# ICE-STEM 2020

## Proceedings of the 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics

https://proceedings.uhamka.ac.id/index.php/ie

Manage by:
Mathematic Education
Physical Education
Biology Education

Universitas Muhammadiyah Prof. DR. HAMKA, Indonesia
Jakarta, 23 September 2020

Uhamka
UNIVERSITAS MUHAMMADIYAH PROF. DR. HAMKA

## Preface

This book contains the proceedings of the 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (2nd ICE-STEM 2020) where held on 23 September 2020 in Jakarta, Indonesia. The conferences organized respectively by Mathematics education, Biology education, and Physical Education, Faculty of Teacher Training and Education, Universitas Muhammadiyah Prof. DR. HAMKA. The papers from these conferences collected in a proceedings book entitled: Proceedings of 2nd ICE-STEM 2020.

In publishing process, ICE-STEM were collaboration conference presents three plenary and invited speakers from Malaysia, Thailand, and Indonesia. Besides speaker, around 52 researchers covering lecturers, teachers, participants and students have attended in this conference. The ICE-STEM meeting is expected to yield fruitful result from discussion on various issues dealing with challenges we face in this Industrial Revolution (RI) 4.0. The purpose of ICE-STEM is to bring together professionals, academics and students who are interested in the advancement of research and practical applications of science, technology, engineering, and mathematics. To succeed in this new information-based and highly technological society, developing proficiency in these subjects is inevitable consequence.

The presentation of such conference covering multi disciplines will contribute a lot of inspiring inputs and new knowledge on current trending about: Mathematical Sciences, Mathematics Education, Physical Sciences, Physics Education, Biological Sciences, Biology Education, Chemical Sciences, Chemistry Education, and Computer Sciences. Thus, this will contribute to the next young generation researches to produce innovative research findings. Hopely that the scientific attitude and skills thruough research will promote Unimed to be a well-known university which persist to be developed and excelled.

Finally, we would like to express greatest thankful to all colleagues in the steering committee for cooperation in administering and arranging the conference. Hopefully these seminar and conference will be continued in the coming years with many more insight articles from inspiring research. We would also like to thank the invited speakers for their invaluable contribution and for sharing their vision in their talks. We hope to meet you again for the next conference of ICE-STEM.

**Editor**

**Scientific Committee**
**Dr. Sigid Edy Purwanto, M.Pd.** Universitas Muhammadiyah Prof. DR. HAMKA, Indonesia

**Conference Co-Chair**
**Dr. Acep Kusdiwelirawan M.Si.** Universitas Muhammadiyah Prof. DR. HAMKA, Indonesia

**Publication Chair**
**Susilo, M.Si.,** Universitas Muhammadiyah Prof. DR. HAMKA, Indonesia
**Syafika Ulfah, M.Sc.,** Universitas Muhammadiyah Prof. DR. HAMKA, Indonesia
**Liszulfah Roza, M.I.S.,** Universitas Muhammadiyah Prof. DR. HAMKA, Indonesia

**Steering Committee**
**Dr. Susanti Murwitaningsih, M.Pd.,** Universitas Muhammadiyah Prof. DR. HAMKA, Indonesia
**Meyta Dwi Kurniasih, M.Pd.,** Universitas Muhammadiyah Prof. DR. HAMKA, Indonesia
**Husnin Nahry Yarza, M.Si.,** Universitas Muhammadiyah Prof. DR. HAMKA, Indonesia
**Dr. Gufron Amirullah, M.Pd.,** Universitas Muhammadiyah Prof. DR. HAMKA, Indonesia
**Trisna Roy Pradipta, M.P.Mat.,** Universitas Muhammadiyah Prof. DR. HAMKA, Indonesia
**Dr. Slamet Soro, M.Pd.,** Universitas Muhammadiyah Prof. DR. HAMKA, Indonesia
**Subhan Ajiz Awaludin, M.Sc**., Universitas Muhammadiyah Prof. DR. HAMKA, Indonesia

**Internastional Scientific Committee / Reviewers**
**Dr. Sigid Edy Purwanto, M.Pd,** Universitas Muhammadiyah Prof. DR. Hamka, Indonesia
**Dr. Liszulfah Roza, M.I.S.,** Universitas Muhammadiyah Prof. DR. Hamka, Indonesia
**Dr. Yoppy Wahyu Purnomo, M.Pd.,** Universitas Negeri Yogyakarta, Indonesia
**Tian Abdul Aziz, Ph.D.** Universitas Negeri Jakarta, Indonesia
**Krisna Satrio Perbowo, M.Pd.** University of Warwick, United Kingdom
**Dr. Ervin Azhar, S.Si. M.Si.,** Universitas Muhammadiyah Prof. DR. Hamka, Indonesia
**Susilo, M.Si.,** Universitas Muhammadiyah Prof. DR. Hamka, Indonesia
**Dr. Budi Akbar, M.Si.,** Universitas Muhammadiyah Prof. DR. Hamka, Indonesia
**Harry Ramza, MT., Ph.D.,** Universitas Muhammadiyah Prof. DR. Hamka, Indonesia
**Dr. Dahlan Abdullah, ST, M.Kom, IPU.,** ASEAN Eng Universitas Malikussaleh, Indonesia
**Prof. Dr. Suyono, M.Si.,** Universitas Negeri Jakarta, Indonesia
**Dr.rer.nat. Andri Hutari, M.Sc.,** Universitas Negeri Jakarta, Indonesia
**Dr. Goib Wiranto,** LIPI, Indonesia
**Dr. Dan Mugisidi, M.T**., Universitas Negeri Jakarta, Indonesia
**Prof. Dr. Terry Mart.,** Universitas Indonesia, Indonesia

Theme: STEM Education for the Indrustrial Revolution 4.0
The Topics ICE-STEM 2020 included to the following topics:
1. Mathematical Sciences
2. Mathematics Education
3. Physical Sciences
4. Physics Education
5. Biological Sciences
6. Biology Education
7. Chemical Sciences
8. Chemistry Education
9. Computer Sciences
10. Environmental and Earth science

**DAFTAR ISI** **Hal**

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

# Loops All the Way Down – How Incorporating Feedback Loops into Our Teaching Perspective Can Elevate Math Pedagogy

**Christopher Yu[1]**

[1]Drexel University
3141 Chestnut St, Philadelphia, PA 19104, United States

*Correspondence email: yu.chris@gmail.com

## ABSTRACT

This paper analyzes secondary math student behavioral patterns from the lens of a systems theorist. Using the concept of feedback loops, we can see why some students fall into detrimental patterns that lead to low achievement in mathematics. Also, the author will relate his experience with Thinking Classroom Methodology, work by the professor Peter Liljedahl, and how it improves math pedagogy also through the lens of feedback loops.

**Keywords:** Secondary math education, self-regulated learning (srl), feedback loops, thinking classroom, vertical non-permanent surfaces (vnps)

## INTRODUCTION

Students are always learning, but not always what we expect them to learn.

Primum non nocere – Hippocratic Oath (First do no harm!)

What started a journey that led to this article was a series of conversations with a colleague while teaching secondary students STEM subjects. During those conversations, we pondered on the fact that some students acquired a deep dislike for math and science subjects even before they have reached our classrooms. Could it be that schooling could be harmful? Educators don't take the Hippocratic Oath like medical doctors, but maybe educators need a similar code of ethics. This missing code of ethics should state that we fail as educators when students leave school with a dislike for learning. In a review of the literature surrounding motivation patterns in mathematics, Middleton [1] stated that "[it is] particularly distressing, that students learn to dislike mathematics and that this dislike becomes an integral part of their mathematical self-concept."

The issue of reduced and meagre motivation of students in STEM is a deep and complex issue that this article only scratches the surface. In the significant paper from the Chicago Consortium [2], have put together a framework with academic mindsets as the top category of non-cognitive factors that lead to student achievement. The work of Dweck, Boaler, Duckworth and many others have elevated the importance of non-cognitive factors like grit, motivation, and mindset in the minds of educators. This paper examines a small piece of the puzzle, by looking at the issue from a systems perspective. Two common behavioral patterns in the mathematics classroom will be examined using a concept taken from Complex Systems, namely feedback loops. In the first behavioral pattern, the feedback loop will be used to postulate how students become disengaged in their own learning process. The second behavioral pattern will examine the opposite of lowly motivated students, which are self-regulated learners. From examining those two patterns, the role of teachers as a causal agent in dampening student motivation can be theorized. Finally, some ideas will be suggested to improve the feedback loop patterns, with a focus on the exciting and promising impact of using Thinking Classrooms methodology created by Liljedahl.

## RESULTS AND DISCUSSION

*Our World is Built on Feedback Loops*

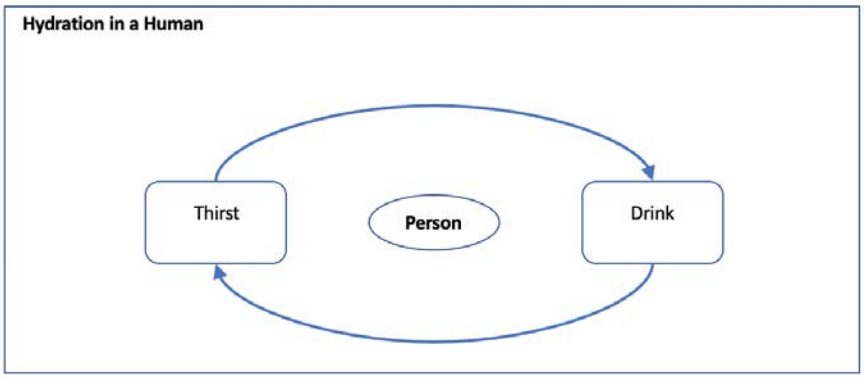



**Figure 1.** A simplified diagram of a feedback loop that shows body water homeostasis

What exactly is a feedback loop? Let's start with a system. A system is "an interconnected set of elements that is coherently organized in a way that achieves something" [3]. Almost everything can be described as a system, ranging from very complex with many parts, like governments, ecosystems, or circulatory systems in an organism, or very simple with only a few parts, like a person, his thirst, and a glass of water. Systems have three major components which are the elements, interconnectedness and a function or purpose. If we look at how systems are interconnected, the connections between the elements will eventually form loops. One way to see feedback loops is through a chain of cause and effects. Here's an example of a balanced feedback loop. See Figure 1. Over time, as a person loses water, his thirst increases. This causes him to seek out drinks. As he imbibes some drinks, his thirst is satiated. The body is the system and homeostasis is its goal. Without feedback loops, the body cannot operate. Feedback loops could also be reinforcing or dampening. For a reinforcing feedback loop, think of a microphone pointed to a speaker. Ouch! For a dampening loop, think of what happens when a company has a culture of shooting the messenger. Everyone is afraid to speak up. See [3] for a good primer on systems.

Feedback loops are neither good nor bad, but are powerful in ways that can shape institutional culture. It can lead to ingrained beliefs and habits, and sometimes feedback loops make culture and habits resistant to change. Before my discussion of the two common patterns that are observed in the context of a math classroom, a short digression on the use of the term feedback in the education literature.

The term feedback, as espoused in educational research and literature, is commonly acknowledged to be essential to learning. Hattie [4] has stated in his meta-study of what works in education that "feedback is a common feature of successful teaching" and that feedback can be "…provided in many ways" [4] [4]. In other literature, feedback is synonymous with formative assessment [5], or comparing the effects of grades versus written comments [6], or feedback is described in terms of what teachers can do [7]. In most cases, the term feedback is used in a narrow way that doesn't take into account the holistic nature of feedback loops. Another problem is that the notion that feedback is something done to students. Obviously, many books and articles are written for teachers, so notions of feedback are framed from the teacher's perspective and the advice prescribes 'teacher moves' in the classroom. See Hattie [8] for a good overview of feedback as used in the math classroom.

Can this narrow view of feedback be camouflaging a pattern of feedback that is demotivating students?

*The Case of the in-Curious Learner*

As educators, we've all encountered a special species of students that seem to proliferate as fast as weeds. Students in this archetype have some of these characteristics. They are solely interested in the grade and not any learning that is attached to that grade. If an assignment is not graded, they will not do it. They choose to copy their friends' work instead of doing the work themselves. When they are caught cheating on a test, they are mad at the teacher for ruining their reputation as a student. If they

are honest, when you suggest them to do extra practice to improve their skills, they scoff and say sarcastically, “Like I would do math in my free time.”

Is there anything wrong with these students? Some educators might be inclined to blame the students, but can you see yourself in the students’ shoes? Could it be that the school systems have trained them to act in that way? Here is an example of a typical pattern in math class. See Figure 2.

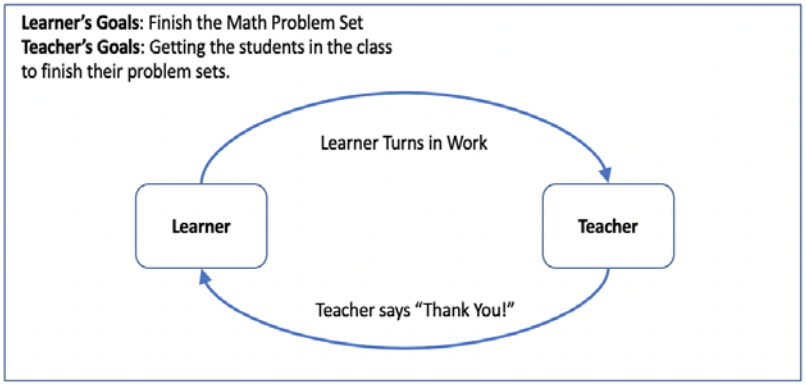



**Figure 2.** A typical feedback loop that students go through on a regular basis

This pattern might be very common and maybe teachers who are in this pattern don’t sense the danger. From the perspective of the learner, it also looks perfectly fine. The learner is perfectly happy. By completing the loop and receiving closure by the teacher, the student feels finished, done, satisfied. That’s how the psychology of open loops work in the mind. Open loops, which are processes not yet completed, cause tension in the mind of a person; our natural tendency is to want to close the loop. This is well known by entertainers and storytellers. That’s why writers use cliffhangers to keep the audience coming back for the next installment. That’s why hypnotists use open loops to embed suggestions. That’s why comedians use callbacks to enhance the laughter. That’s why the person with OCD, must check all the locks before he goes to sleep.

Therefore, it feels very natural to be in a pattern like Figure 2. The student feels accomplished by completing an assignment and turning it in, hearing the teacher acknowledge their work, and also the teacher feels accomplished that the students are working. However, this pattern that gets repeated over and over again, is training the student that his goal is to turn something in, his goal is to satisfy the teacher. What’s missing is the learning. The goal of learning has been replaced by the goal of finishing. What’s missing is the quality of the work. Of course the teacher might ask for revisions the next day, but in the mind of the student, it’s over. Another important problem with this loop is that the student doesn’t have full agency over their work. It becomes the teacher’s prerogative whether to accept the student’s work as acceptable. Rather than guiding students to because more skillful mathematicians, teachers are taking away students’ capacity to determine the value in their own work. With math, students often turn in work with easily identifiable errors that could be fixed with simple checking, or they have the answer key in the back of a textbook that they could use to verify their work. So, over the years as this pattern in Figure 2 repeats itself this lack of learning will catch up to the student when they move on to a higher level math class. As this pattern continues over the years, a dependency on teachers leads to helplessness, lack of confidence and uneasiness. Students enjoyment and interest in a topic comes from their belief in their ability to learn [1]. By taking away this ability, no wonder so many students develop an intense dislike of mathematics. The end result is the in-curious learner.

*Self-Regulated Learners, the Holy Grail of Students*

For more than thirty year, researchers in the field of educational psychology, have studied students who they call self-regulated learners [9]. Self-regulated learners ultimately have control over their own learning. They set their own goals and determine their strategies and methods to reach those goals. They seek feedback to understand if they are successful. Finally they reflect on what they did. A few different models of Self-Regulated Learning (SRL) exist, but they all clearly demonstrate: that learners guided by strong motivation strategies and beliefs, that learners who take control of their learning and behavior, and that learners who plan and reflect, are very successful in the academic world [10]. As

educators, or to anyone who has spent time trying to motivate young students, the success of self-regulated learners seems like an obvious conclusion. Let's examine the feedback loop of a self-regulated mathematics student. See figure 3.

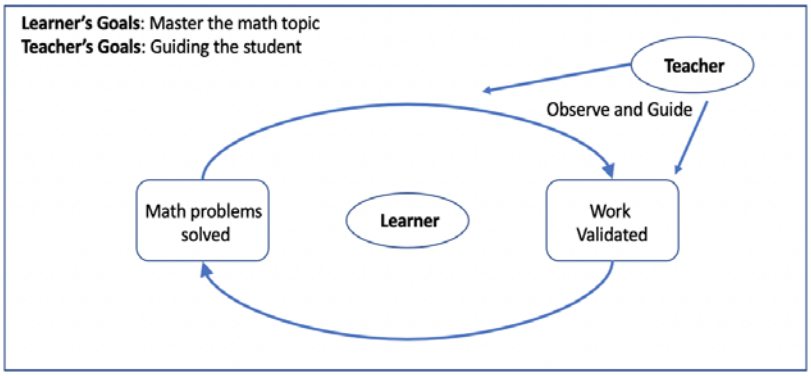



**Figure 3.** The learner at the center of her learning.

A student at the center of their own learning becomes a competent student; the student has authority, taking advantage of different methods of validating their own work while the teacher is on the outside guiding and observing. Some examples are students that takes out their calculators to check their work after their finished, or students that take advantage of the answers listed in the back of a textbook, or students discuss their work with a friend, or the student that uses estimation and other strategies to verify their own work. Also the model in Figure 3 can be used to analyze a student's behavioral patterns on a range of different time resolutions, whether working to excel in class, prepare for the AP test which has a time scale of months, or we can zoom in to a calculation that a student can verify with a calculator that happens over the course of a minute. If we continue to examine a self-regulated mathematics student working through problem after problem in the course of a day, every successful loop becomes reinforcing, building confidence, skill and enjoyment with math. Comparing this to the in-curious learner, every problem leads in the other direction where every loop is taking away from the students' confidence and enjoyment.

7+1 Suggestions for Teachers

Here are some ideas to try to move the model of learning in our classrooms to one of independence and self-regulation. Any lack of credit given to the sources is solely the author's defect.

1. Plan for activities that students can verify their own answers without the teacher. One example is Marcy Cook Tile Math. The students have numbered tiles from 0-9 that they use on a worksheet, where each worksheet is designed to use each tile once. That way it's easy for the students to recognize when they are correct and when they have made a mistake.

2. For students that forget to check and verify their work before they turn it in. Place an 'X' on the ground that students pass by on their way to turn in a paper. This 'X' is used as a visual cue for students to check their work. Teach the students that when they should stop on the 'X' before they turn in their papers, and then ask themselves if they have checked all their work.

3. Create incentives for students to check their work, or disincentives to turn in work quickly. Example of an incentive, on a math test, include a box where they get a bonus point for checking their answers. Example of a disincentive, in a English class, students who turn in their work (writing a paragraph) must rewrite the whole paragraph if they forget their punctuation.

4. Always convey the message that it's not about the answer, but the logic of getting to the answer. For example, James Tanton, a mathematician, shared that he supplied answers, even on quizzes to bring home the message that it's not about getting an answer.

5. While we are interacting with students and they often ask if their answer is correct, we can turn the question back and ask them how they can know if the answer is correct. Show the students how to

verify, how to check with a different method, and how to use estimation to gauge if the answer makes sense.

6. The author has only tried this with his own daughter, not with any student in class. It seems to have worked. When the daughter asked for help on a math question, the author waved his hands over her head and hummed off-key saying that he transfers energy into her brain. It seems to have worked. The daughter asks for help on her math homework maybe once every few years.

7. Incorporate a few ideas from Use Thinking Classrooms, developed by Professor Liljedahl. This will be elaborated in the next section.

8. Ask yourself, are you having fun?

What is Special about Thinking Classrooms

There's a similar journey that some math educators go on. The first is the thought, "Hey, I'm pretty good at math, teaching math must not be too hard." Then that initial optimism is shattered as they realize that it's much harder to teach mathematics than they thought. The next stage of the journey involves going on the path of self-improvement, and learning from our elders. Along this path, we come across many different schools of thought, many different methodologies. Some of these may be familiar to you: Japanese Lesson Study, Five Practices, Notice/Wonder, Singapore Math, 3 Act Math, and many more. What is rare is a methodology with results that are immediately noticeable.

Over more than a decade, Professor Liljedahl has been studying the factors that go into a classroom that he defines as thinking versus non-thinking [11]. Classrooms where students are engaged, working together, and learning. Through his research, he has put together a prescriptive framework of fourteen different methods that push a class towards thinking versus non-thinking. In this article, only one method of the fourteen, using Vertical Non-Permanent Surfaces (VNPS) will be analyzed by a feedback loop.

Using Vertical Non-Permanent Surfaces (VNPS) means to have the students work standing up on whiteboards, blackboards, windows, or whatever surfaces that are erasable [12]. The benefits are: students are more active while standing, and students are more willing to take risks with erasable surfaces. The most important benefit, in the perspective of the author, is that it helps the teacher in monitoring the students. Delays have a great impact on feedback loops. When students, mostly in-curious, are working in a typical classroom on horizontal desks, the delay is longer because the teacher must work much harder to monitor what the students work. Errors in their work, and errors in their logic can proliferate until a typical cycle of collecting work, correcting and returning to students. Even with an exit ticket, the teacher can only notice and respond during the next class. Also if we wait to respond in another class, as we have discussed before, students have already moved on because in his mind, once his work is turned in, he is done. On the other hand, monitoring students around a classroom working on VNPS, is quick, immediate and easy. The teacher can quickly glance across the room and see who is engaged and who is not. It is much harder to hide. The teacher can also quickly see how the students are tackling the problem and what sort of obstacles they are having. An excellent practice for math teachers is to anticipate errors that students might make, but if a teacher is new to a school district or new to a grade level, sometimes anticipating is extremely hard. This helps teachers monitor for student misconceptions that the teacher didn't anticipate.

## CONCLUSIONS

There are three goals of this paper. One is to raise awareness that school systems and teachers even with good intentions could be harming students, evidence can be seen when students learn to dislike a subject. The second goal is to encourage more research in what factors create more in-curious learners so we know what we need to stop and more research on how to move students from being in-curious to self-regulated. Finally, the last goal is to endorse and spread the news of Professor Liljedahl's work in Thinking Classrooms.

Let's take a step back and look at the structures in place in our classrooms and schools, and always be asking if there's a better way.

## REFERENCES

[1] Middleton, J. A. and Spanias, P. A, "Motivation for achievement in mathematics: Findings, generalizations, and criticisms of the research', *Journal for Research in Mathematics Education,* vol. 30, no. 1, pp. 65–88, 1999, doi: 10.2307/749630.
[2] Farrington, C. A. et al. () "Teaching Adolescents To Become Learners". *The Role of Non Cognitive Factors in Shaping School Performance: A Critical Literature Review*, pp. 1–108, June, 2012.
[3] Meadows, *D, Thinking in Systems: A Primer*. London, UK: Earthscan, 2008.
[4] Hattie, J., *Visible Learning for Teachers*. New York: Routledge, 2012.
[5] Santos, Leonor & Pinto, Leão, Lights and shadows of feedback in mathematics learning. *Proceedings of the 33rd Conference of International Group for the Psychology of Mathematics Education*, vol. 5, pp. 49-56, 2009.
[6] Wiliam, D. "Formative Assessment in Mathematics Part 2: Feedback", *Mathematics and Special Educational Needs*, vol. 5, no. 3, pp. 8–11, 1999.
[7] Wiggins, G., "Seven Keys to Effective Feedback", *Educational Leadership*, pp. 10–16, 2012.
[8] Hattie, J., "Visible Learning Mathematics, grades K-12: what works best to optimize student learning", *Corwin Mathematics*, California, 2017.
[9] Panadero, E., "A review of self-regulated learning: Six models and four directions for research", *Frontiers in Psychology*, vol. 8, pp. 1–28, April, 2017, doi: 10.3389/fpsyg.2017.00422.
[10] Butler, D. L. and Winne, P. H., "Feedback and Self-Regulated Learning: A Theoretical Synthesis", *Review of Educational Research*, vol. 65, no. 3, pp. 245–281, 1995, doi: 10.3102/00346543065003245.
[11] Liljedahl, P., "Building Thinking Classrooms: Conditions for Problem Solving", *Posing and Solving Mathematical Problems,* October, 2016, doi: 10.1007/978-3-319-28023-3.
[12] Liljedahl, P., "Conditions for Supporting Problem Solving: Vertical Non-permanent Surfaces in Mathematical Problem Solving, pp. 289–310, 2019, doi: 10.2307/2686811.

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

# Profile of science process skills of class x high school students in Sragen district based on the teaching experience of teachers

**Hidayah Ina Qodriyani[1]*, Suyitno Aloysius[1] and Slamet Suyanto[1]**

[1]Postgraduate Biology Education, Yogyakarta State University
Colombo Yogyakarta Street, No.1, Special Region Yogyakarta, 55281, Indonesia

*Correspondence email: hidayah.ina1209@gmail.com

## ABSTRACT

The research aimed to determine the profile of science process skills, to know mastery aspects of science process skills, and to know profile of science process skills in terms of the teaching experience of teachers. This research was a descriptive qualitative survey method research. The research population was grade X students from six high schools in Sragen Regency, Central Java Province. The sample was 198 students and 6 biology teachers. Data collection on science process skills with confirmatory tests and teacher interviews. The results show that science process skills in Sragen Regency are in the moderate category with an average of 19.22 out of a total score of 32, the highest mastery of aspects science process skills are communicating and predicting, while the lowest aspects are identifying variables, collecting and processing data. There is a relationship between the profile of science process skills in Sragen Regency with teaching experience.

**Keywords:** Profile of science process skills, teaching experience, teachers

## INTRODUCTION

The demands and challenges that exist in the 21st century have an impact on changes in learning patterns that exist in education in Indonesia. Education must be able to develop competent human resources who have competitiveness. There are six competencies to face the challenges of the 21st century that must be developed through education, namely the ability to think critically and solve problems, the ability to communicate and work together, the ability to create and renew, the literacy of information and communication technology, the ability to learn contextually and the ability of information and media literacy [1].

Education in Indonesia has not reached the six competencies of the 21st century optimally. This is proven by the results of the 2018 PISA survey and the 2015 TIMSS. According to the results of the 2018 PISA survey, students' scientific ability in Indonesia only has a score of 396 and is ranked 69th out of 71 countries surveyed by PISA. Meanwhile, according to the 2015 TIMSS survey results which showed the achievements of Indonesian science earned a score of 397. Indonesia ranked 36th out of 39 countries surveyed by TIMSS. This means that on average Indonesian students in the field of science are only able to recognize some fundamentals of science but have not been able to apply complex and abstract concepts, and the ability to think of high-level Indonesian students is still low.

Science, including biology, is one that has a significant role and opportunity to prepare qualified and competent human resources. Biology is not only characterized by a collection of knowledge in the form of facts, concepts, or principles, but also is characterized by the existence of scientific methods, scientific work, values, and scientific attitudes [2]. The scientific processes involved in learning biology are known as science process skills. Science process skills are scientific skills that allow students to discover new concepts themselves. The science process skills are needed by students because they can develop students' thinking abilities and creativity in learning. Besides, students will actively develop and apply their abilities to solve problems according to their capacity and level of thought development [3].

Science process skills are divided into two, namely basic science process skills which include the ability to observe, predict, conclude, group, communicate, and take measurements. While integrated science process skills include identifying variables, making hypotheses, analyzing investigations, making data tabulations, identifying variables, planning and conducting investigations [4].

The implementation of learning science process skills is inseparable from the role of the teacher who is a learning planner and implementer in schools. The teacher is one of the main factors determining the success of science process skills possessed by students. Through teachers, science process skills are introduced and developed by students in biology learning [5]. Based on the results of research [6] shows that the longer the teacher teaches the more professionalism and teaching ability increases. These factors are assumed to be influential in teachers implementing science process skills-based learning.

Teachers can improve their skills in carrying out science process skills-based learning through participation in training, discussions, seminars, research, certification, and participation in MGMP activities. The activity gives teachers knowledge of how learning and assessment of science process skills should be taught to students so that students master science process skills.

This study aims to analyze the mastery of class X science process skills reviewed based on the teaching experience of teachers. The teacher is a planner for learning activities based on science process skills for students. Class X is the first-class level in senior high education so that information on science process skills in class X is very important as an evaluation material.

This research is important because so far it has not been known with certainty the science process skills of high school students in Sragen District. In addition to describing the science process capability profile of the students, they also analyzed the relationship between the teaching experience of teachers variable and the profile of the science process skills of class X students. The results of this study are expected to be the main information for the Education Office in Sragen District to prepare students for the 21st century.

## RESEARCH METHOD

This research uses quantitative descriptive methods using survey methods. This research was conducted in six high schools in Sragen District which were selected based on the teaching experience of class X teachers, namely SMA N 1 Sragen, SMA N 2 Sragen, SMA N 3 Sragen, SMAN 1 Gondang, SMA N 1 Plupuh, SMAN 1 Gemolong. The population of this study was students of class X in six high schools in Sragen District and six class X teachers selected. Student and teacher research samples were taken by cluster sampling technique with a total sample of 198 class X students and 6 biology teachers.

Data collection techniques in the form of test and non-test instruments. The test instrument was in the form of a confirmatory test of science process skills on biology as many as 32 questions given to class X students and non-test instruments in the form of an interview sheet and questionnaire to find out the teacher's teaching experience given to class X teachers.

The data analysis technique used to determine the value of the mastery of science process skills is to analyze the answer data by manually checking. If the correct answer gets a score of 1 and if the wrong answer is given a score of 0. The maximum score obtained is 32 while the minimum score is 0. The score data obtained is then average and is used to analyze the profile of the whole sample with categories [7].

**Table 1.** Science process skill profile categories

| Categories | Science process skill scores |
|---|---|
| Low | 0 – 10.66 |
| Medium | 10.67 – 21.33 |
| High | 21.34 - 32 |

This category is useful for interpreting the level of mastery of students' science process skills. While the percentage of mastery of science process skills is calculated by the calculation formula [8].

NP = $^{R}/_{SM}$ x 100%

Information:
NP = percentage value of science process skill mastery in every aspect
R = true total score of every aspect
SM = maximum score on every aspect of science process skills

The percentage of values obtained by students for each aspect of science process skills is grouped into criteria [8].

**Table 2.** Criteria for mastery of each aspect of science process skills

| Percentage (%) | Criteria |
|---|---|
| 86 – 100 | Very high |
| 76 – 85 | High |
| 60 – 75 | Medium |
| 55 – 59 | Low |
| ≤ 54 | Very low |

The results of science process skills scores were analyzed descriptive statistics to get the average score, standard deviation, lowest score, highest score, and the number of samples in each rombel (study group), especially to see trends and the distribution of science process skills profiles in general. The relation of teachers' teaching experience can be known by comparing the results of the average score of science process skills obtained by students reviewed based on the teaching experience of biology teachers in class X high school.

## RESULTS AND DISCUSSION

The results of this study describe the field conditions empirically through quantitative data in the form of written test results. Data on the measurement results of the science process skills of students in SMA Sragen District in table 3.

**Table 3.** Results of science process skills test for class X students in Sragen District.

| Codes | Schools | N | $\bar{y} \pm s$ | Max | Min | Categories |
|---|---|---|---|---|---|---|
| A | SMAN 1 Sragen | 32 | 23,62 ± 3,20 | 30 | 18 | High |
| B | SMAN 2 Sragen | 32 | 21,90 ± 2,57 | 26 | 16 | High |
| C | SMAN 3 Sragen | 34 | 15,20 ± 2,18 | 18 | 11 | Medium |
| D | SMAN 1 Gondang | 36 | 17,81 ± 2,81 | 20 | 14 | Medium |
| E | SMAN 1 Plupuh | 30 | 15,43 ± 1,89 | 18 | 12 | Medium |
| F | SMAN 1 Gemolong | 34 | 21,38 ± 1,81 | 24 | 16 | High |
| | Total | 198 | 19,22 ± 2,41 | 30 | 11 | Medium |

Information:
N = number of students taking the test
Min = lowest score
Max = highest score
$\bar{y}$ = average score
s = standard deviation

Table 3 explains the profile of class X science process skills in Sragen District high school which is classified as medium, shown by the average score of 19.22 from a total score of 32. Students who score 30 indicate students have high science process skills, meaning that students have mastered the process skills science, while students who score 11 show that students have moderate science process skills, meaning that students have enough mastery of science process skills. This means that learning biology can develop science process skills in class X students but is not optimal and evenly distributed because there is a difference between the highest and lowest scores which is quite far i.e. 19. The standard deviation obtained by 2.41 indicates that the general profile of science process skills in Sragen District High School is quite varied, seen in SMA A has a higher standard deviation than other high schools, this means students in SMA A have more mastery of science process skills than students from other schools. The ability of high school students' science process skills should be already high, considering that according [9] based on Piaget's theory high school students are at the formal operational stage. This means students can think abstractly in developing ideas and thoughts to solve biological problems. But the fact that the varied scores in several high schools in Sragen District show the uneven level of students' ability in science process skills. According to [10], science process skills are still less than optimal for students, one of which is caused by teachers who teach more concepts in the learning process through the transfer of knowledge and examples that students tend to memorize so students cannot develop their science process skills with maximum.
The results of research on the percentage of mastery of aspects of science process skills in class X SMA Sragen District are in table 4.

**Table 4.** Percentage of mastery of various aspects of science process skills in class X high school students of Sragen District.

| Codes | Aspects | Percentage of mastery (%) | Categories |
|---|---|---|---|
| A. | Observing | 76 | High |
| B. | Communicating | 83 | High |
| C. | Classifying | 62 | Medium |
| D. | Measuring | 76 | High |
| E. | Concluding | 48 | Very low |
| F. | Predicting | 78 | High |
| G. | Identifying variables | 43 | Very low |
| H. | Making a table | 63 | Medium |
| I. | Making a chart | 63 | Medium |
| J. | Describing between variables | 76 | High |
| K. | Collecting and processing data | 40 | Very low |
| L. | Analyzing research results | 54 | Very low |
| M. | Constructing a hypothesis | 52 | Very low |
| N. | Establishing operational variables | 76 | High |
| O. | Arranging experiments | 68 | Medium |
| P. | Carrying out an experiment | 52 | Very low |

Information
Very high = very good at mastering science process skills
High = good at mastering science process skills
Medium = enough to master the science process skills
Low = lack of knowledge of science process skills
Very low = very little knowledge of science process skills

Based on table 4 the highest mastery of science process skills is the communication aspect 83%, and the prediction is 78%. This proves students master the science process skills well in communicating and predicting aspects. In the communicating aspect, following the results of the biology teacher interview that the learning process in the classroom uses more discussion and presentation methods. According [11], the discussion method makes students creative, active and skilled both in thinking and skilled in gaining knowledge. Based on this the teacher's habit of using the discussion method can develop students' communication skills. While predicting skills are skills in predicting the results to be obtained in an experiment. This proves that teachers do quite often do practical activities so that students' ability to predict is good.

Very low mastery of science process skills is an aspect of identifying the 43% variable, gathering and processing 40% data. This proves that students are very lacking in science process skills in aspects of identifying variables, collecting and processing data. The aspect of identifying variables is still low due to the lack of recognition and training to distinguish variables by teachers. Based on the results of the interview the practicum activities are already equipped with practical manuals made by the teacher, and students just do the practicum according to the guidelines of the book, so the ability to distinguish variables is still less than optimal. Meanwhile, the skills to collect and process data are still very lacking because in practicum activities students are accustomed to groups so that they tend to only rely on other group members to collect or process data, so these skills are less than optimal. The difference in teacher teaching experience to the ability of science process skills is shown in table 5.

**Table 5.** Profile of science process skills in class X SMA Sragen District based on teachers' teaching experience

| Codes | Schools | Teaching Experience | N | $\bar{y} \pm s$ | Max | Min | Categories |
|---|---|---|---|---|---|---|---|
| A | SMAN 1 Sragen | 28 | 32 | 23,62 ± 3,20 | 30 | 18 | High |
| B | SMAN 2 Sragen | 24 | 32 | 21,90 ± 2,57 | 26 | 16 | High |
| F | SMAN 1 Gemolong | 21 | 34 | 21,38 ± 1,81 | 24 | 16 | High |
| C | SMAN 3 Sragen | 17 | 34 | 15,20 ± 2,18 | 18 | 11 | Medium |
| E | SMAN 1 Plupuh | 9 | 30 | 15,43 ± 1,89 | 18 | 12 | Medium |
| D | SMAN 1 Gondang | 5 | 36 | 17,81 ± 2,81 | 20 | 14 | Medium |

Information:
N = number of students taking the test
Min = lowest score
Max = highest score

ȳ = average score
s = standard deviation

Table 5 shows that teachers who have taught more than 20 years, namely SMA A, B, F, have high science process skills in their students, whereas teachers who have less than 20 years of teaching namely SMA C, E, D have high science process skills. Is on the students. The longer the teacher teaches the more frequent activities in the form of training, and MGMP and the more experience they have so that it also has an impact on the learning process in the classroom. According to [12], the process of learning biology is a system whose components cannot be separated namely raw input (students), instrumental input (curriculum, teacher, learning resources, media, methods, learning infrastructure), environmental (environment) and output (output results).

## CONCLUSIONS

Based on the results of research on "Profile of Science Process Skills of Class X High School Students in Sragen District Based on The Teaching Experience of Teachers" it can be concluded that the science learning process of high school grade X students in Sragen District was in the moderate category with an average value of 19.22 out of a total score of 32, mastery aspects of the science process fields on the subject of the highest level of high school class X students in Sragen is communicating and predicting. The lowest aspects are identifying variables, acquiring and processing data, there is found the relationship between the profile of science process skills with the teaching experience of biology teachers.

## REFERENCES

[1] Wahyuni, *Peningkatan Kompetensi Guru Menuju Era Revolusi Industri 4.0*, Jakarta: Rajawali Press, pp. 13-18, 2018.
[2] Puskur, *Kajian Kebijakan Kurikulum Keterampilan*, Dekdikbud, pp. 25-26, 2007.
[3] Ongowo & Indoshi, *Science Process Skills in the Kenya Certificate of Secondary Education Biology Practical Examinations Creative Education,* pp. 713–717, 2013.
[4] Rezba 2007 Science Process Skills (United States, Kendall/Hunt Publishing Company) pp 76-80
[5] Kusnandar, *Guru Profesionaln*, Jakarta: Rajawali Press, p. 78, 2011.
[6] Sa'diyyah, Milatus, Kemampuan Berpikir Divergen dalam Keterampilan Proses Sains Peserta Didik SMA Negeri di Kabupaten Kulon Progo pada Mata Pelajaran Biologi Ditinjau Berdasarkan Latar Belakang Pendidikan Guru, *Jurnal Pendidikan Biologi UNY*, pp. 4-5, 2016.
[7] Sudjana, *Dasar-Dasar Proses Belajar Mengajar*, Bandung: Sinar Baru Algensindo, p. 30, 2005.
[8] Purwanto, *Prinsip-prinsip dan Teknik Evaluasi Pengajaran*, Bandung: PT Remaja Rosdakarya, p. 24, 2002.
[9] Sund & Trowbridge, *Teaching Science by Inquiry in the Secondary School 2*, Columbus: Merrill Publishing Company, pp. 78-83, 1973.
[10] Juhji, Peningkatan Keterampilan Proses Sains Siswa Melalui Pendekatan Inkuiri Terbimbing *Jurnal Penelitian dan Pembelajaran IPA,* vol. 2 pp. 58-60, 2016.
[11] Segala, *Konsep dan Makna Pembelajraan*, Bandung: Alfabeta, p. 41, 2010.
[12] Suhardi, *Pengembangan Sumber Belajar Biologi*, Yogyakarta: UNY Press, p. 56, 2013.

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

# Analysis User Interface: Development of E-Fotonovela for Deaf Students

**Imas Ratna Ermawati[1*], Aisyah Fitriana[1] and Andita[1]**

[1]University of Muhammadiyah Prof. Dr. Hamka, Tanah Merdeka Street, Kp.Rambutan, Pasar Rebo, East Jakarta, 13830, Indonesia

*Correspondence email: imas_re@uhamka.ac.id

## ABSTRACT

This research deals with the use of development applications using mobile devices as tools for mixed learning models. However, in developing learning applications, one important concern is the user interface (UI). Therefore, the purpose of this research is to find out which UI design components are easy to use and according to the user to be more user friendly, so that the purpose of using mobile applications for education can be realized. This study covers design principles that are appropriate for applications developed for platforms. Based on research, user interface testing has been carried out from 5 user interface principles and analysis using the System Usage Scale (SUS) given to 12 respondents. The results showed that the majority of respondents agreed that the mobile application developed had met the requirements of the user interface element.

**Keywords:** E-Fotonovela, deaf, mobile devices

## INTRODUCTION

Efforts to improve the quality of education are always carried out in order to face the process of globalization and face the development of science and technology which are increasingly complex and greatly affect the joints of life. Learning is one component in education. In the learning process involves the interaction between educators and students. Success in the learning process depends on the creativity of the educator in delivering learning material and on the desire or motivation of students to accept learning.

Multimedia technology has promised great potential in changing the way a person learns, obtains information, adjusts information and so on. Multimedia also provides opportunities for educators to develop learning techniques so as to produce maximum results.

Children who are categorized as children with special needs are children who have mental retardation, learning disabilities or attention disorders, emotional or behavioral disorders, physical barriers, communication, autism, traumatic brain injury, hearing impairment, visual impairment, and children who have special talent [1]. In SLB, deaf children receive the teaching of Natural Sciences (IPA), where physics is one of their knowledge. Physics is one of the branches of science that aims to study and analyze natural phenomena or processes and the nature of substances and their application [2]. The values of character education can be developed, integrated and internalized with students through the learning process, including physics learning [3].

Based on the results of previous research by Farida Ariyani, Taras Nayana, Antomi Saregar, Yuberti, Agitha Pricilia in her research entitled 'Development of Photonovela with Character Education: As An Alternative of Physics Learning Media or Photonovela Development Based on Character Education', stated that the assessment results by material experts got a percentage of 85%, media expert ratings were 90%, and middle school teacher ratings were 84.16%, while the responses from students in three junior high schools were 87.6%, 94%, and 93.6%. In conclusion, the study produced a product in the form of appropriate and appropriate photo media as a medium for learning physics with character education in business and energy material [4].

## Theoritical review

*Learning Media*

Media is important in the teaching and learning process between teachers and students to achieve interactive learning in school. Based on the theories of experts regarding learning media, the media have the same meaning, namely the media as a component of learning resources. Temmy Syamsu Taufiq defines learning media as a single unit, meaning that efforts can be used not only in the learning process but in daily life so that learning programs can be sustained and students' progress in learning will be more quickly achieved [5].

Learning media are included in the learning resource component that contains instructional material in the student environment that motivates students to learn. Tools used as learning resources by students that contain learning materials that can arouse student motivation to learn. Learning media can help the teaching and learning process and function to clarify the meaning of the message conveyed, so that it can achieve learning goals better and perfect [6]

*Fotonovela*

Learning media are classified into several types of media that are used based on needs in the learning process. Fotonovela media is a variety of visual media in the form of images or photos that are put together into books. According to Parlato et al in Ridho Adi Negoro, said that fotonovela has a uniformity with comic and comic that is containing messages that are equipped with pictures and illustrations. Fotonovela uses images with high reality in the form of photographs while comics and comics that use pictures with reality that are lower than fotonovela because it is in the form of abstract images [7].

Djohani et al in Dwi Wahyuni's book stated that fotonovela is a media that resembles comics or picture stories, using photographs instead of illustrated images. Fotonovela is a visual media that has general characteristics, which are easy to make themselves in a simple, inexpensive, in accordance with students' emotional, easy to prepare and use, very practical treatment and themes in this media are lifted from the conditions of students with the intention that students more easily understand it [8]. According to Boyte, et al. in the research of Ruth Koops van Jag t Jagt, et al., stated that the benefits of the visual form of narration, fotonovela, are strategies to reach audiences with low literacy levels. Fotonovela is a small book that portrays a dramatic story with photos and captions, enabling engaging audiences with realistic characters, simple texts, and real photographs [9].

Making fotonovela begins with making a story script as a basic material. This text is then arranged into a storyboard for reference to take pictures (photographs). So, fotonovela relies more on the strength of the script rather than the strength of the scene and the player's expression. Based on the results of Kirova's [10] fotonovela is an effective approach as a medium because it makes it possible for children to realize a picture of something visually. Fotonovela is very appropriate to be used as a learning medium in deaf children, because they use a lot of vision [10].

*Deaf*

Every child has their own characteristics. Some children are born with perfect physical but some have limitations or deficiencies in one of the senses of the body. The limitation to the functioning of the sense of hearing is called deafness. Children with hearing impairment are children with hearing loss with some level of hearing loss from low, moderate to severe, so that they have problems in receiving information in language that causes children with hearing loss also experience problems with speech due to lack of vocabulary absorbed by hearing.

According to the Librarian in the book Ministry of Education and Culture states that deaf children are children who have difficulty hearing ability from mild to severe, which are classified as deaf and less hearing, thus inhibiting the process of receiving language information through hearing whether using hearing aids or not, by therefore special guidance and education is needed in accordance with their needs to optimize the language and its potential [11]. In general, deaf children who are not accompanied by other abnormalities, have a normal level of intelligence, but often determined their academic achievement is lower than children hearing the same age. According to Lanny Bunawan as quoted by [12], disability does not result in a deficiency in their intelligence potential, but deaf students often show lower academic achievement results compared to children hearing their age [12].

## RESEARCH METHOD

In designing this research to build mobile applications used thunkable applications. After the mobile application is developed, user interface testing is carried out. Survey questions from 5 user interface principles based on research by Bunga Lailatul Riqki [13]. Aspects include: content, natural use, navigation, consistency, flexibility. Questionnaire analysis used the System Usability Scale (SUS) given to 32 respondents. Respondents try to install the application and open all the application features so they need to rate each question from 1 to 4 (1 = strongly disagree, 2 = disagree, 3 = agree and 4 = strongly agree). The data collected was analyzed descriptively as mean. The final results of this survey will indicate the level of user interface of the prototype developed.

## RESULTS AND DISCUSSION

The development of this media uses the development method of research from Akker which is presented through the stages of research carried out, namely: preliminary research (preliminary research), prototype stage (prototyping stage) consisting of six stages, summative evaluation (summative evaluation), systematic reflection and documentation (systematic reflection and documentation).

**Table 1.** Component Menu of the Application

| Component | Details |
|---|---|
| Selection Screen | Display selection Indonesia |
| Main Menu | E-Fotonovela, and Student Center menu (link platform e-learning) |
| E-Fotonovela Menu | Display the learning sub-menu theory |
| Video Menu | Display video learning from lecturer linked on Youtube |
| Student Center | Display e-learning for SLB-B students |
| Practice | Display evaluation test for general visitor students (English Version) |

The following are some screen design application screenshots


**Figure 1**. E-Fotonovela

The expert instrument by media experts consisted of 4 aspects with 18 statements to get a proper category in the media fotonovela. While the instrument in the material expert consists of 4 aspects with 15 statements that must be filled out by the material expert in order to find out the suitability of the material contained in the media photonovela. Then the validator results are used as a reference for the feasibility of developed learning media.

This application is rated user interface. Based on the findings from Figure 1 it can be concluded that respondents have a high level of agreement on the mobile application development user interface. This is indicated by the overall average score for the 4 principles of user interface at a high level (language average = 54%; material average = 98%; average benefit = 85.67% and design 87%).

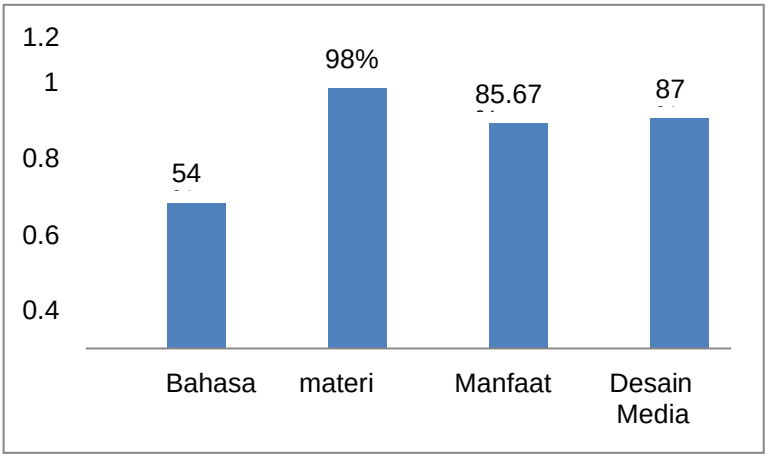



**Figure 2.** Graph of Average value for 4 user interface principles

Data analysis and percentage data of assessment by media experts and material experts as well as the percentage of respondents' ratings in the validation test of small groups. Based on the principles of identified user interface results (Figure.1, and figure 2.), below are some discussions about the android application that is being developed. The first principle, the overall application of the content presented is relevant to competencies for students. The contents of the application are also designed in the form of stories so students can easily find important information. However, because this content is magnetic, there are some symbols that are not appropriate.

Then, the second principle, the application installation process is easy to do and the process can be used in all versions of Android with all screen resolutions. But, this application has a large size memory. The third principle is navigation. The button display works fine but suggestions for revision are given additional buttons on the screen to move to another page or to move to another section with only one or two key presses. After that, consistency, all page layouts are designed the same. And then, the principle of suggestion flexibility is to make the menu button back on the screen so that users can jump from one section to another easily.

## CONCLUSIONS

Evaluating the user interface is important in developing mobile applications. By knowing the achievement of the principle of the user interface can improve the quality of application functions that are made so that it is easier and more interested in using. In this study the results obtained from the assessment of 4 user interface principles were 98% which were considered high. The results showed that the majority of respondents agreed that the application developed had a good user interface.

## REFERENCES

[1] Mudjito, et al., *Inclusive Education*. Baduose Media, p. 146, 2013.
[2] Maknu, J., Application of Constructivism Learning to Improve Understanding of the Basic Concepts of Physics of Vocational High School (SMK) Students, *Proceedings of the International Seminar on Science Education. Faculty of Tarbiyah and Teacher Training. UIN Syarif Hidayatulah*, p. 26-39, 2007.
[3] Anwar, M. K., Deep Learning to Shape Students' Characters as Learners. *Tadris: Journal of Teacher Training and Tarbiyah Science,* vol. 2, no. 2, pp. 97-104, 2017, https://doi.org/10.24042/tadris.v2i2.
[4] Farida Ariyani. Development of Photonovela With Character Education: As An Alternative Of Physics Learning Media. *Scientific Journal of Physical Education Al-Biruni*, vol. 07, no. 2, pp. 227-237, 2018, E-ISSN: 2503-023X, doi: 10.24042/Jipfalbiruni.V7i2.3072
[5] Temmy Syamsu Taufiq, *Learning Planning and Making Media for Children with Special Needs*, Jakarta: Ministry of Education and Culture, 2014.
[6] Kustandi, Cecep, & Bambang Sutjipto, *Learning Media; Manual and Digital*. Bogor: Ghalia Indonesia Publisher, 2011.

[7] Ridho Adi Nugroho, et al., "Development of Audio-Assisted Photonovela Learning Media Audio Sound Material for Lb/Mts Lb Middle School Deaf Students", *UPEJ,* vol. 6, no. 2, 2017, http://journal.unnes.ac.id/sju /index.php/upej

[8] Dwi Wahyuni, "The Effect of Using Photonovela Media on Learning Outcomes of Material Science Effect of Forms of Energy in Daily Life Class Iii Sd Nurul Islam", *proceeding*, p. 15, 2017.

[9] Ruth Koops Van't Jagt, et al., Sweet Temptations: How Does Reading a Photonovela About Diabetes Affect Dutch Adults with Different Levels of Literacy?, *Health Communication*, pp. 284-290, 2017, doi: 10.1080 / 10410236.2016.1258617.

[10] Kirova, A., & Emme, M., "Photonovela as a research tool in image-based participatory research with immigrant children", *International Journal of Qualitative Methods*, vol. 7, no. 2, pp. 35-57, 2008.

[11] Ministry of Education and Culture*, "Let's Sing Music Coaching For Children with Special Needs",* Bandung: PPPPTK and PLB Bandung, 2013, p. 48

[12] Wardani, Astati, Hernawati T., & Somad P*., Introduction to Special Education*, Jakarta: Open University, 2009.

[13] Bunga Lailatul Rizki. Pengembangan Kamus Bahasa Inggris Bergambar bagi Anak Tunarungu di SMALB. *Jurnal Ortopedagogia*, vol. 2, no. 2, pp. 96-99, November 2016.

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

# Student's Mathematical Critical Thinking Ability and Self-Efficacy Through SAVI Learning Model

**Nur Fadilah[1], Isnaini Handayani[1*], Fitri Alyani[1]**

[1]University of Muhammadiyah Prof. Dr. Hamka, Tanah Merdeka Street, Kp.Rambutan, Pasar Rebo, East Jakarta, 13830, Indonesia

*Correspondence email: isnaini_handayani@uhamka.ac.id

## ABSTRACT

This study aims to analyze the increase of critical thinking skills and mathemactical self-efficacy of junior High School students through the SAVI learning model (Somatic, Auditory, Visualization, Intellectually). This research is a quantitative study with a pretest-posttest control group design. The population in this study is the Junior high school students in Bekasi with the sample of 84 students being assigned with a cluster random sampling technique. The results of this study came to the conclusion that the increase in critical thinking skills and mathematical self-efficacy of the students whose learning process used SAVI learning models is better than the students whose learning process did not use the SAVI one.

**Keywords:** Critical Thinking Ability, Self-Efficacy, SAVI Learning Model

## INTRODUCTION

Mathematics is the science that relies on one's mindset to solve a problem. In mathematics, students are faced with a problem to be solved. To solve a problem in mathematics, the students need to have an important basic skill to produce the right and logical answer. One of the basic capabilities the students must have is critical thinking skills.

ATC21S (Assessment and Teaching of 21st Century Skills) stated that the study of mathematics in the 21st century has a purpose with 4C characteristics, namely; Communication, Collaboration, Critical Thinking and Problem Solving, Creativity and Innovation [1]. This is in line with the results of research being conducted by more than 250 researchers from 60 institutions worldwide who become the members of the ATC21S (Assessment and Teaching of 21st Century Skills) grouping 21st century skills in four categories, one of which is a way of thinking [1]. The ability of thinking becomes one of the important capabilities that students must have to support their learning process in modern times as it is today. Critical thinking skills enable people to learn the problems they face systematically, to face various challenges in an organized way, to formulate innovative questions, and to devise original solutions [2].

Thinking skills can't develop naturally, because thinking skills should be enriched by various environmental stimuli and diverse atmospheres [3]. Therefore, the environment is very important in developing one's ability to think. Critical thinking ability is basically able to develop self-efficacy. Self-efficacy is a person's beliefs about oneself ability to produce an accurate problem solving which affects their lives [4].

How do people behave in a particular situation depends on reciprocity between the environment and cognitive conditions, particularly the cognitive factors related to the belief that he or she is able or unable to perform a satisfactory action, Bandura calls this self-confidence or expectations as self-efficacy [5]. The right environment and varied atmosphere can develop thinking skills as well as one's self-efficacy in one time. Therefore, one of the factors to know and determine one's self-efficacy is to know how a person thinks [6].

However, in reality, the critical thinking skills of students in Indonesia are still at the low level [7]. In his research indicates that mathematical critical thinking ability of the students in junior high is still at the low level. The average value of mathematical critical thinking skills of Junior High School students is only 68 in the 0-100 scale. The value is still included in the category of enough. In addition to that, based on a preliminary study [8], of the 30 students, only 2 students in junior Ar-Rahman Percut were

able to answer the critical thinking skills critical test mathematically correctly and completely, while others were simply guessing the answer.

In the PISA report, it is also stated the same thing, that mathematical literacy skills of the Indonesian students were in the bottom group of all participating countries. In PISA 2009, mathematical literacy of Indonesian students is in the 60th position out of of 64 participating countries with a score of 375 [9]. In PISA 2012, Indonesia was at the 64th osition out of 65 participating countries with a score of 375 [10]. In PISA 2015 Indonesia was at the 62th position out of 70 participating countries and luckly it increased the score to 386 [11]. In PISA 2018, Indonesia was at the 73th position out of the 78 participating countries. Unfortunately, Indonesian mathematics PISA score was decreased to number 379 in 2019 [12]. Mathematical literacy being defined is the ability of students in the analysis, reasoning and effective communication at the time of displaying, solving and interpreting mathematical problems [9]. The results of PISA 2009 report also showed that self-efficacy of mathematics of the Indonesian students is very low compared with the students from other countries, except the students from Brazil, Thailand, and Tunisia [9].

Cabera stated that the mastery of critical thinking skills is not sufficiently targeted as educational purposes only, but also as a fundamental process that enable students to cope with the uncertainty of the future [13]. Critical thinking skill is also necessary for life, so that the students can filter the information and respond critically any information they get, and can choose the good from the bad for the future life as well as anticipate all the things that could endanger their lives.

The low level of mathematical critical thinking can give a significant impact on cognitive development of the students because the students tend to being incapable of solving the problem the teacher gives, then as a result, the students cannot effectively participate in teaching and learning process.

The weak of mathematical critical thinking skills level of the students can be caused by several factors [14]. Mention one factor that caused the mathematical critical thinking skills is learning process being implemented. Learning mathematics should actively engage and facilitate students to be able to use their critical thinking skills [14]. In addition to that, if the students are allowed to train their thinking ability, the training will form a habit to be able to distinguish between true and untrue, allegations and reality, fact and opinion, as well as knowledge and belief [2].

Factors causing weak critical thinking skills are also expressed that students often have difficulty in solving problems which require the students to think critically because the students are rarely trained on how to solve problems which require critical thinking skills. Therefore, to improve critical thinking skills and mathematical self-efficacy, students need an appropriate learning model.

Sumarmo says, in order that learning process can maximize the learning process and results of mathematics, teachers should encourage students to engage actively in discussions, ask and answer questions, think critically, explain each answer given and to give reasons for any proposed answer [13], so that teachers play an important role in creating an optimal l and fun learning so that students can actively involve in the learning.

Stated "it is the time the old learning pattern is replaced by SAVI (Somatic Auditory Visual Intellectual). Somatic as learning by moving and doing (learn by moving and doing). The auditory is learning by talking and hearing (learning by speaking and listening). Visual is interpreted as learning by observing and picturing (learning by observing and describing). Intellectual means learning by problem-solving and reflecting (learning with problem-solving and doing reflection [15]. SAVI learning model is expected to improve critical thinking skills and mathematical self-efficacy of the students.

SAVI learning is the learning that emphasizes the meaningful learning through listening, listening, speaking, presenting, arguing, expressing, and responding, as well as using other thinking (minds-on) to increase the concentration of the mind through reasoning, investigating, identifying, locating, creating, constructing, solving and implementing the problems [16]. Learning mathematics using SAVI learning model is expected to make the students more enthusiastic in following the subject matter because by using SAVI learning model, it will create teaching and learning process more active than conventional learning models.

Based on the problems that have been described, learning using the learning model of SAVI can become one of the ways to improve critical thinking skills and mathematical self-efficacy of the students. It is thus, the research on "Student's Mathematical Critical Thinking Ability and Self-Efficacyn Through SAVI Learning Model" becomes very important to conduct.

Aim of Study

The purpose of this study is to determine whether there is an increase in critical thinking skills and mathematical self-efficacy of the students through the SAVI learning model (Somatic, Auditory, Visualization, Intellectually).

## LITERATURE REVIEW

Learning is a process of interaction between students and educators [17]. Each individual can always take the learning in every event that happened to the changes in his or herself. Learning can happen anywhere and anytime. Learning can be in formal institutions such as in school. In school, students are required to solve the problem that is given by the educator.

### *The ability of Critical Thinking Mathematically*

Ability is the main capital of a person from the birth to be able to complete a job. The abilities and skills a person has are certainly in accord with the level of education they follow, the higher a person's education is assumed the higher the knowledge, skills, and abilities they got [18]. Based on that statement, the ability can be interpreted as the effort of a person to improve his or herself in order to become a better person.

Glaser defines critical thinking as: (1) an attitude would think deeply about issues and many things being within the reach of one's experience; (2) knowledge about the methods of examination and logical reasoning; and (3) a kind of a skill to apply these methods [19]. So it can be interpreted that critical thinking is a skill or attitude of a person to solve the problems using the method of examination and logical reasoning.

According to Ennis critical thinking is a thinking that is reasonable and reflective focusing to decide what should be believed or done [19]. By thinking critically we can determine what is right and wrong by considering the reasons that make sense.

Richard Paul argues that critical thinking is a method of thinking - about something, any substance or matter - in which the thinker improves the quality of his or her thinking by handling skilfully the structures being inherent in his or her thinking and applies the standards of intellectual to him or herself [19]. It has been suggested that critical thinking is a method of thinking to solve a problem by applying intellectual standards.

Critical thinking is thinking to investigate systematically the thinking process itself, which means that it is not only thinking on purpose but also examining how do we and others use the evidence, assumptions, and logic [2].

According to Susanto mathematical critical thinking is thinking activity about the idea or ideas related to the concept or problem being given [8]. Meanwhile, according to Ennis critical thinking is a process which naimed at so that we can make logical decisions so that what we consider the best about the truth can be done in the right way [20]. It is from both opinions above; it can be concluded that the ability of mathematical critical thinking is a higher-level thinking processes to be able to identify a problem to obtain a rational conclusion from the results examined.

Some of the critical thinking skills which are very important are as follows: (1) to identify elements in the case under consideration, in particular, the reasons and conclusions; (2) to identify and evaluate assumptions; (3) to clarify and interpret the statements and ideas; (4) to assess the acceptability, in particular, credibility and the claims; (5) to evaluate the arguments of various types; (6) to analyze, evaluate, and produce explanations; (7) to analyze, evaluate and make decisions; (8) to draw inferences; (9) to produces arguments [19].

*Self-Efficacy*

Efficacy is a self-assessment, whether to take action is good or bad, right or wrong, can or can't do as required [5]. Efficacy is different from the aspirations (ideals), because the aspiration is describing something that should be achieved (achievable), whereas the efficacy is describing the assessment of one's capability [5].

Self-efficacy is an individual belief concerning his or her ability to organize and complete a task which is required to achieve a particular result [21].

According to [21] the four main sourcesbwhich give an impact on a person's self-efficacy are:

a. Experience success of someone in the face of certain tasks at an earlier time. If someone has successfully completed the task in the past so when he or she encountered problems in the future he or she will be able to complete the task which signifies that his or her self-efficacy is getting higher and higher. However, contradictory with that, if someone experienced failure in the past then when he or she meets the current problems in the future, one self-efficacy becomes decreasing.

b. The experience of others. Individual who sees the success of others in doing the same activities and same ability can increase self-efficacy of that person, otherwise if the person who sees the failure, then it can decrease that person's self-efficacy.

c. Verbal persuasion, ie information about the person's ability conveyed verbally by influential people can increase confidence that the capabilities he or she has can help him or her to achieve what is desired.

d. Physiological condition is a state of physical and emotional conditions. The physiological state of a person can affect the belief in her abilities in the face of the task. If the condition of a person in a state of good, it will reduce the level of self-efficacy. Contradictory with that, if someone is in prime condition, this will contribute positively to the development of self-efficacy.

In addition to the above factors, there are other factors such as age, because the older the person the higher self-efficacy he or she has if it is compared with his or her previous one [22]. As for the measurement of self-efficacy in this study, this study focused on four characteristics being adapted from [23] as follow:

a. To believe in the ability of one self, namely a belief in oneself against all the phenomena related to the individual's ability to evaluate and overcome the phenomenon occurred;

b. To act independently in taking decision, that is the ability to act in making decisions about what is done independently without involving others. In addition to that is the ability to believe action being taken.

c. To have a positive self-concept, that is the good judgment of the self, both from the view and the action taken, then it rises a positive sense to the self.

d. To have the caurage to express their opinions, namely the attitude to be able to express something in oneself which is disclosed to others without coercion or disclosures that may restrain those feelings.

*SAVI Learning Model*

SAVI is a model of learning that involves movement, such as the physical movement of certain parts of the body such as speaking, listening, seeing, observing, and using the intellectual ability to think, describe, connect, and make conclusion [24].

According the elements of this learning model (Somatic, Auditory, Visualization, Intellectually (SAVI)) is consisted of Somatic ie learning with physical activity, moving, and doing (hands on) [25].

Stated "it is the time that the old pattern is replaced by SAVI (Somatic Auditory Visual Intellectual). Somatic as learning by moving and doing (learn by moving and doing). The auditory is learning by talking and hearing (learning by speaking and listening). Visual interpreted learning by observing and picturing learn by observing and describing). Intellectual means learning by problem-solving and reflecting (learning with problem-solving and reflection [15].

According to Meier and Colin in [16], SAVI has the characteristics in each element of learning, through the elements of somatic are: (a) to make the concept of learning in a process or procedure, (b) to physically move and demonstrate the various components in a process or system, (c) to train ]active learning (simulations or learning games), (d) to gain experience and to discuss and reflect on it and apply it, (e) to provide and receive explanations in line with the following ways, (f) to express emotions through body language, (g) to conduct various learning activities (reviewing field, writing, drawing, interviewing, competing or gaming, and others), (h) to conduct creative activities such as making the crafts (the concept of mind mapping), coming forward to explain or present the results of the work, playing or competing through the educative games and so on.

Through elements of auditory were: (a) to say aloud what is and has been studied, (b) to learn through listening to the radio, watching the drama, and watching and participating in debate, (c) to make a dialogue (receive and deliver information) through words (verbal) (d) to express emotion verbally through changing tone or vocal, (e) to handle projects the basis of the procedures, to debate the issue, to overcome the problem verbally, (f) to remember better and to memorize the words or ideas that have been spoken, (g) to respond better when hearing than reading information, (h) to do creative activity such as singing, storytelling, playing music, making a dialogue, debating, and others.

Through the visual elements are: (a) to emphaze on reading, watching, and observing the situation then summarizing, (b) to accept the explanation whose emphasis is more on the use of visual media such as images, maps, photographs, and others, (c) To state emotions through facial expressions, (d). to do creative activities such as; writing, drawing, painting, designing, and others.

Through the intellectual elements are: (a) to formulate the question, (b) To find and filter information, (c) To analyze the observations, (d) To undertake strategic planning, (e) To produce creative ideas, (f) to solve the problem. Besides the characteristics, SAVI learning also has many other stages of learning such as preparation, delivery, training, and appearance of results.

SAVI learning model (Somatic Auditory Visual Intellectual) is a learning model that prioritizes vision and auditory senses in the learning process in order to create learning athmosphere which is fun and exciting to maximize the gestures, the function of the senses, the intellecttual, and emotion in acquiring the material concept and importance of excitement in learning.

## RESEARCH METHOD

This research is a quantitative type of experimental research with a group pretest-posttest design. The experimental research method can be interpreted as the research methods used to find a specific treatment effect against the other in under control condition. This type of research used was Quasi-Experimental Designs for researchers in this design can't control all external variables that affect the course of the experiment.

The research design was pretest-posttest control group design. The design is [26].

| | | |
|---|---|---|
| $O_1$ | X | $O_2$ |
| $O_3$ | | $O_4$ |

Information:
X : Treatment using SAVI learning model
O1 and O3 : pretest
O2 and O4 : posttest

In this design, the grouping of research subjects was done randomly and selected two classes, namely as a control group and the experimental class, the experimental class was treated of learning by using SAVI learning model (X), and class control was treated by using conventional learning models, then

each research class was given pretest and posttest (O). O1 and O3 is the result of critical thinking skills and mathematical self-efficacy of the students before treatment. O2 is the result of critical thinking skills and mathematical self-efficacy of the students after being treated and O4 is the result of critical thinking skills and mathematical self-efficacy of the untreated students.

This study population was all students of class VIII 14 of Junior High School in Bekasi. Sample of this study were 84 students, consisting of 42 students who obtained SAVI learning and 42 students who obtained conventional learning.

To obtain the data, this study used a test instrument which consists of a written test to observe mathematical critical thinking skills of the students and the questionnaires of self-efficacy which contains a set of statements to know self-assessment of the students in general that should be filled by the students to choose answers having been provided. From the study, the data obtained are thus of two kinds namely test critical thinking skills data and that of self-efficacy questionnaire.

The improvement of critical thinking skills and self-efficacy of the students thus is reviewed based on normalized gain value (n-gain). N-gain value is determined using the following formula [24]:

$$N - gain = \frac{skor\ post\ tes - skor\ pre\ tes}{SMI - skor\ pre\ tes}$$

The high or low value of n-gain is determined based on the following criteria:

Table 1. Criteria Value N-gain

| Values of N-Gain | Criteria |
|---|---|
| ***N-gain*** **≥ 0.70** | High |
| **0.30 <N-gain <0.70** | Moderate |
| ***N-gain*** **≤ 0.30** | Low |

## RESULTS AND DISCUSSION

Based on data obtained from the research results, it can be concluded that the increase in critical thinking skills and mathematical self-efficacy of the students through the SAVI learning model is better than the increase in critical thinking skills and mathematical self-efficacy of the students through conventional learning models.

### The Increase Ability of Critical Thinking Mathematically of the Students

To understand whether there are differences in the increase in critical thinking skills in experimental and control classes then t-test using statistical tests Compare Mean Independent Sample Test is conducted. The results of complete calculation can be presented in Table 2 below.

Table 2. The mean score of N-Gain Critical Thinking Mathematical Ability of the Students

| Aspect | Class | Aver age | Kolmogorov-Smirnov[a] | | | t | Df | $t_{table}$ | Sig | $H_0$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Statistics | Df | Sig. | | | | | |
| N-gain Critical Thinking Skills | Experiment | 0,6460 | 0.169 | 42 | 0,004 | 4,593 | 82 | 1,989 | 0.0000 | Rejected |
| | Control | -0,3440 | 0.262 | 42 | 0,000 | | | | | |

Based on Table 2 the average score gain critical thinking skills mathematically the experimental class is classified into the medium catagory, while the average score of gain of mathematical critical thinking skills in the classroom control is classified into the low category. Then, to know whether there are differences of the average, can be seen that the value of $t_{hitung}$ = 4.593> 1.989 = $t_{table}$ with significant value (p-value) of 0,000. 0,000 significance value < 0,05. So it can be concluded that $H_0$ which states there is no difference between the increase in critical thinking skills and the experimental class control

class is rejected. This shows that the increase of mathematical critical thinking skills of the students whose learning applied mathematical SAVI models is better than those whose learning applied conventional learning models.

**The Increase of Self Efficacy of the Students**

To know whether there are differences in the increase of critical thinking skills in experimental and control classes then the t-test using statistical tests Compare Mean Independent Sample Test is conducted. More calculation results can be presented in Table 3 below.

Table 3. Normality Test Scores N-Gain Self Efficacy of Students

| Aspect | Class | Average | Kolmogorov-Smirnov[a] | | |
|---|---|---|---|---|---|
| | | | Statistics | Df | Sig. |
| N-gain Self Efficacy | Experiment | 0,1796 | 0,169 | 42 | 0,004 |
| | Control | -0,3172 | 0,262 | 42 | 0,000 |

Based on table 3 on the experimental class the average score of n-gain of self-efficacy of the students is still relatively low, while the control class the score of n-gain of the students is low as well. In the data normality test n-gain in experimental class, the score obtained is Sig 0,004 smaller than 0,005 and the data n-gain of control class the score obtained is Sig. 0,000 less than 0,05. Therefore, it can be concluded that self-efficacy data of the students are not normally distributed. Hypothesis testing is done by using a non-parametric test because in non-parametric tests data are not required to be normally distributed. Test averages then is done by using test Independent-Samples T-Test for non-parametric statistics (Mann-Whitney U-Test) with significance level of 0,05.

Mann Whitney test is done to know whether an increase in self-efficacy in both groups is significantly different or not. Comparative test is conducted with n-gain value of the students with the help of software IBM SPSS Statistics 24. The following is a summary of the results of the Mann-Whitney test:

Table 4. Results of Mann-WhitneySelf Efficacy of Students Experiment Group and Control

| | ***SE*** |
|---|---|
| Mann-Whitney U | 599,000 |
| Asymp. Sig. (2-tailed) | 0,011 |

Based on Table 4.13 it can be seen that the value of Asymp.Sig. (2-tailed) of 0,011 is smaller than $\alpha = 0{,}05$ then based on decision-making in the Mann-Whitney test if it rejects $H_0$ and accepts $H_{1,\text{ thus it}}$ can be concluded that the increase of self-efficacy of the studenst who obtain SAVI learning model of self-efficacy is better than the students who obtain conventional learning.

**CONCLUSIONS**

The increase of mathematical critical thinking skills and self-efficacy of the students who applied SAVI learning models is better than mathematical critical thinking skills and self-efficacy of the students with conventional learning models.

**REFERENCES**

[1] Arifin, Z., "Developing Critical Thinking Skills Gauge Instruments Students in the 21st Century Learning Maths Theorems, vol. 1, no. 2, pp. 92-100, 2017, https://doi.org/10.1016/j.neulet.2013.10.065
[2] Johnson, E.B., *Contextual Teaching & Learning: Making Entertaining Learning Teaching-Learning Activities and Meaningful*. Bandung: Kaifa, 2014.
[3] Ariyati, E., Based Learning Lab to Improve Students Critical Thinking Skills. *Journal of Mathematics and Science*. vol. 1, no. 2, pp. 3, 2010.
[4] Laili, NI, & Azizah, U., Implementation of Problem Based Learning Model (PBM) to Melatihkan Critical Thinking Skills and Self-Efficacy on Main Material Factors Affecting Reaction Rate of Class XI SMA Negeri 4 Sidoarjo. *Unesa Journal of Chemical Education*, vol. 4, no. 1, pp. 62-68, 2015.

[5] Alwisol, *Personality Psychology*. Malang: UMM Press, 2009.
[6] Hanifah, N., & Agustini, R., Improved Self Efficacy and Critical Thinking Through Application of Inquiry Learning Model Topic Acid Base Class XI SMAN 9 Surabaya [Increase In Self Efficacy And Critical Thinking Through Implementation Model Study of Inkuiry on Subject Matter of. *Unesa Journal of Chemical Education*, vol. 1, no. 1, pp. 27-33, 2012.
[7] Syahbana, A., Upgrades Critical Thinking Mathematically Junior High School Students Through Contextual Teaching and Learning approach. *Edumatica*, vol. 02, pp. 45-57, April, 2012.
[8] Jumaisyaroh, T., Napitupulu, E.E., & Hasratuddin, H., Upgrades Critical Thinking Mathematically And Smp Student Learning Independence Through Problem-Based Learning. *Kreano, Creative Innovative Mathematical Journal*, vol. 5, no. 2, p. 157, 2016, https://doi.org/10.15294/kreano.v5i2.3325.
[9] OECD, *PISA 2009 Results: Executive Summary,* 2010, retrieved from https://www.oecd.org/pisa/pisaproducts/46619703.pdf
[10] OECD, *PISA 2012 Results in Focus 2014*, retrieved from https://www.oecd.org/pisa/keyfindings/pisa-2012-results-overview.pdf
[11] OECD, *PISA 2015 PISA Results in Focus 2018*, retrieved from https://www.oecd.org/pisa/pisa-2015-results-in-focus.pdf
[12] OECD., *PISA 2018 Results Combined Executive Summaries Volume I, II & III*, 2019.
[13] Fachrurazi, Application of Problem Based Learning To Enhance Critical Thinking Skills and Communication Mathematical Elementary School Students. *UPI Education Research Journal*, vol. 1, pp. 76-89, 2011, Retrieved from http://jurnal.upi.edu/penelitian-pendidikan/view/637/
[14] Happy, N., & Widjajanti, D.B., Judging PBL effectiveness of Critical and Creative Thinking Skills Mathematical and Junior High School Students Self-Esteem. *Mathematics Education Research Journal*, vol. 1 no. 1,p. 49, 2014.
[15] Mariya, D., Mastur, Z., & Pujiastuti, E., Effectiveness Of Learning Tool Figure Savi Aided Ability To Resolution Info Articles Abstract. *Unnes Journal Of Mathematics Education*, vol. 2, no. 2, 2013.
[16] Wahyuni., Savi Learning Model Application To Improve Skills In Primary Resolution Sri Wahyu Kusumawati PGSD FIP Surabaya State University. p. 2014.
[17] Annisa Mustika, and the S.S., Through the application of contextual learning Hands On Probelem Solving Material and Beam Cube Class VIII SMP Negeri 10 Banda Aceh. *Journal of Mathematics Education,* vol. 1, pp. 49-58, 2016.
[18] Sagala, S., *The concept and meaning of learning*. Bandung: Alfabeta, 2012.
[19] Fisher, A., *Critical Thinking An Introduction*. Jakarta: Erland, 2009.
[20] Ismaimuza, D., Critical Thinking Skills Beginning Knowledge Mathematical Viewed from Students. 2 (class VIII), pp. 11-20, 2011.
[21] Bandura, A., *Self-Efficacy The Exercise of Control*. New York: WH Freeman and Company, 1997.
[22] Students, M., Man, I.N., Maulida, F., Alminingtias, N., Soro, S., & Hand, I., Relationship With Self-Efficacy Of Learning. vol. 01, pp. 365-371, 2018.
[23] Hendriana, Learning with metaphorical Thinking Approach to Improve Understanding of Mathematical Ability, Communication Confidence Maths and Junior High School Students. *Dissertation UPI Bandung*, Unpublished, 2009.
[24] Lestari, K.E., & Yudhanegara, M.R., *Mathematics Education Research,* Bandung: PT. Refika Aditama, 2015.
[25] Wardani, D., Use of Instructional Model Somatic, Auditory, Visualization, and Intellectualy (Savi) To Improve Understanding of Concept Style. *Use of Instructional Model Somatic, Auditory, Visualization, and Intellectualy (Savi) To Improve Understanding of Concept Style*, vol. 2, 2013.
[26] Sugiyono, *Quantitative Research Methods, Qualitative and R & D (Mixed Methods),* Bandung: Alfabeta, 2016.

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

# The Analysis of the Misconceptions of Class VII Junior High School Students in the Topic of Counting Operations

**Laela Amriani[1*], Tian Abdul Aziz[2] and Andi Sessu[1]**

[1]University of Muhammadiyah Prof. Dr. Hamka
Tanah Merdeka Street, Kp.Rambutan, Pasar Rebo, East Jakarta, DKI Jakarta, 13830, Indonesia

[2]Department of Mathematics Education, Jakarta State University
Rawamangun Muka Raya street, East jakarta, DKI Jakarta, 13220, Indonesia

*Correspondence email: dklamriani@gmail.com

## ABSTRACT

This research is a case study found in Jakarta 48 public junior high school which aims to analyze students' misconceptions of algebraic arithmetic operations in class VII. The method used is descriptive research in the form of 13 question test items given to 106 VII grade students who have previously been given training. The results of student research after analysis turned out that many experienced misconceptions in algebraic material both in understanding notation / letters and error rules when answering questions given. Overall misconceptions from students due to students 'low memory abilities, lack of student interest in learning, and students' cognitive development that is not in accordance with the instructional materials that are of interest, so that the inculcation of algebraic learning concepts is still a complicated and difficult thing.

**Keywords:** Misconceptions, algebraic arithmetic operations.

## INTRODUCTION

Mathematics is a science that has an important role in human life that functions to develop the ability to calculate, measure, lower and use mathematical formulas needed in everyday life through algebraic material, geometry, mathematical logic, opportunities and statistics Mathematics is often interpreted by most students as a science that contains the calculation of complex numbers and a collection of rules that need to be understood [1]. This view arises from the experience of students while studying mathematics, so there are some students who do not like mathematics. Even though mathematics is a compulsory subject taught in elementary, junior high, senior high school and even in college.

The low mastery of concepts is one of the obstacles in the learning process and can result in low learning outcomes. One of the causes of the low mastery of concepts is the existence of misconceptions and learning conditions that do not pay attention to the initial conceptions (preconceptions) of students [2].

Based on the results of observations of learning that have been done by researchers at the time of learning in class it can be seen that students experience misconceptions in working on arithmetic operations in the form of algebraic forms of addition and subtraction because the initial concepts they have are not yet complete. In this section we will discuss the notions of variables, constants, coefficients and terms that are similar and not the same. Students will also learn about arithmetic operations in algebraic form using the principles of arithmetic operations on integers. This explains that every material in mathematics learning cannot be separated from facts, concepts and principles.

According to [3] [4] quoted from Leading English Education and Resource Network (LEARN) in the Mathematics Program of Study entitled Algebra: Some Common Misconceptions wants to know the extent of misconceptions on students' algebraic thinking abilities, misconceptions that will be categorized into 4 forms of misconceptions, that is; Misconception of letter understanding, Misconception of notation, Misconception of generalization, Misuse of rules.

## RESEARCH METHOD

The study was conducted at SMPN 48 South Jakarta School, 2019/2020 school year in odd semester. Participants who were given the test as many as 3 classes totaling 106 students were given a test item description consisting of 13 questions on algebraic subjects adjusted to the syllabus and indicators. The

study was conducted using descriptive qualitative research and obtained through the analysis of data results and in-depth interviews to determine the location of students' misconceptions. In this study, the data credibility test was carried out by triangulation. Data analysis consists of three activities that occur simultaneously, namely data reduction, data presentation, and data verification

## RESULTS AND DISCUSSION

The purpose of this study is to describe the forms of misconceptions experienced in the Material Operations for Calculating Forms of Algebra. Based on preliminary studies that have been carried out, data are obtained that in class VII there are students who experience misconceptions on algebraic material. The data was obtained from the results of working on the test questions in the form of algebraic forms given by researchers to students.

Examples of students doing algebraic misconceptions include:

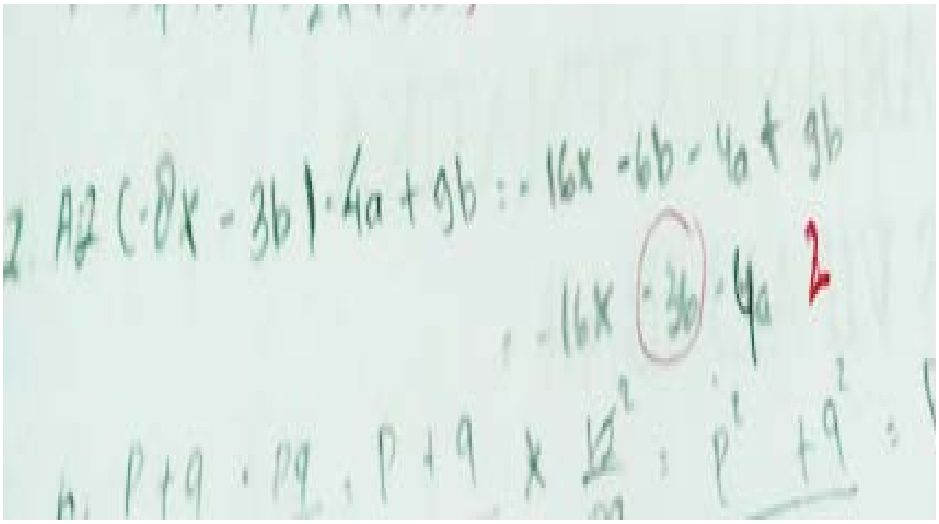


**Figure 1.** Examples of students doing algebraic misconceptions

In this case it can be seen that students make mistakes in answering that: -16x -6b-4a + 9b = -16x-3b-4a. In this problem students ignore the positive and negative signs. It identifies that students' understanding of algebraic form operations is still low, this will make students experience misconceptions. Acording [5] students can experience misconceptions.

## CONCLUSIONS

Based on the results of the discussion of data analysis in chapter four, it was found that there were still students who were categorized as not experiencing misconceptions and also students who were experiencing misconceptions in solving algebraic concept questions. However, there are also students who are categorized as understanding concepts because of their low memory capacity, lack of student interest in learning, and students' cognitive development that is not in accordance with the instructional materials that are of interest, so that the cultivation of algebraic learning concepts is still a complicated and difficult thing.

There are a number of suggestions that are expected to be used to improve learning based on misconceptions, including: For students, they should study harder and practice more exercises on algebraic forms to better understand the concepts of algebraic forms. Teachers should give more practice questions that include understanding the concept of algebraic form to students so students better understand the concept of algebraic form and must also be able to utilize the time allocation that has been determined so that the learning process runs well and students accept the correct concept of algebraic form. For further researchers, they should use the best time in conducting research so that research results can be maximized.

## REFERENCES

[1] Lew, H., Developing Algebraic Thinking in Early Grades : Case Study of Korean Elementary School Mathematics, vol. 8, no. 1, pp. 88–106, 2004.
[2] Fitria, A., Miskonsepsi Mahasiswa dalam Menentukan Grup pada Struktur Aljabar Menggunakan Certainty of Response Index (Cri) di Jurusan Pendidikan Matematika IAIN Antasari. *Jurnal Pendidikan Matematika,* 2017, doi: https://doi.org/10.18592/jpm.v1i2.50.
[3] Saputra, N. N., Prosiding Seminar Nasional Pendidikan Matematika Dan Matematika Universitas Muhammadiyah Tangerang, 2018.
[4] Aygor, N., & Ozdag, H., Misconceptions in Linear Algebra: the Case of Undergraduate Students. *Procedia - Social and Behavioral Sciences*, 2012, https://doi.org/10.1016/j.sbspro.2012.05.602.
[5] Karolin, N., Subanji, & I Made, S., Miskonsepsi Pada Penyelesaian Soal Aljabar Siswa Kelas VIII Bedasarkan Proses Berpikir Mason. *Jurnal Pendidikan*, 2016.

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

# Relationship between Analytical Thinking Ability and Creative Thinking Ability in Ecological Materials

**Mayarni[1*], Diyanah Hazimah[1]**

[1]Universitas Muhammadiyah Prof. Dr. Hamka
Jl. Tanah Merdeka Kampung Rambutan Jakarta Timur, Indonesia 13830

*Correspondence email: mayarni@uhamka.ac.id

## ABSTRACT

The 21st century is a century full of challenges for developing countries, including Indonesia. Indonesia has very complex challenges, especially in the era of globalization and digitalization. By facing this challenge, of course the quality of human resources needs to be prepared in various ways, such as ensuring welfare and justice for all Indonesian people. To improve human resources, it is also necessary to improve the quality of education and the quality of learning, so that the state's goal to be able to educate the nation's children can be achieved and able to face challenges in the era of globalization and digitalization. This research uses the correlation description method, to see the relationship between analytical thinking and creative thinking. Participants who helped this research came from high school as many as 43 students, totaling 2 classes. Data were collected from the instrument about the ability to think analytically and the ability to think creatively and then analyzed using linear regression correlation test. The students had an average analytical thinking ability of 89.56 and creative thinking ability of 82.63. The results showed that r count > r table with r count obtained a value of 0.69 and a value of r table with a significance level of α = 5% of 0.38 then, Ha was accepted and H0 was rejected. The conclusion from the results obtained is that there is a relationship between the ability to think analysis with the ability to think creatively in class X SMAN Bakti Idhata Jakarta. The development of analytical and creative thinking skills needs to be applied in all learning carried out.

**Keywords**: 21st century; Analytical Thinking Ability; Creative Thinking Ability

## INTRODUCTION

The rapid development of science in the 21st century requires humans to adapt to responding to the challenges in the 21st century. Science education plays an important role in helping humans prepare themselves to enter an increasingly modern world [1]. The world of education in the 21st century has growing challenges in this modernization era, so that the quality of education and the development of learning models should also have novelty in this increasingly globalized era to improve the quality of human resources. Learning that is carried out is required to improve the quality of learning and can improve and develop an attitude of collaboration, communication and cultivate skills in creative thinking. Knowledge required in the 21st century such as analytical thinking skills and creative thinking skills [2].

The 21st century is very different from the previous century, because in this century the role of teachers is very important to face international demands in the learning process which requires 4C skills consisting of critical thinking, creative thinking, communication, and problem solving [3]. 21st century learning emphasizes learning that applies higher order thinking skills or Higher Order Thinking Skills (HOTS) and development of literacy skills and character education [4].

The quality of human resources required is to have the ability to think or think systematically, analytically, logically, critically, and creatively, balanced with the inner will to work together effectively. Indonesia is involved in the Program for International Student Assessment (PISA), which is a way to see how far learning programs in Indonesia have progressed, compared to other countries in the world. This PISA describes an international level research made by the Organization for Economic Cooperation and Development (OECD). PISA questions require the ability to solve problems, as well as abilities in reasoning and analysis [5].

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

This shows that there needs to be an increase in the quality of education in learning to support students' analytical thinking skills and creative thinking skills to answer the challenges of the 21st century. As in the journal Setiawati, the ability to think analytically is also one of the life skills that students must have as a preparation for life in order to compete in the 21st century [6]. Not only that, in the current era of globalization, it shows that students' creative thinking skills are very important [5].

Analytical thinking skills need to be developed because analytical thinking skills are needed [7]. The low ability of this analytical thinking requires the importance of developing higher order thinking skills such as analytical thinking skills [8]. Improving low analytical thinking skills is done by honing more analytical thinking skills in the learning process [9]. Research conducted on eighth grade students in Surakarta got low results on students' analytical thinking skills [6]. Low analytical skills need to be improved with the help of motivation for each individual to get enthusiasm in developing analytical thinking skills [10].

The characteristics of someone's analytical thinking ability, namely: thinking systematically, having high discipline, being able to appreciate and respect a fact that is conveyed logically, like things that are arranged, careful and focus on small parts of the problem, usually have rigid character or personality, making decisions tends to take longer than others [11].

There are indicators on the ability to think analysis which are listed in table 1. as follows:

**Table 1.** Indicators of Analytical Thinking Ability

| No. | Categori | Indicator | Verb |
|---|---|---|---|
| **1** | Differentiating | Be able to select related pieces of information | Find Knowing |
| **2** | Organizing | Able to compile relevant information sections | Examining Rationalize |
| **3** | Attributing | Able to choose the purpose and relation of an information | Conclude Hook up |

There are factors that affect a person's thinking ability which are divided into two, namely internal factors that come from the individual himself who is learning. Internal factors consist of: the student's desire, a source of reference or reference, the habit of using analytical thinking skills when studying, adjustments in the face of a new experience, and the person's physical and psychological state.

External factors that affect the ability to think analytically, namely someone who is learning is affected by a situation from outside the person. External factors consist of: the learning methods given are related or not related to the development of analytical thinking skills, the learning media used are able or related to sharpening analytical thinking skills, display of the learning media used, learning activities carried out, evaluation of learning related to analytical thinking, about whether or not he used to develop analytical thinking skills.

Higher order thinking skills that need to be honed and developed, in addition to analytical thinking, are the ability to think creatively. Asmi's research on the understanding of the ability to think creatively, which is creativity in a person in developing ideas or ideas or products on problems [12].

The ability to think creatively is a very important part of learning for students to have this creative thinking ability. Creative thinking is the skill to discover and produce something new by sharing current thoughts that can be used for problem solving or skills to see interactions between existing parts [13]. Research on students' creative thinking skills conducted at SMAN in Samarinda, found that students tend not to think creatively [14]. Another study conducted obtained the results of high school students' creative thinking skills belonging to the weak category [15].

Low creative thinking skills in students require appropriate methods to improve it by continuing to apply training to the learning process [16]. The creative thinking ability of students at SMA N 5 Depok is still low,

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

so there is a need for training in questions for the development of creative thinking [17]. Higher-order thinking skills such as the ability to solve problems, skills, be creative, think critically, and have a scientific attitude are very adaptable to the environment, because the environment plays an important role in the growth and development of students' abilities [18].

The ability to think creatively leads to the ability to generate an idea to solve various or different problems that are new and open compared to previous ideas or problem solving. Creative thinking is also defined as producing a product [19].

The characteristics of someone who has the ability to think creatively are as follows: able to ask questions or thoughts that are different from other people, curiosity about something is high, has an open mind to new experiences, is interested in experimenting, has and likes his own way of understanding things, likes something that is challenging for him, likes things related to discussion, likes new things compared to existing or usual things or ways of solving problems [20]. The indicators on creative thinking skills are listed in table 2. As follows:

**Table 2.** Indicators of Creative Thinking Ability

| Indicator | Information |
|---|---|
| Fluency | Able to generate an idea to solve a problem |
| Flexibility | Able to generate a variety of ideas in solving problems |
| Originality | Able to produce a new thought and different from others |
| Elaboration | Able to develop and detail a thought |

The research objective was to determine the relationship between analytical thinking skills and creative thinking abilities of class X SMA Bakti Idhata on ecology material. This research is expected to find out analytical thinking skills and creative thinking skills in students.

## RESEARCH METHOD

The research method used is descriptive correlation research method, to determine the relationship between analytical thinking skills with students' creative thinking abilities in ecological material. This research was conducted in June - August 2020 at Bhakti Idhata High School. The study population was 43 students of SMA Bhakti Idhata. Saturated sampling technique was used for sampling in this study. Researchers conducted research by collecting information about the ability to think analytically and creatively to 43 class X students. The test instrument was given online with the help of google form, after testing the validity and reliability.

There are as many as 6 items on ecology material with indicators of analytical thinking skills, while in questions of creative thinking skills as many as 8 items that the researcher has designed for this study. The question indicators used in the research for the instrument of analysis were distinguishing, organizing and connecting. Meanwhile, indicators for creative question instruments are fluency, flexibility, authenticity and elaboration. The questions used are in the form of a description. The essay test is a question that demands answers in the form of a description, provides an excuse, explains, and differentiates, using your own language according to the questions given because the written test demands reasoning skills such as analytical thinking [21].

The data validity test was collected by providing question instruments to respondents, namely students of class XI at SMA Bhakti Idhata via google form. Researchers obtained data with an instrument, namely a test, in the form of a description of 6 items of analytical thinking skills and 8 questions of creative thinking skills. Data validity was analyzed using Microsoft Excel application as well as calculations on reliability using Microsoft Excel.

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

The validity formula used to calculate using the product moment correlation technique is as follows [22], [23]:

$$r_{xy} = \frac{n\sum xy - (\sum x)(\sum y)}{\sqrt{\{n\sum x^2 - (\sum x)^2\}\{n\sum y^2 - (\sum x^2)\}}}$$

Information:
$r_{xy}$ : The correlation coefficient for the variables x and y, the two variables being correlated
$\sum xy$ : The sum of the multiplication of the variables x and y
$\sum x^2$ : Sum of the squares of the x values
$\sum y^2$ : Sum of the squares of the y value
n : Number of students or respondents

There are criteria for the validity of the assessment used presented in table 3. As follows:

**Table 3.** Criteria for the Validity of the Assessment

| Validity | Interprestasi | Kriteria |
|---|---|---|
| 0,00 – 0,20 | Very Low | Invalid |
| 0,21 - 0,40 | Low | Valid |
| 0,41 – 0,60 | Enough | |
| 0,61 – 0,80 | High | |
| 0,81 – 1,00 | Very High | |

[24]

After calculating the validity of the questions, the calculation used is reliability with the following formula :

$$r_{11} = \left(\frac{n}{n-1}\right)\left(\frac{\sum \sigma^2 i}{\sigma_i^2}\right)$$

Information :
$r_{11}$ : reliability
n : number of valid items
$\sum \sigma^2$ : number of valid items
$\sigma_i^2$ : total variance

The reliability interpretation criteria [24] used are listed in table 4 as follows:

**Table 4. Reliability Interpretation**

| Validity | Interprestasi |
|---|---|
| 0,00 – 0,20 | Very Low |
| 0,21 - 0,40 | Low |
| 0,41 – 0,60 | Enough |
| 0,61 – 0,80 | High |
| 0,81 – 1,00 | Very High |

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

The research consisted of 3 stages, namely: preparation, implementation and observation. The preparatory stage that is carried out starts from making a permit letter to the school and making question instruments. The instrument was made by conducting expert validation by the supervisor and teacher of the Biology subject, the number of questions was 6 items for analytical thinking and 8 items for creative thinking skills.

$$\text{Coefficient value a} = \frac{(\sum x^2)(\sum y)-(\sum x)(\sum xy)}{n(\sum x^2)-(\sum x)^2}$$

$$\text{Coefficient value b} = \frac{n(\sum xy)-(\sum x)(\sum y)}{n(\sum x^2)-(\sum x)^2}$$

After that the score of analytical skills and creative abilities is obtained by a formula [25]. In the implementation stage, data collection was carried out in the same way, namely giving and filling out the question instruments via google form. After analyzing the collected respondent data, data analysis was carried out using the Pearson product moment correlation. The calculation of the Pearson product moment correlation at the coefficient values a and b, to ensure the regression equation and determine the positive or negative regression direction with the formula y = a + bx as follows: [26]

$$\text{Scoring} = \frac{\text{Score Obtained}}{\text{Maximum Score}}\ x\ 100$$

## RESULTS AND DISCUSSION

The research data from the analytical thinking ability obtained the average percentage value presented in Figure 1.

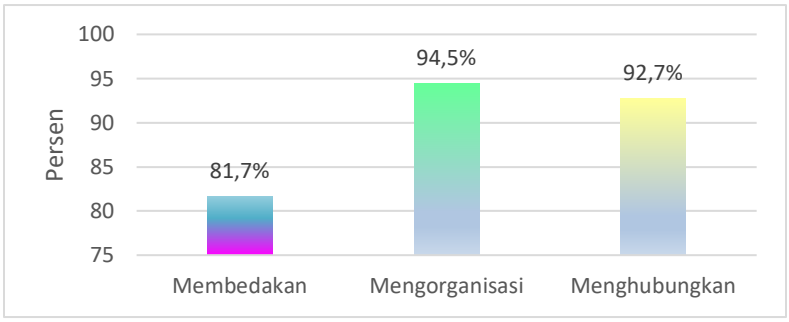



**Figure 1.** Bar Chart of Average Percentage of Analytical Thinking Ability

Figure 1.Shows the average percentage of analytical thinking skills with the highest average percentage found in the organizational ability indicator of 94.5%, then the ability to connect is 92.7%, and the lowest is 81.7% on the indicator of distinguishing ability. There is also an average percentage of creative thinking skills as presented in Figure 2.

Figure 2 shows the highest average percentage of creative thinking skills, namely the original ability or originality of 87.2%, then the fluency ability is 84.9%, the flexibility ability is 80.2%, and the lowest is 77.6% of the ability. elaboration.

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

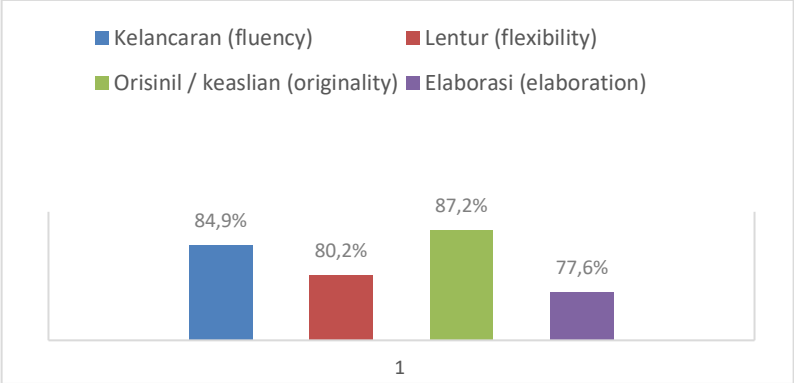



**Figure 2.** Bar Chart of Average Percentage of Creative Thinking Ability

Furthermore, in this research hypothesis experiment shows a significant relationship between analytical thinking skills (X) and creative thinking skills (Y). Hypothesis testing.

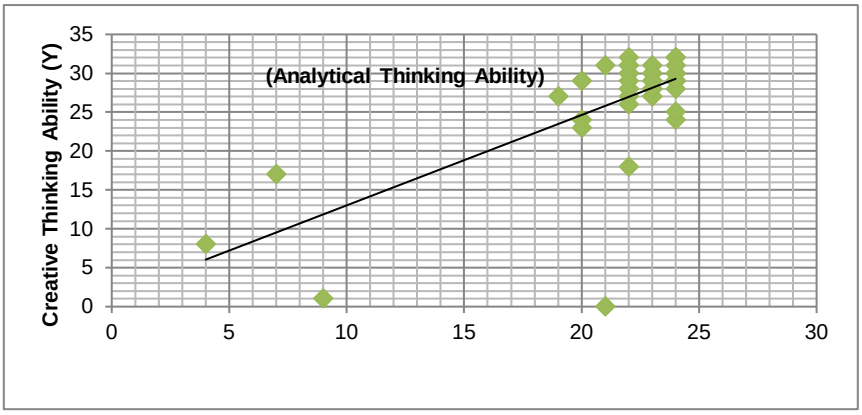



**Figure 3.** The Scatter Diagram of the Regression Equation y = y = 30.37 + 1, 16x

used is simple linear regression which is notified in the format of the regression equation. Based on the calculation obtained from the translation of simple linear regression, it has a regression equation of y = 30.37 + 1, 16x on the relationship between analytical thinking skills and creative thinking skills as shown in Figure 3.

Figure 3. The points on the graph are near a line that shows a normal distribution and a positive relationship is obtained between variable X and variable Y, so it can be seen that the Y value will tend to increase or go upward, along with the increasing value of X. The results obtained are reinforced by the research that has been carried out, namely the results obtained from the calculation are Y = 77.25 + 0.429x, and the results of the calculation of linear regression analysis obtain the presence of points in the data according to totality, scattered around the line, thus indicating between variables X and Y have a positive correlation, and the calculation shows that the Y value tends to increase along with the increasing or increasing value of X (Rizqah et al., 2019)

Hypothesis testing is carried out in this research to determine whether there is acceptance or rejection of the hypothesis as follows:
H0 = There is no significant relationship between analytical thinking skills and creative thinking skills
Ha = There is a significant relationship between analytical thinking skills and creative thinking skills

The determinant coefficient (kd) is a number used to determine the participation or contribution given by one variable or two variables X to the Y variable.The r value or the correlation value is used to measure the

strength of the relationship between two variables, namely X and Y, or more variables. (Nasir, 2016). After doing the calculations, the α correlation value is 0.69 which means there is a strong relationship. Then for the value of r square or the coefficient of determination (kd) obtained a value of 0.49. As shown in table 7.

**Table 7 . Determinant Coefficient**

| R | R *Square* |
|---|---|
| 0,69 | 0,49 |

Based on table 7 regarding the determinant coefficient, the results are shown in table 7. So it can be interpreted that the variable x, namely the ability to think analysis in this study, has a contribution effect of 49% on the variable y where the y variable is the ability to think creatively. Based on the results of the calculations that have been done, it can be concluded that there is an influence between variable x on variable y with a contribution of 49%, while the rest is influenced by other factors of 52%. The hypothesis obtained from the research results is presented in table 8 below:

**Table 8. Hypothesis Test Results**

| Correlation | $R_{hitung}$ | $R_{tabel}$ | Results |
|---|---|---|---|
| Analytical Thinking Ability with Creative Thinking Ability | **0,69** | **0,38** | **$H_a$ received** |

Based on table 8, the results of calculations carried out using the help of the casio fx-991ES calculator, the acquisition of rcount shows a value of 0.69, the value of the rtabel with a significance level of 5% or 0.05 of 0.38. So that based on the results of the calculations that have been done 0.69> 0.38. So that the calculation of the hypothesis based on the calculation is thus Ha accepted, H0 rejected. So from the calculation results it can be concluded that "there is a significant relationship between analytical thinking skills and creative thinking skills".

There are factors behind the research results of students' analytical thinking skills and creative abilities, namely students are used to practicing higher-order thinking skills. Another factor that makes high-order thinking skills (HOTS) high in students is because students have high enthusiasm for studying so that they get good results on higher-order thinking skills (Suratno et al., 2020). The way that must be applied or done to help develop higher-order thinking skills is to train students in solving and solving problems both through the questions given (Suryapuspitarini et al., 2018)

The results of the analysis obtained in this study, there is a contribution between analytical thinking skills and creative thinking skills of SMA Bakti Idhata students of 0.48 or 48%. As in the following theory which states that creative thinking by implementing it into a work of creativity to be able to increase the ability to think creatively, creative thinking aims to solve the problem requires the stages of analyzing the problem, then finding an idea, then arguing with the idea that is owned, then applying it be a creation or creativity (Firdaus et al., 2018). Analytical thinking skills and creative thinking skills are part of HOTS that must be trained to be able to reason problems to find solutions to these problems, innovate, and try to create something for the development of higher-order thinking skills that are owned (Nisa et al., 2018).

The research that has been obtained is based on the research that has been done, the authors provide suggestions for learning to be carried out that must always be related to a thought-solving problem related to higher-order thinking skills, so that the abilities that are owned can continue to be felt and developed, so that it becomes a habit of thinking. high level.

## CONCLUSION

Based on the results of the study, the contribution of analytical thinking skills to creative thinking skills has a strong category with a contribution of 48%.

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

## REFERENCE

[1] M. Nofiana and T. Julianto, "Upaya Peningkatan Literasi Sains Siswa Melalui Pembelajaran Berbasis Keunggulan Lokal," *Biosf. J. Tadris Biol.*, vol. 9, no. 1, pp. 24–35, 2018.

[2] A. D. Corebima, "Pembelajaran Biologi di Indonesia Bukan Untuk Hidup," *Semin. Nas. XIII Biol. Sains, Lingkungan, dan Pembelajarannya di Pendidik. Biol. FKIP UNS*, vol. 13, no. 1, pp. 8–22, 2016.

[3] I. Aripin, M. K. Sugandi, I. H. Mu'minah, and A. Mulyani, "PELATIHAN PEMBELAJARAN BIOLOGI ABAD 21," *BERNAS J. Pengabdi. Kpd. Masy.*, vol. 1, no. 3, pp. 150–158, Jul. 2020.

[4] S. Wening, "Revitalisasi Pendidikan Vokasi Melalui Inovasi Sistem Penilaian Berbasis Kecakapan Abad ke-21," *Pros. Semin. Nas. Pendidik. Tek. Boga dan Busana*, vol. 12, 2017.

[5] D. Kurniati, R. Harimukti, and N. A. Jamil, "Kemampuan Berpikir Tingkat Tinggi Siswa SMP di Kabupaten Jember dalam Menyelesaikan Soal Berstandar PISA," *J. Penelit. dan Eval. Pendidik.*, vol. 20, pp. 142–155, 2016.

[6] B. T. Setiawaty, W. Sunarno, and Sugiyarto, "Profil Kemampuan Berpikir Analisis Siswa Sekolah Menengah Pertama di Surakarta," pp. 234–238, 2019.

[7] Indriaty, "Telaah Kemampuan Berpikir Analisis Mahasiswa Pendidikan Biologi Melalui Tugas Meringkas Sejarah Perkembangan Mikrobiologi di Universitas Samudra," vol. 4, no. 2, pp. 54–60, 2017.

[8] R. R. Putri, Y. Ahda, and D. Rahmawati, "Analisis Aspek Kemampuan Berpikir Tingkat Tinggi pada Instrumen Penilaian Materi Protista untuk Peserta Didik SMA / MA Kelas X Aspect Analysis in Higher Order Thinking Skills on the Evaluation Instrument of Protist Topic for the Grade 10 Senior H," *J. BIODIK*, vol. 4, no. 1, pp. 8–17, 2018.

[9] Winarti, "Profil Kemampuan Berpikir Analisis Dan Evaluasi Mahasiswa Dalam Mengerjakan Soal Konsep Kalor," vol. 2, pp. 19–24, 2015.

[10] S. Nurkamilah, "Pengaruh Minat Belajar Terhadap Kemampuan Analisis Mahasiswa IPI Garut," *Life Sci. J. Pendidik. dan …*, vol. 1, no. 1, 2019.

[11] E. Suhartanto, J. Kartika, A. W. Sumarlin, A. Suhita, and R. Sofrani, *BREAKTHROUGH Thinking Bagaimana Cara para Inovator Berpikir*. Jakarta: PT Elex Media Komputindo, 2009.

[12] S. Asmi, M. Hasan, and R. Safitri, "Penerapan Model Pembelajaran Berbasis Proyek pada Materi Suhu dan Kalor untuk Meningkatkan Keterampilan Proses," *J. Pendidik. Sains Indones.*, vol. 05, no. 1, pp. 20–26, 2017.

[13] A. H. Panjaitan and E. Surya, "Creative Thinking (Berpikir Kreatif) dalam Pembelajaran Matematika," no. December, 2017.

[14] R. Sari, E. T. Massawet, and M. A. Masruhim, "Perangkat Pembelajaran Kecerdasan Eksistensial dan Keterampilan Berpikir Kreatif Siswa dalam Pembelajaran Biologi," pp. 1068–1075, 2018.

[15] S. W. Wibowo, E. Hartadiyati, W. Haryanti, S. P. Biologi, B. Kritis, and B. Kreatif, "Analisis Kemampuan Verbal Dan Pengaruhnya Terhadap Kemampuan Berpikir Kritis Dan Berpikir Kreatif Siswa SMA Dalam Pembelajaran Biologi Materi Echinodermata," pp. 134–139, 2018.

[16] W. P. Saroinsong, "Penerapan Model Pembelajaran Berbasis Proyek untuk Meningkatkan Keterampilan Berpikir Kritis dan Kreatif Mahasiswa," *J. Pendidik. Sains Indones.*, vol. 1, pp. 66–72, 2018.

[17] Y. B. P. Santosa, T. Nuriah, M. Winarsih, and Sarkadi, "Pengaruh Metode Pembelajaran dan Kemampuan Berpikir Kreatif Terhadap Hasil Belajar Sejarah Siswa di SMA Negeri 5 Depok Kelas 11 IPS," *J. Pendidik. Sej.*, vol. 6, pp. 1–11, 2017.

[18] F. Anggriani, B. Karyadi, and A. Ruyani, "Kemampuan Berpikir Kritis Siswa Melalui Pembelajaran Berbasis Lingkungan untuk Studi Ekosistem Sungai," *PENDIPA J. Sci. Educ.*, vol. 3, no. 2, pp. 100–105, 2019.

[19] Mahfud, "Berpikir dalam Belajar; Membentuk Karakter Kreatif Peserta Dididk," *J. tarbawi Al Haditsah*, vol. 1, no. 2, pp. 1–26, 2013.

[20] R. A. Sani, *Pembelajaran Berbasis HOTS (Higher Order Thinking Skills)*, Revisi. Tangerang: Tira Smart, 2019.

[21] Tarhadi, Kartono, and Yumiati, "Penggunaan Tes Uraian Dibandingkan dengan Tes Pilihan Ganda Terstruktur dan Tes Pilihan Ganda," *J. Pendidik.*, no. September, pp. 101–109, 2007.

[22] A. Suharsimi, "Dasar-Dasar Evaluasi Pendidikan," Jakarta: Bumi Aksara, 2013.
[23] Nurmalasari and D. Wulandari, "Pengaruh Penggunaan Gadget Terhadap Tingkat Prestasi Siswa SMPN Satu Atap Pakisjaya Karawang," vol. 3, pp. 211–218, 2018.
[24] T. N. Irawati and M. Mahmudah, "Pengembangan Instrumen Kemampuan Berpikir Analisis Siswa SMP dalam Menyelesaikan Soal Pemecahan Masalah Matematika," *Kadikma J. Mat. dan Pendidik. Mat.*, vol. 9, pp. 1–11, 2018.
[25] D. N. Fithriyah, M. N. Fadlil, and N. N. Fithriyah, "Penerapan Strategi Catatan Terbimbing Untuk Meningkatkan Pemahaman Mata Pelajaran IPS Kelas IV MI Islamiyah Pakel Montong Tuban," *Elem. J. Ilm. Pendidik. Dasar Islam*, vol. 2, pp. 33–39, 2020.
[26] A. Kusdiwelirawan, *Statistika Pendidikan*. Jakarta: UHAMKA PRESS, 2014.

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

# The Effect of Inquiry Learning on Science Process Skills of Pre-Service Elementary School Teacher

**Prima Mutia Sari[1]**

[1]University of Muhammadiyah Prof. Dr. HAMKA
Jl. Tanah Merdeka, Kp Rambutan, Pasar Rebo, East Jakarta 13830, Indonesia

*Correspondence email: primamutiasari@uhamka.ac.id

## ABSTRACT

The aim of the research was to analyze the effect of inquiry learning on science process skill of pre-service elementary school teacher student. The research method was Quasy Experiment with The One Group Pretest-Posttest Design. The research population was all 5th students of pre-service elementary school teacher in one of private universities in Jakarta. The research sample was class 5E, the sampling technique was Cluster Random Sampling. The research instrument was science process skill test. The data analysis using t-test Sample K_S One Sample Kolmogorov Smirnov. The result showed that there was a significant difference of science process skill between pretest and posttest. Therefore, there was an effect of Inquiry Learning on science process skills.

**Keywords:** Science process skill, inquiry learning, elementary school

## INTRODUCTION

Science process skills are the basic skills for understanding science. Science process skills are skills that students use when doing science that is developed through an investigation or problem solving. Science process skills need to be possessed by a preservice elementary school teacher because according to the results of research a teacher who has an understanding in mastering science process skills will be able to apply them in learning [1]. Furthermore, based on the results of research on students of the elementary school teacher education in one of private universities in Jakarta , the results of science process skills of students are still low with an average value of all indicators of 46.46 [2]. One way to improve science process skills is to use the Inquiry Learning.

Inquiry has some variation in the application at the classroom. There are four types of inquiry: 1) Confirmation or Verification (student confirm a concept through an activity, the result has been determine before), 2) Structured Inquiry (student investigate a question which was given by teacher through some procedures which was determined by the teacher), 3) Guided Inquiry (student investigate a question which was given by teacher through some procedures which was determined by student), 4) Open Inquiry (student investigate a topic which was determined by student itself use procedures which was determined by student itself) [3]. In this research, the researchers used guided inquiry. Moreover, a research in elementary school in Turkey revealed that guided inquiry helped to improve level student academic achievement, however, the influence of model for academic achievement was smaller than science process skills. On the other hand, this model could increase science process skills of student [4].

## RESEARCH METHOD

The research method was Quasy Experiment with The One Group Pretest-Posttest Design. The research population was all 5th students of pre-service elementary school teacher in one of private universities in Jakarta. The research sample was class 5E, the sampling technique was Cluster Random Sampling. The research instrument was science process skill test. The data analysis using t-test Sample K_S One Sample Kolmogorov Smirnov.

## RESULTS AND DISCUSSION

The result showed that there was a difference of science process skill value between pretest and posttest like the picture below.

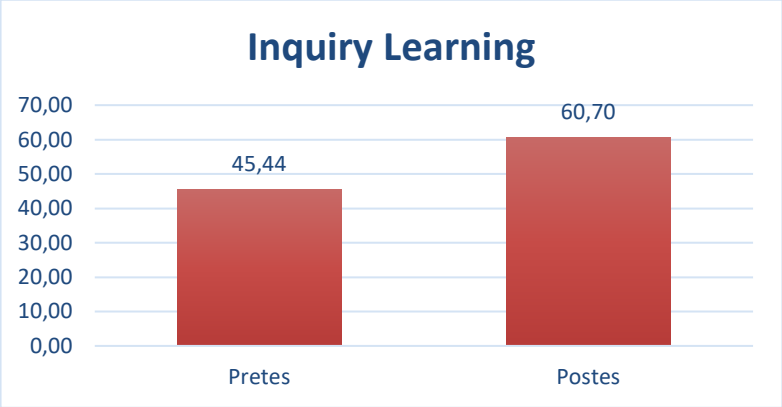



**Fig 1.** The Average Difference between Pretest and Posttest

Furthermore, the average value of science process skill was tested using t test Sample K_S One Sample Kolmogorov Smirnov. There are prerequisite tests that must be done before the t test, namely the normality test and the homogeneity test. The result of normality tests like table below.

**Table 1.** Normality Test Result

| Kind of Test | Significance Level | Criteria of Significance Level | Conclution |
|---|---|---|---|
| Pretest | 0.198 | 0.05 | Data was distributed normally |
| Posttest | 0.001 | 0.05 | Data was not distributed normally |

Furthermore, the result of homogeneity test were shown in table 2 below..

**Table 2.** Homogeneity Test Result

| Kind of Test | Significance Level | Criteria of Significance Level | Conclution |
|---|---|---|---|
| Homogeneity Test | 0.48 | 0.05 | Data was not homogen |

Based on the normality and homogeneity result, the statistical test used were a non-parametric test namely t test Sample K_S One Sample Kolmogorov Smirnov like table 3 below.

**Table 3.** The Result of 1 Sample K_S Test: One Sample Kolmogorov Smirnov

| Kind of Test | Significance Level | Criteria of Significance Level | Conclution |
|---|---|---|---|
| 1 Sample K_S Test: One Sample Kolmogorov Smirnov | 0.000 | 0.05 | There was a significant difference |

Based on the result above, it seemed that there was a significance difference between pretest and posttest of science process skills. Therefore, Inquiry Learning gave an effect for science process skill value. This was suitable with a research about application of Inquiry Based Learning in 5th grade of elementary school student in Turkey, the research revealed that Inquiry Learning gave an influence to science process skill especially on measuring, classification and hypothesizing skill [5]. Moreover, this result also supported with the application of 12 hours inquiry activities in grade 11 student in Thailand that result described that those activities can improve student integrated science process skill [6]. The

difficulties of this research was lack of the time because some obstacles like flood and many holidays. Then, in the beginning, students looked still confused with what they must done with the activities.

## CONCLUSIONS

Based on the research that has been done can be concluded that Inquiry Learning gave an effect to science process skills of preservice elementary school teacher. Based on the conclusions that have been drawn, the researchers gave the following recommendations. First, lecturer should develop learning that can improve the science process skill. Second, student should be introduced to a model before the lecturer use it.

## REFERENCES

[1] J. Ambross, L. Meiring, and S. Blignaut, "The implementation and development of science process skills in the natural sciences : A case study of teachers ' perceptions," no. February 2015, pp. 37–41, 2014.
[2] P. M. Sari and Zulfadewina, "Profile of Science Process Skill Mastery from Pre-service Elementary School Teacher," *J. Inov. Pendidik. Dasar*, vol. 3, no. 2, pp. 65–72, 2018.
[3] Randy L. Bell, Lara Smetana, and Ian Binns, "Simplifying Inquiry Instruction," *Sci. Teach.*, vol. 72, pp. 30–33, 2005.
[4] E. A. Koksal and G. Berberoglu, "The Effect of Guided-Inquiry Instruction on 6th Grade Turkish Students ' Achievement , Science Process Skills , and Attitudes Toward Science," *Int. J. Sci. Educ.*, vol. 36, no. November 2014, pp. 66–78, 2014.
[5] P. Şimşek and F. Kabapinar, "The effects of inquiry-based learning on elementary students' conceptual understanding of matter, scientific process skills and science attitudes," *Procedia - Soc. Behav. Sci.*, vol. 2, no. 2, pp. 1190–1194, 2010.
[6] W. Lati, S. Supasorn, and V. Promarak, "Enhancement of Learning Achievement and Integrated Science Process Skills Using Science Inquiry Learning Activities of Chemical Reaction Rates," *Procedia - Soc. Behav. Sci.*, vol. 46, pp. 4471–4475., 2012.

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

# Development of Blended Learning Media Using Epocket Book Based on Character Values

**Lutfiatul Afifah[1*], Imas Ratna Ermawati[1]**

[1]Department of Physics Education, Universitas Muhammadiyah Prof. DR. Hamka
Jl. Tanah Merdeka, Kp Rambutan, Pasar Rebo, East Jakarta 13830

*Correspondence email: luthfiaaa28@gmail.com

## ABSTRACT

This research was conducted to address the problem of learning activities of students who are less active and lack understanding of learning materials. The purpose of this research is to develop the medium of physics learning in the form of applications on mathematics physics courses for many function materials. This research is a development research by adopting ADDIE development model. At the analysis stage, researchers conduct library studies and field studies, namely by conducting needs analysis. At the design stage researchers conduct product design, and instrument manufacturing. At the development stage researchers asked experts to test the validation of products already made. Then the implementation stages of the product are tested to the respondent, to see if the product is viable or not implemented in the learning process in the classroom. The final stage is evaluation, the product is evaluated so that the product can be used at a wider range. At the field trial stage, the media was tested on a small scale with 25 respondents. Data obtained through observation methods is descriptively qualitatively analyzed. Meanwhile, validation data is analyzed descriptively qualitatively and quantitatively. Average material expert score 78.34% (good), media expert 80.00% (good), small scale test 81.69% (good), large-scale test 81.73% (good), character score result 79.21% (often). So it can be concluded that this application is worth using as a physics learning medium

**Keywords:** Media Learning, blended Learning, epocket book

## INTRODUCTION

Education becomes a provision in the future, which is indeed needed by every human being. Education can be referred to as a provision, because in fact education is an establishment and development of self-potential that will be useful for life in the long term. This is in line with the national educational objectives described in (Law No. 20 of 2003) that stated, "Education is a conscious and planned effort to realize the learning atmosphere and learning process so that students actively develop their potential to have religious spiritual strength, self-control, personality, intelligence, noble morality, as well as the skills necessary for themselves, society, nation and State" [1].

[5] argue that, "science and technology or science technology are developing to encourage various reform efforts in the utilization of technological outcomes in the learning process" [2]. The benefits of technology itself are huge in the world of education, especially in learning systems, because information and communication technology provides a wide range, fast, effective, and efficient to the dissemination of information to various corners of the world. One of the fast-growing technologies is the arrival of gadgets called smartphones. [5] in his research stated that, "according to the results of the market share in December 2013 as cited by [5] shows that the gadget market presentation is controlled by Android by 81.3%" [3].

The utilization of information and communication technology for higher education learning activities in Indonesia is increasing and conducive to the publication of the Decree of the Minister of The Ministry of National Education (SK Mendiknas) in 2001 that encourages conventional universities to conduct distance education. With the publication of the Mendiknas Decree, a blended learning process is implemented in a learning.

According to [4] argue that, "blended learning is a combination of face-to-face learning system and online learning" [4]. Blended learning is also known as hybrid learning and mixed learning. Blended learning learning is supported by an effective combination of delivery methods, teaching methods and different learning styles. According to Driscoll in [5], "blended learning can also be the integration of materials in

different formats" [5]. For example, a blended learning program starts with the delivery of prerequisite material asynchronously, then the delivery of the next material is done through a virtual class. Efforts to improve learning are designing a learning medium in an effort to facilitate the learning process.

Online learning media is one of the solutions for learning in this era of industry 4.0, where indeed learning in the classroom must benefit from a technological advancement. Interesting and not boring learning media that students desperately need. Learning media that will generate interest in learning especially in physics learning. One way is with an epocket book.

Pocket book is a book containing learning materials compiled succinctly. The advantage of e-pocket book is that it contains a summary of the material, easy to carry anywhere, and efficient. Pocket book to be presented in the form of an application. The content of this e-pocket book is, among others: theory, images, videos explaining the concept of materials, quis, which are used for discussion, task creation or assignment delivery, and online whiteboards that will be used as supporting the blended learning model.

Based on the results of preliminary studies that have been conducted by filling out online questionnaires on Students at two universities located in Jakarta 56% stated that there needs to be an online learning. Respondents also chose mobile phones as a medium that supports learning with a percentage of 62.02%. This is because mobile phones can be used more practically to study at any time, and carried anywhere. A total of 52.08% said they needed an epocket book. Students choose online learning by using epocket book because it can support in understanding a material, more effective and efficient, can be carried anywhere and opened at any time because the mobile phone seems to never be left to carry. Based on the above description stipulated as a problem, it can be concluded that researchers aim to develop learning media using epocket book based on character value.

## RESEARCH METHOD

In a study, the research method is interpreted as a scientific way of obtaining data with specific purposes and uses [12]. This research includes development research using research and development (R&D) methods. This research uses procedural model development methods developed by ADDIE. The data analysis techniques used are qualitative and quantitative descriptive analysis. The data obtained came from a validator consisting of material experts, language experts, and media experts, and two reviews and respondents. Steps to produce learning media as follows: needs analysis, media creation design, design data collection, media design loading, media creation, validation, trial, and revision

## RESULTS AND DISCUSSION

Text Preliminary study results include library study results and field study results. The results of the library study were obtained from various reading sources related to this study. The results of the field study were obtained using interview sheets and questionnaires distributed to a number of respondents who sampled in this study and used literary studies. Research instruments used are interview sheets, questionnaires and literature related to the learning media Blended Learning Epocket Book.

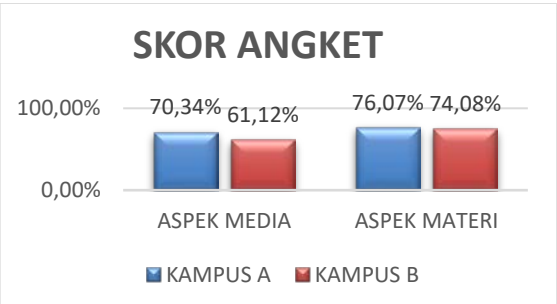



**Fig 1.** Score for each Aspect Questionnaire

Based on the results of the questionnaire given to students who are studying the Physics Education Study Program, most students need an epocket book in order to understand the concept of materials

well. Based on preliminary studies conducted on campus A, the average results were 70.34% on media aspects and 76.07% on material aspects. Meanwhile, preliminary studies on campus B obtained an average of 61.12% on media aspects and 74.08% on material aspects.

For the development stage, the product is validated by two experts, namely for material experts and media experts. The results of the media expert validation test are as follows:

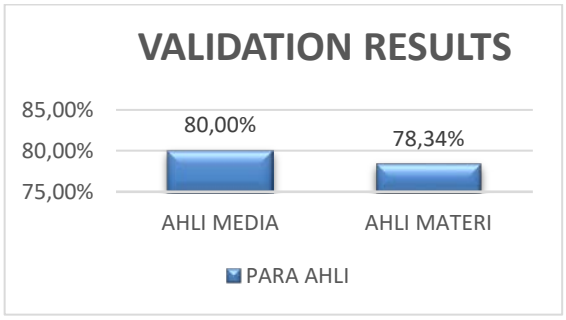
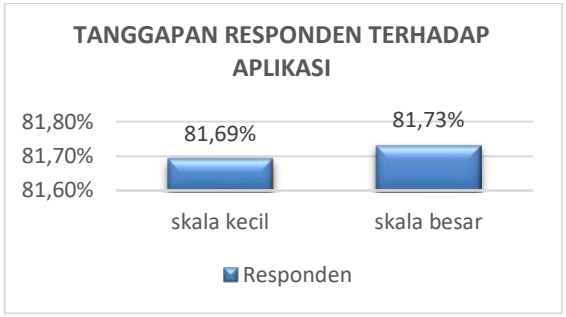



**Fig 2.** Expert Validation Results

Based on the chart above, the results of validation tests by media experts with four indicators get 80.00% percentage with good category, while the results from material experts with two indicators get a percentage of 78.34% with good category.

Then at the implementation stage, the application is tested to the respondent. This is done to know whether or not the application is feasible if it is implemented as a learning medium into the learning process in the classroom. This can be seen in graph 3




**F 3.** Results of Respondents' Responses to Applications

In this study, product testing was conducted on a small and large scale. For small scale there are 25 Respondents, while large scale 58 Respondents. The result of respondents' response on a small scale was to get a percentage of 81.69% with good category. Then for responses of respondents on a large scale that is 81.73% with good category. It can be concluded that the products developed in this study deserve to be implemented into the learning process in the classroom.

## CONCLUSION

The end result of this development is a blended learning medium implemented into the application of epocket book with discussion on mathematical physics material. Where there are several features, among others: materials in pdf form, videos explaining material concepts, examples of questions and exercises, notif assignments for assignments or assignment delivery, and online whiteboards that will be used as supporting blended learning models.

The developed media has also passed the due diligence phase by material experts and media experts. Assessments by material experts earned a percentage of 78.34% in the good category. Assessments by media experts get a percentage of 80.00% in good categories. Based on expert assessment of materials and media then the developed media is worth using.

In addition to being assessed by material experts and media experts, the media developed by researchers was also tested on students. Small-scale trials were conducted for 25 students. In small-scale trials, it gained a percentage value of 81.69% with good predicate.

Then there was also a large-scale trial of 58 students. The results of large-scale trials gained a percentage of 81.73% with good predicate. This means that the media developed by researchers can be said to be worth using.

## REFERENCES

[1] *"Undang-undang nomor 20 tahun 2003 tentang Sistem Pendidikan Nasional".* Jakarta: Transmedia Pusaka, 2008
[2] Rusman, dkk., "*Pembelajaran Berbasis Teknologi Informasi dan Komunikasi".* Depok: PT RajaGrafindo Persada, 2012.
[3] Sumiharsono, Rady dan Hasanah, H. 2018. *Media Pembelajaran*. Jember: Pustaka Abadi.
[4] Khuluqo, Ihsana El. "*Belajar dan Pembelajaran Konsep Dasar".* Yogyakarta: Pustaka Pelajar, 2017
[5] Marhadini, SAK., dkk. "*Pengembangan Media Pembelajaran Berbasis Android pada Materi Gerak Parabola untuk Siswa SMA"* Unnes Physics Education Journal, 2017.
[6] Hamka, Defrizal dan Noverta Effendi., "P*engembangan Media Pembelajaran Blended Learning Berbasis Edmodo Pada Mata Kuliah Fisika Dasar di Program Studi Pendidikan IPA", Jurnalunimed*, 2019.
[7] Banggur, MDV, dkk. "*Pengembangan Pembelajaran Berbasis Blended Learning pada Mata Pelajaran Etimologi Multimedia*. Journalpendidikan, 2018.
[8] Puri, Sekar Asrining "*Pengembangan Media Pembelajaran Berbasis Blended Learning pada Mata Kuliah Tailoring*. Jurnal Tata Busana, Vol 7, no. 3, 2018
[9] Ash-Shiddieqy "*Pengembangan Mobile Pocket Book sebagai Media Pembelajaran Berbasis Android Menggunakan Adobe Flash Professional CS 5.5 Pada Materi Gerak Lurus SMA Kelas X. Skripsi*, Universitas Sebelas Maret, 2015.
[10] Salyani, Resi., dkk "*Pengembangan Buku Saku pada Materi Reaksi Reduksi Oksidasi (Redoks) di MAN Model Banda Aceh",* Jurnal Unsyiah, 2018.
[11] Syahroni "*Pengembangan Buku Saku Elektronik Berbasis Android Tentang Signal-Signal Wasit Futsal Untuk Wasit Futsal Di Kabupaten Pasuruan",* 2016.
[12] Sugiyono, S "Metode Penelitian Pendidikan". Bandung: Alfabeta, 2015

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

# The Level of Students' Critical Thinking Skills and Mathematical Reasoning

**Muhamad Akrom[1*], Triyanto[1], F Nurhasanah[1]**

[1]Universitas Sebelas Maret Surakarta, Jl. Ir. Sutarmi No. 36A, Surakarta, Jawa Tengah 57126

*Correspondence email: akromyoums43@gmail.com

## ABSTRACT

The purpose of this topic is to determine students' critical thinking skills and mathematical reasoning on the absolute value topic. This type of research is quantitative study with quantitative descriptive design. Participants of the research are grade X students in three different schools in the Surakarta. The total number of the participants are 83. The data collection technique was carried out by using a test consisting of 4 question items. The Result study shows that students who had low critical thinking skills were 86%, students who had medium critical thinking skills were 12%, and students who had high critical thinking skills were 2%. Whereas for students who have low mathematical reasoning as much as 60%, students who have medium mathematical reasoning abilities are 29%, and students who have high mathematical reasoning abilities are 11%. These results indicate that there are still many students who have low critical thinking skills and there are still many students who have low mathematical reasoning abilities.

**Keywords:** Critical thinking, mathematical, skills, systematically

## INTRODUCTION

**B**ody In the 21st century, students must have a high-level thinking skill [1]. Cheng [2] stated that 21st century skills and literacy include basic skills, technology skills, problem solving skills, communication skills, critical and creative thinking skills, information or digital skills, inquiry or reasoning skills, interpersonal skills, and multicultural and multilingual skills. Therefore critical thinking skills and reasoning abilities are important for students to have. In this case, the efforts made by the government are contained in the 2006 Ministry of Education Regulation. The Minister of National Education Regulation (Permendiknas, 2006) that the competency standards that apply in mathematics learning at the secondary school level must improve students' logical, analytical, systematic, critical, creative, and cooperative abilities[3]. Besides, the Minister of National Education Regulation No. 22 of 2006 concerning Content Standards for Elementary and Secondary Education Units stipulates that one of the goals of mathematics is to enable students to push themselves to achieve reasoning abilities in terms of patterns and qualities, carry out mathematical manipulations in generalizing, gathering evidence, or explaining ideas and statements mathematics [4].

Some experts put forward the definition of critical thinking including namely Ennis in Baron and Stenberg (1987) stated that critical thinking is defined as reflective thinkingwhich is grounded and focused on the determination of what is believed or done[5]. According to Hassoubah [6],critical thinking is the ability to give reasons in an organized manner and evaluate the quality of a reason systematically. Whereas Glazer [7] explained that critical thinking is ability and disposition to involve prior knowledge, mathematical reasoning, and cognitive strategy to generalize, prove or evaluate unfamiliar mathematical situation reflectively.

Marzano said [8], components of critical thinking skills are analyzing, making comments, self-regulation, assumption identification, explanation, and evaluation. Sumarmo [9] revealed that indicators of mathematical critical thinking ability consisted of 1) focusing on one question, problem, and theme. 2) check the truth of arguments, statements and solution processes. 3) ask and answer accompanied by reasons. 4) observe with criteria, identify assumptions, understand well, and identify relevant and irrelevant data. 5) reduce and induce. 6) make judgments, assess thoroughly. 7) find alternatives. Whereas Ennis [10] revealed 12 indicators of critical thinking skills divided into the following five major groups, 1) providing simple explanations such as focusing questions, analyzing arguments, asking and answering about an explanation or challenge, 2) building basic skills such as considering the credibility

of the source, observing and considering an observation report, 3) concluding such, deducting and considering the results of the deduction, inducing and considering the results of induction, making and determining the value of consideration, 4) providing further explanations such as, defining terms and considering definitions, 5) identify assumptions. Manage strategies and tactics such as, determine actions, interact with others.

[11]The mathematical reasoning is the skill of learners to give reasons and prove the outcome of their thinking using time and manner or procedure appropriately. Mathematical reasoning is a basic of mathematics in understanding the concepts, ideas and procedures to draw a conclusion [12]. Ario stated that in general mathematical reasoning can be classified into two types, namely inductive reasoning and deductive reasoning. Inductive reasoning is reasoning based on a limited number of cases or examples that are observed. Deductive reasoning is the process of reasoning from knowledge of principles or general experience that leads us to conclusions for a particular [13]. Sumarmo and Hendriana [14] further explained inductive reasoning including analogy reasoning, generalization, estimation or estimation of answers and solution processes, and constructing conjectures. Inductive reasoning above can be classified as thinking mathematically low or high level depending on the complexity of the situation involved. While deductive reasoning includes performing arithmetic operations; draw logical conclusions; explain the model, facts, nature, relationships or patterns; propose opposing examples; follow the rules of inference; check the validity of arguments; construct valid arguments; formulate a definition; and construct direct proof, indirect proof, and proof by mathematical induction.

Based on the description above, the researcher will investigate the level of critical thinking skills of students with indicators: analyze and explain questions, answers, or arguments, make deductions; and students' mathematical reasoning abilities with indicators: make logical conclusions, estimate answers and process solutions, proof, and carry out calculations based on certain rules or formulas.

## RESEARCH METHOD

The research method used is quantitative study with quantitative descriptive design. The quanitative descriptive research methods have become the common procedures in conducting the research in many disciplines, including education[15]. The participants of the study are grade X students in three different schools in the Surakarta. The total number of the participants are 83.

In this study, there are 3 stages, namely: (1) Preparation stage, wherein this preparation stage makes and studies problems contained in the field, makes the background of theoretical studies, arranges instruments, prepares instruments, manages licenses to the principal by asking permission to the School Representative in the Curriculum field, then discuss with the mathematics subject teacher to determine the schedule and class to be examined. (2) The next stage is the implementation phase, where at this stage provides tests in the form of instruments about critical thinking skills and mathematical reasoning to students in the form of 4 item description questions that have been consulted with the supervisor. (3) The next step is to analyze the data obtained from the provision of critical thinking skills tests and mathematical reasoning of grade X students on the absolute value topic. The results of student work are then given a score by referring to the grading rubric that has been modified as in Table 1.

**Table 1.** Scoring Rubric of Students' Critical Thinking Ability

| Indicator | Student responses to questions | Score |
|---|---|---|
| Analyze and explain questions, answers, or arguments | Does not answer or answer does not match the problem | 0 |
| | Expressing most of the questions, answers or arguments correctly. | 1 |
| | Expressing a part of the question, answer or argument correctly. | 2 |
| | Expressing almost all questions, answers or arguments correctly. | 3 |
| | Express all the questions, answers or arguments correctly and completely | 4 |
| Do deductions | Does not answer or answer does not match the problem. | 0 |
| | Do almost the right deduction | 1 |
| | Do a partial deduction correctly | 2 |
| | Do almost complete deduction correctly. | |

| | |
|---|---|
| Perform deductions correctly and completely | 4 |

Grouping criteria for students' critical thinking skills according to Arikunto [16] as in Table 2 below.

**Table 2.** Criteria for Critical Thinking Ability

| Score | Criteria |
|---|---|
| $\mathbf{80\% - 100\%}$ | Very high |
| $\mathbf{66\% - 79\%}$ | High |
| $\mathbf{56\% - 65\%}$ | Medium |
| $\leq \mathbf{55\%}$ | Low |

As for the assessment of mathematical reasoning ability based on the following Table 3.

**Table 3.** Scoring Rubrics on Students' Mathematical Reasoning Capabilities

| Indicator | Student responses to questions | Score |
|---|---|---|
| Make logical conclusions | Does not answer or answer does not match the problem | 0 |
| | Conclude from false statements | 1 |
| | Conclude from statements but there are some errors | 2 |
| | Conclude from statements but there are few errors | 3 |
| | Draw conclusions from statements | 4 |
| Estimating the answer and the solution process. | Not answering or answering is not following the problem | 0 |
| | Proposing the answer is almost partially correct | 1 |
| | Propose a possible answer partially correct | 2 |
| | Propose possible answers with almost all of them correct | 3 |
| | Submitting possible correct and complete answers | 4 |
| Proof | Does not answer or answer does not match the problem | 0 |
| | Carry out proof that is almost partly true | 1 |
| | Carry out partial proof correctly | 2 |
| | Carry out proof that is almost entirely correct | 3 |
| | Proving correctly and completely | 4 |
| Carry out calculations based on certain rules or formulas | Does not answer or answer does not match the problem | 0 |
| | Finding the relationship between facts, concepts, principles of certain rules in solving problems is almost partly true | 1 |
| | Finding the relationship between facts, concepts, principles of certain rules in problem-solving with partially correct | 2 |
| | Finding the relationship between facts, concepts, principles of certain rules in solving problems is almost entirely correct | 3 |
| | Finding the relationship between facts, concepts, principles of certain rules in solving problems correctly and completely. | 4 |

Furthermore, to find out the category of student scores can be seen in the following Table 4.

**Table 4.** Categories of Results in Students' Mathematical Reasoning Assessment Capabilities [17]

| Category | Achievement of Mathematical Reasoning Capabilities |
|---|---|
| High | $> 70\%$ |
| Medium | $55\% \geq 70\%$ |
| Low | $< 55\%$ |

## RESULTS AND DISCUSSION

Students data regarding critical thinking skills and mathematical reasoning abilities of students are then processed to determine the level of student ability. The results of student data processing on critical thinking skills are presented in Table 5 below.

**Table 5.** Level of students' critical thinking skills

| Category | Total Students | Percentage |
|---|---|---|
| High | 2 | 2% |
| Medium | 10 | 12% |
| Low | 71 | 86% |

Next is shown the percentage of the number of students in each score on each indicator as in Table 6 below.

**Table 6.** Percentage of Number of Students in Each Score on the Critical Thinking Indicator

| Indicator | No. Question | Score 1 | | Score 2 | | Score 3 | | Score 4 | |
|---|---|---|---|---|---|---|---|---|---|
| | | N | % | N | % | N | % | N | % |
| Analyze and explain questions, answers, or arguments | 1 | 57 | 68,67 | 16 | 19,28 | 6 | 7,23 | 1 | 1,20 |
| Do deductions | 2 | 19 | 22,89 | 31 | 37,35 | 20 | 24,10 | 3 | 3,61 |

Based on the data in table 6 above, it can be seen that from the research subjects were 83 students, the number of students on the indicator analyzed and explained questions, answers or arguments score 1 was 68.67%, score 2 was 19.28%, score 3 was 7, 23%, and a score of 4 as much as 1.20%. From these scores, it can be concluded that the highest number of students is in score 1, thus 68.67% of students can only state most questions, answers or arguments correctly. More details are presented in the form of a pie chart as in Figure 1 below.

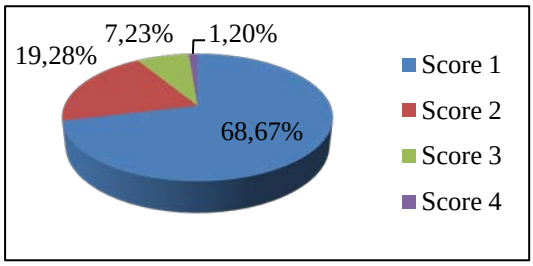



**Figure 1.** Percentage of Number of Students in Each Score on the Indicator Analyzing and Explaining Questions, Answers, or Arguments

On the indicators of deduction, the number of students on a score of 1 was 22.89%, score of 2 was 37.35%, a score of 3 was 24.10%, and score of 4 was 3.61%. From these scores, it was concluded that the percentage of the number of students who dominated the indicators of deduction was a score of 2, thus 37.35% of students did a partial deduction correctly. More details are presented in the form of a pie chart as in Figure 2 below.

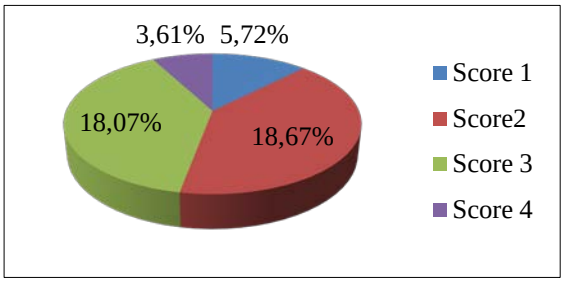



**Figure 2.** Percentage of Number of Students in Each score on the Indicator Deduction

While the results of student data processing on mathematical reasoning ability are presented in Table 7 below.

**Table 7.** Students' Mathematical Reasoning Ability Levels

| Category | Total Students | Percentage |
|---|---|---|
| High | 9 | 11% |
| Medium | 24 | 29% |
| Low | 50 | 60% |

Next is shown the percentage of the number of students in each score on each indicator as in Table 8 below.

**Table 8.** Percentage of Number of Students in Each Score on the Mathematical Reasoning Indicator

| Indicator | No. Question | Score 1 | | Score 2 | | Score 3 | | Score 4 | |
|---|---|---|---|---|---|---|---|---|---|
| | | N | % | N | % | N | % | N | % |
| Make logical conclusions | 1a | 27 | 32,53 | 20 | 24,10 | 18 | 21,69 | 13 | 15,66 |
| Estimating the answer and the solution process. | 1b | 24 | 28,92 | 15 | 18,07 | 11 | 13,25 | 31 | 44,57 |
| Proof | 2a | 59 | 71,08 | 11 | 13,25 | 3 | 3,61 | 4 | 4,82 |
| Carry out calculations based on certain rules or formulas | 2b | 12 | 14,46 | 32 | 38,55 | 4 | 4,82 | 7 | 8,43 |

Based on the data in table 8 above, it can be seen that from the research subjects as many as 83 students, the number of students on the indicators making logical conclusions on a score of 1 was 32.53%, a score of 2 was 24.10%, a score of 3 was 21.69%, and a score of 4 was 15.66%. From these scores, it can be concluded that score 1 is a score that dominates among other scores, thus 32.53% of students conclude false statements. More details are presented in the form of a pie chart as in Figure 3 below.

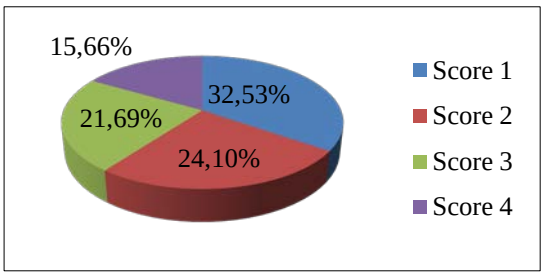



**Figure 3.** Percentage of the Number of Students in Each Score on the Indicator Making Logical Conclusions

The number of students on the indicator estimates the answer and the solution process obtained a score of 1 was 28.92%, a score of 2 was 18.07%, a score of 3 was 13.25%, and a score of 4 was 44.57%. From these scores, it can be concluded that the score that dominates among other scores is a score of 4, thus 44.57% of students can submit possible answers correctly and completely. More details are presented in the form of a circle diagram as shown in Figure 4 below.

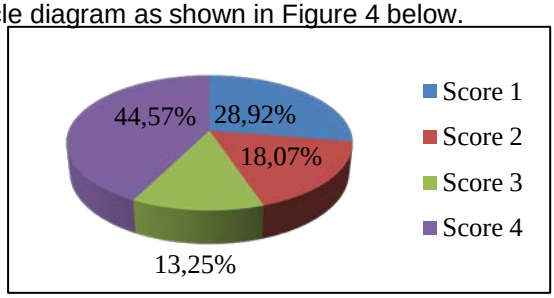



**Figure 4.** Percentage of Number of Students in Each Score on Indicator Estimating Answers and Solution Process

The number of student scores on the proof indicator obtained a score of 1 was 71.08%, a score of 2 was 13.25%, a score of 3 was 3.61%, and a score of 4 was 4.82%. From these scores, it can be concluded that the score that dominates among other scores is a score of 1, thus as much as 71.08%, students can only do proof with almost partially correct. More details are presented in the form of a pie chart as in Figure 5 below.

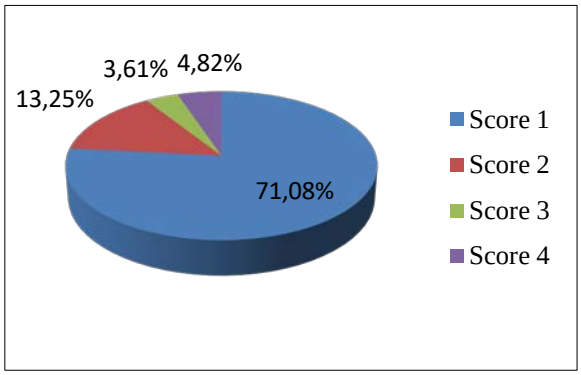



**Figure 5.** Percentage of Number of Students in Each Score on the Proof Indicator

The number of students in each score on the indicator carrying out calculations based on certain rules or formulas obtained a score of 1 was 14.46%, a score of 2 was 38.55%, a score of 3 was 4.82%, and a score of 4 was 8.43%. From these scores, it can be concluded that the score dominates among other scores is score 2, thus 38.55% of students can find the relationship between facts, concepts, principles of certain rules in solving problems partially correctly. More details are presented in the form of a circle diagram as shown in Figure 6 below.

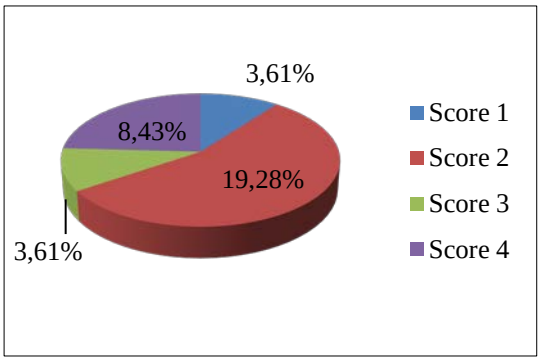



**Figure 6.** Percentage of Number of Students in Each Score on the Indicator Carry Out Calculations Based on Specific Rules or Formulas

## CONCLUSIONS

Based on the description above, it can be concluded that students who have low critical thinking skills are 86%, students who have moderate critical thinking skills are 12%, and students who have high critical thinking abilities are 2%. Furthermore, the percentage of the number of students who dominated in each score on the indicator of critical thinking ability starts from analyzing and explaining questions, answers or arguments is a score of 1 as much as 68.67%, the number of students in each score on the indicator of deduction that dominates is a score of 2 as much as 37, 35%. Whereas for students who have low mathematical reasoning as much as 60%, students who have moderate mathematical reasoning abilities are 29%, and students who have high mathematical reasoning abilities as much as 11%. Furthermore, the percentage of the number of students who dominated in each score on the indicators of mathematical reasoning ability starting from making logical conclusions is a score of 1 as much as 32.53%, the number of students in each score on the indicator giving answers and the solution process that dominates is a score of 4 as much as 44.57%, the number of students in each score on the indicator proves that the dominant one is 71.08%, and the number of students in each score on the indicator to calculate based on certain rules or formulas that dominate is a score of 2 as much as 38.55%.

## REFERENCES

[1] N. N. Alifia, Budiyono, and D. R. S. Saputro, “Mathematical Critical Thinking Skills Profile of High School Students in Solving Linear Program Word Problems,” *J. Phys. Conf. Ser.*, vol. 1211, no.

1, pp. 1–8, 2019.
[2] A. N. Chasanah, "Cognitive Growth Learning Model to Improve the Students' Critical Thinking Skills," *JRAMathEdu (Journal Res. Adv. Math. Educ.*, vol. 4, no. 2, pp. 112–123, 2019.
[3] L. P. Apriliana, I. Handayani, and S. A. Awalludin, "The Effect of a Problem Centered Learning on Student's Mathematical Critical Thinking," *JRAMathEdu (Journal Res. Adv. Math. Educ.*, vol. 4, no. 2, pp. 124–133, 2019.
[4] W. Ayuningtyas, Mardiyana, and I. Pramudya, "Analysis of student's geometry reasoning ability at senior high school," *J. Phys. Conf. Ser.*, vol. 1188, no. 1, pp. 1–8, 2019.
[5] R. Widyatiningtyas, Y. S. Kusumah, U. Sumarmo, and J. Sabandar, "The Impact of Problem Based Learning Approach for Senior High School Students' Mathematics Critical Thinking Ability," *J. Math. Educ.*, vol. 6, no. 2, pp. 107–116, 2015.
[6] T. dkk Martaida, "The Effect of Discovery Learning Model on Student's Critical Thinking and Cognitive Ability in Junior High School," *IOSR-JRME*, vol. 7, no. 6, pp. 1–8, 2017.
[7] R. Runisah, T. Herman, and J. A. Dahlan, "Using the 5E Learning Cycle with Metacognitive Technique to Enhance Students' Mathematical Critical Thinking Skills," *Int. J. Emerg. Math. Educ.*, vol. 1, no. 1, pp. 87–98, 2017.
[8] G. S. Aktaş and M. Ünlü, "Critical Thinking Skills of Teacher Candidates of Elementary Mathematics," *Procedia - Soc. Behav. Sci.*, vol. 93, pp. 831–835, 2013.
[9] A. Pebianto, G. Gunawan, R. Yohana, and A. Nurjaman, "Analisis Kemampuan Berpikir Kritis Siswa MTsN Kota Cimahi pada Materi Persamaan Linier Dua Variabel Ditinjau dari Kepercayaan Diri," *J. Educ.*, vol. 01, no. 03, pp. 9–20, 2019.
[10] L. P. I. Budayawati, V. Jovanka, S. Fitriyah, and Z. Finali, "The Analysis of The Implementation of Research-Based Learning to Improve Students' Critical Thinking Skills Based on Their Cognitive Style," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 243, no. 1, pp. 1–10, 2019.
[11] G. I. Ratnasari and A. M. Abadi, "Investigating Mathematical Literacy, Mathematical Reasoning Skill, and Self Esteem of a Public High School," *J. Phys. Conf. Ser.*, vol. 1097, no. 1–8, 2018.
[12] E. S. Wahyuni, Susanto, and A. F. Hadi, "Profile of The Student's Mathematical Reasoning Ability in Solving Geometry Problem," *J. Phys. Conf. Ser.*, vol. 1211, no. 1, pp. 1–9, 2019.
[13] B. I. Yusdiana and W. Hidayat, "Analisis Kemampuan penaaran Matematis Siswa SMA Pada Materi Limit Fungsi," *J. Pembelajaran Mat. Inov.*, vol. 1, no. 3, pp. 409–414, 2018.
[14] M. Bernard and S. Chotimah, "Improve Student Mathematical Reasoning Ability with Open-Ended Approach Using VBA for Powerpoint," *AIP Conf. Proc.*, vol. 2014, 2018.
[15] A. M. Karunika, T. A. Kusmayadi, and L. Fitrana, "Profile of Mathematical Reasoning Ability of Female Students Based on Self-Efficacy," *J. Phys. Conf. Ser.*, vol. 1265, no. 1, pp. 1–9, 2019.
[16] M. Furrahmah, R. Johar, and B. Zaura, "Kemampuan Berpikir Kritis Siswa pada Materi Pola Bilangan di Kelas VIII MTsN Model Banda Aceh," *JIMPMat*, vol. 3, no. 2, pp. 83–90, 2018.
[17] S. Rodiah and V. A. Triyana, "Analisis Kemampuan Penalaran Matematis Siswa Kelas IX MTS Pada Materi Sistem Persamaan Linear Dua Variabel Berdasarkan Gender.," *J. Kaji. Pembelajaran Mat.*, vol. 3, no. 1, pp. 1–8, 2019.

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

# Effect of PDEODE-STEM Learning on Students' Critical Thinking Ability on Work and energy Topics

**M.R.A. Taqwa[1], A. Zainuddin[1*]**

[1]Departement of Physics, Faculty of Mathematics and Science, Universitas Negeri Malang
Jl. Semarang 5 Malang, 65145 Telp. (0341) 551312 Malang, Indonesia

*Correspondence email: abuzainuddin@unesa.ac.id

## ABSTRACT

This study aims to see the effectiveness of the implementation of PDEODE-STEM in improving students' critical thinking ability. The study was conducted at SMAN 8 Malang, with a sample of 108 students divided into three classes with a total of 36 students in each class. To achieve this goal 10 essay questions were designed based on indicators of critical thinking. Data analysis was performed with one-way ANOVA test with post hoc test, effect size and N-gain. The results showed that in the three classes there were significant differences in pretest-posttest critical thinking ability. However, classes taught with PDEODE-STEM are better than PDEODE and conventional.

**Keywords:** Critical thinking, PDEODE-STEM learning, ability,

## INTRODUCTION

One of the goals of learning physics is so that students have a deep and comprehensive understanding of concepts. Deep understanding of concepts is very useful to help students solve the problems and explain the various physical phenomena [1]–[5]. One of the fundamental topics that students must understand is work and energy [6], [7]. The concept of work and energy is closely related to everyday phenomena [8].

However, the findings show that many students have many difficulties to understanding the concepts of work and energy, such as difficulties in understanding the system [9]; applying the law of conservation of mechanical energy, determining the relations of work and displacement, and applying the concepts of work and energy in everyday life [10]; difficulty in correlating the concept of energy with other subjects [11], etc. Difficulties of students in understanding the concept causes low critical thinking ability of students. Based on the results of the study, students' understanding of concepts correlates significantly with critical thinking ability [12]. Though critical thinking is an important aspect that students must have in the 21st century [13]–[15]. So in science learning students must be directed to have critical thinking ability.

Students' critical thinking ability can be improved by applying well-planned learning. One of the lessons that can improve students' critical thinking ability is constructivist learning. Predict-Discuss-Explain-Observe-Observe-Discuss-Explain (PDEODE) is one of learning model with constructivist principles. The implementation of PDEODE can help students understand everyday phenomena, make learning more meaningful, and make students the center of learning [16]. In PDEODE learning students are facilitated to discuss. Discussion learning can improve critical thinking ability effectively [17]. Each stage in PDEODE learning trains students to observe phenomena, to make predictions, to prove and conclude the predictions. These stages can facilitate students to practice critical thinking ability.
In addition to using learning models, there is way to improve students critical thinking, namely Science, Technology, Engineering and Mathematics (STEM) education [18]. The goals of STEM are the same as the goals of the 21st century education so that students are able to solve problems, make decisions, analyze assumptions and develop knowledge to be applied in daily life. STEM is able to create an active learning system because all four aspects are needed simultaneously to solve problems [19], [20]. Although STEM has great opportunities in building students' abilities in various aspects, in Indonesia STEM still has not received special attention by teachers in teaching [21]. Especially research by implementing PDEODE-STEM learning is still very rarely done in Indonesia. Therefore, this research will focus on exploring the effectiveness of STEM integrated PDEODE implementation to improve students' critical thinking ability.

## RESEARCH METHOD

This study uses a quasi-experimental research with pretest-posttest design [22]. The study was conducted on 108 grade X students of SMA Negeri 8 Malang, East Java, Indonesia. There are 3 classes with 36 students in each class. The class is an experimental class I, an experimental class II, and a control class. Students in the experimental class I were taught using PDEODE-STEM, students in the experimental class II were taught using PDEODE, and students in the control class were taught using conventional learning methods.

PDEODE learning is carried out through 6 stages namely, predict, discuss, explain, observe, discuss, and explain [23]. Learning in PDEODE-STEM classes is done by integrating several STEM components, namely Science, Technology, Engineering, and / or Mathematics in PDEODE learning. STEM is integrative so it can be integrated into various learning models. STEM integration in PDEODE learning such as, (1) at the predicting stage, the scientific aspects are used by students in predicting phenomena using their knowledge; (2) at the discussion stage, technological aspects are used when students are allowed to look for solutions to problems using the internet and aspects of matematics are used by students by formulating solutions to the phenomena presented by the teacher; (3) at the observe stage, technological aspects are used when students design experimental sets to prove predictions and engineering aspects are used when students are required to be creative in designing experimental sets.

Data obtained from pretest-posttest using 10 essay questions. The questions given have fulfilled the test instrument criteria, which are valid and reliable. The questions are designed according to the critical thinking indocator developed by Ennis. Data on the critical thinking ability scores of students were analyzed using one-way ANOVA with post hoc tests, effect size and N-gain.

## RESULTS AND DISCUSSION

In the first part of the research results, we describe the results of descriptive statistical analysis. Descriptive statistics of the pretest-posttest data as shown in Table 1.

**Table 1.** Descriptive Statistics of Pretest-Posttest Data

| | Class | Mean | Standar Deviation | Skewness |
|---|---|---|---|---|
| **Pretest** | Eksperiment Class I | 30.47 | 8.49 | -0.19 |
| | Eksperiment Class II | 31.14 | 7.24 | 0,08 |
| | Control Class | 30.68 | 7.01 | -0.22 |
| **Posttest** | Eksperiment Class I | 64.37 | 7.56 | 0.10 |
| | Eksperiment Class II | 57.93 | 9.17 | 0,24 |
| | Control Class | 44.68 | 8.43 | -0,16 |

Based on the data in Table 1, we can see that the average score of students in all classes shows an increase. The average score of students in the experimental class I increased from 30.47 to 64.37, experimental class II increased from 31.14 to 57.93, and the control class increased from 30.68 to 44.68. Based on these data it appears that the skewness value for each data group is in the range -1 to +1. This indicates that all data in each class is normally distributed [24].

In research with quasi-experimental designs, it is important to see that the whole class has relatively similar characteristics. It's useful to reinforce the claim that increasing of scores in each class is not influenced by the characteristics of students and all classes began with the same conditions. Table 2 shows the results of the one-way ANOVA test for the different tests for each group of data.

**Table 2.** One-Way ANOVA Test

| | Source | Sig. | Alpha | Conclusion |
|---|---|---|---|---|
| **Pretest** | Between-group | 0.437 | 0.05 | No difference |
| **Posttest** | Between-group | 0.000 | 0.05 | Difference |

Based on the data in Table 2, we can conclude that the critical thinking ability of students in each class are not significantly different. This shows that the initial ability of all class groups is relatively no different, so it can be said that the increase in students' critical thinking ability in each class is not influenced by initial abilities. On the other hand, based on the results of the one-way ANOVA test, it can be concluded that the students' critical thinking ability in each class after learning have significant differences. This is indicated by the value of sig. < 0.05. For this reason, further tests are needed to see the difference in students' critical thinking ability in each class. In this study the Post Hoc Test was used. Post Hoc test results as shown in Table 3.

**Table 3.** Post Hoc Tukey Test Result For Posttest Data

| Between Classes | Statistic Test | Sig. | Alpha | Conclusion |
|---|---|---|---|---|
| PDEODE-STEM and PDEODE | Post Hoc Tukey | 0.018 | 0.05 | Difference |
| PDEODE-STEM and Conventional | Post Hoc Tukey | 0.000 | 0.05 | Difference |
| PDEODE and Conventional | Post Hoc Tukey | 0.000 | 0.05 | Difference |

Based on the data in Table 3, we can conclude that the critical thinking abilities of students in each class are significantly different. This is evident from the value of sig. < 0.05. For further, the difference will be more meaningful if the increase is known. N-gain values and categories for each class as shown in Table 4.

**Table 4.** N-gain Value for Each Class

| Parameter | N-Gain | | |
|---|---|---|---|
| | Experiment Class I | Experiment Class II | Control Class |
| **N-Gain** | 0.49 | 0.39 | 0.20 |
| **Category** | Medium | Medium | Low |

N-gain values in the experimental class I and experiment II are in the medium category while the control class is in the low category. These results indicate the positive impact of an increase in students' critical thinking ability after learning by using PDEODE. The improvement of students 'critical thinking ability is in accordance with the results of Diani's study which states that learning with PDEODE * E task can improve students' critical thinking ability [25]. Furthermore, to see how strong the effect of learning that is implemented in each class, the calculation of d-effect size is needed. The results of the calculation of d-effect size as shown in Table 5.

**Table 5.** d-Effect Size Value for Each Class

| Parameter | N-Gain | | |
|---|---|---|---|
| | Experiment Class I | Experiment Class II | Control Class |
| **d-effect size** | 4.22 | 3.27 | 1.81 |
| **Category** | Very high | Very high | Very high |

The effect of PDEODE-STEM, PDEODE, and conventional learning is very large on improving students' critical thinking ability. This is indicated by the value of the d-effect size obtained. Based on Table 5, all classes have d-effect size values in the very high category. Based on the research results obtained, PDEODE learning will be more effective in improving students' critical thinking ability compared to conventional learning. It would be better if integrating STEM into learning PDEODE.

It has been found that learning with a constructivist approach is useful in practicing students' thinking ability With constructivist learning students will be actively involved in building their knowledge. Students not only receive knowledge from the teacher passively. PDEODE which is a constructivist learning is also useful in improving students' thinking ability, including critical thinking ability. Not only students critical thinking ability, the application of PDEODE is also able to increase student motivation [26]–[28]. On the other hand, if students' motivation is high, it will positively influence their critical thinking ability.

These results reinforce the results of this study, where students seem more excited when learning with PDEODE learning compared to conventional learning. Students are more actively involved in learning.

On the other hand, the use of STEM in learning can also effectively improve students' critical thinking ability [29], [30]. learning by integrating STEM can facilitate students to think higher-level through problem solving challenges or phenomena. STEM can provide authentic, practical and meaningful learning experiences [31]. In addition, learning in the future requires the professional development of teachers to prepare students for the world of student work later so it needs to be applied STEM [32]. Therefore, habituation of students to learn better is important, not just being a recipient of information from the teacher.

## CONCLUSIONS

The results showed that there was an increase in students' critical thinking ability in all classes, both taught with PDEODE-STEM, PDEODE, and conventional. Based on the results of the one-way ANOVA test, it can be concluded that the critical thinking abilities of students after learning differ significantly. The N-gain results in the experimental class I are 0.49 (medium), experimental class II is 0.39 (medium), and the control class is 0.20 (low). Finally, the impact of learning on all three classes is very high as indicated by the value of d-effect size. Overall it can be concluded that the learning of PDEODE-STEM is better than PDEODE and conventional to improve critical thinking ability.

## REFERENCES

[1] M. Sajadi, P. Amiripour, and M. Rostamy-Malkhalifeh, “The Examinig Mathematical Word Problems Solving Ability under Efficient Representation Aspect,” *Math. Educ. Trends Res.*, vol. 2013, pp. 1–11, 2013.
[2] B. Hegde and B. N. Meera, “How do they solve it? An insight into the learner’s approach to the mechanism of physics problem solving,” *Phys. Rev. Spec. Top. - Phys. Educ. Res.*, vol. 8, no. 1, pp. 1–9, 2012.
[3] J. L. Docktor and J. P. Mestre, “Synthesis of discipline-based education research in physics,” *Phys. Rev. Spec. Top. - Phys. Educ. Res.*, vol. 10, no. 2, pp. 1–58, 2014.
[4] Q. X. Ryan, E. Frodermann, K. Heller, L. Hsu, and A. Mason, “Computer problem-solving coaches for introductory physics: Design and usability studies,” *Phys. Rev. Phys. Educ. Res.*, vol. 12, no. 1, pp. 1–17, 2016.
[5] M. R. A. Taqwa, R. Faizah, L. Rivaldo, D. E. Safitri, F. N. Aini, and M. I. Sodiqin, “Students’ Problem-Solving Ability in Temperature and Heat Concepts,” *J. Phys. Conf. Ser.*, vol. 1339, pp. 1–4, 2019.
[6] M. C. Chuang and H. W. Ma, “An assessment of Taiwan’s energy policy using multi-dimensional energy security indicators,” *Renewable and Sustainable Energy Reviews*, vol. 17. pp. 301–311, 2013.
[7] K. L. Chen, S. Y. Liu, and P. H. Chen, “Assessing multidimensional energy literacy of secondary students using contextualized assessment,” *Int. J. Environ. Sci. Educ.*, vol. 10, no. 2, pp. 201–218, 2015.
[8] C. F. Herrmann-abell and G. E. Deboer, “Investigating Students’ Understanding of Energy Transformation, Energy Transfer, and Conservation of Energy Using Standards-Based Assessment Items,” *Narst*, pp. 1–13, 2011.
[9] B. A. Lindsey, P. R. L. Heron, and P. S. Shaffer, “Student understanding of energy: Difficulties related to systems,” *Am. J. Phys.*, vol. 80, no. 2, pp. 154–163, 2012.
[10] A. Permatasari, Wartono, and S. Kusairi, “Identification of students difficulties in terms of the higher order thinking skills on the subject of work and energy,” *AIP Conf. Proc.*, vol. 2014, no. September, 2018.
[11] Z. B. Takaoğlu, “Energy Concept Understanding of High School Students: A Cross-grade Study,” *Univers. J. Educ. Res.*, vol. 6, no. 4, pp. 653–660, 2018.
[12] A. Y. R. Wulandari, “Correlation between critical thinking and conceptual understanding of student’s learning outcome in mechanics concept,” *AIP Conf. Proc.*, vol. 2014, no. September, 2018.
[13] S. E. Saleh, “Critical Thinking As A 21st Century Skill: Conceptions, Implementation, and Challenges in the EFL Classroom,” *Eur. J. Foreign Lang. Teach.*, vol. 4, no. 1, pp. 1–16, 2019.

[14] S. ŽivkoviĿ, “A Model of Critical Thinking as an Important Attribute for Success in the 21st Century,” *Procedia - Soc. Behav. Sci.*, vol. 232, pp. 102–108, 2016.
[15] R. N. Hafni and E. Nurlaelah, “Analysis the Students ’ Decision -Making Style in Mathematical Critical Thinking Skill,” *Adv. J. Tech. Vocat. Educ.*, vol. 2, no. 229, pp. 7–12, 2018.
[16] T. Wulandari, M. Amin, S. Zubaidah, and M. IAM, “Students’ Critical Thinking Improvement Through PDEODE and STAD Combination in The Nutrition and Health Lecture,” *Int. J. Eval. Res. Educ.*, vol. 6, no. 2, p. 110, 2017.
[17] A. Asrita and N. Nurhilza, “Students’ Critical Thinking Skills in Group Discussion: The Case Study of Fifth Grade Students in Sukma Bangsa Bireuen Elementary School,” *Sukma J. Pendidik.*, vol. 2, no. 1, pp. 67–92, 2018.
[18] H. W. Hu, C. H. Chiu, and G. F. Chiou, “Effects of question stem on pupils’ online questioning, science learning, and critical thinking,” *J. Educ. Res.*, vol. 112, no. 4, pp. 564–573, Jul. 2019.
[19] L. S. Nadelson and A. L. Seifert, “Integrated STEM defined: Contexts, challenges, and the future,” *Journal of Educational Research*, vol. 110, no. 3. Routledge, pp. 221–223, May-2017.
[20] S. Blackley, Y. Rahmawati, E. Fitriani, R. Sheffield, and R. Koul, “Using a makerspace approach to engage Indonesian primary students with STEM,” *Issues Educ. Res.*, vol. 28, no. 1, pp. 18–42, 2018.
[21] Widayanti, A. Abdurrahman, and A. Suyatna, “Future Physics Learning Materials Based on STEM Education: Analysis of Teachers and Students Perceptions,” *J. Phys. Conf. Ser.*, vol. 1155, no. 1, 2019.
[22] J. W. Creswell, *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, 4th ed. London: Sage Publication Ltd, 2014.
[23] F. Widyastuti, I. Helsy, I. Farida, and F. S. Irwansyah, “Implementation of PDEODE (Predict, Discuss, Explain,Observe, Discuss, Explain) Supported by PhET Simulation on Solubility Equilibrium Material,” *J. Phys. Conf. Ser.*, vol. 1155, no. 1, 2019.
[24] N. L. Leech, K. C. Barrett, and G. A. Morgan, *SPSS For Intermediate Statistics: Use and Interpretation*, Second. London: Lawrence Erlbaum Associates, 2005.
[25] R. Diani *et al.*, “Physics Learning through Active Learning Based Interactive Conceptual Instructions (ALBICI) to Improve Critical Thinking Ability,” *J. Penelit. dan Pembelajaran IPA*, vol. 5, no. 1, p. 48, 2019.
[26] L. Cholisoh, S. Fatimah, and F. Yuniasih, “Critical Thinking Skills in Integrated Science Learning Viewed from Learning Motivation,” *J. Pendidik. Fis. Indones.*, vol. 11, no. 2, pp. 134–141, 2015.
[27] T. Dipalaya and A. D. Corebima, “the Effect of Pdeode (Predict-Discuss-Explain-Observe-Discuss-Explain) Learning Strategy in the Different Academic Abilities on Students’ Critical Thinking Skills in Senior High School,” *Eur. J. Educ. Stud.*, vol. 2, no. 5, pp. 59–78, 2016.
[28] C. Savander-Ranne and S. Kolari, “Promoting the conceptual understanding of engineering students through visualisation,” *Glob. J. Eng. Educ.*, vol. 7, pp. 189–200, 2003.
[29] Y. Elfrida Yanty Siregar, R. Rachmadtullah, N. Pohan, Rasmitadila, and M. S. Zulela, “The impacts of science, technology, engineering, and mathematics (STEM) on critical thinking in elementary school,” *J. Phys. Conf. Ser.*, vol. 1175, no. 1, 2019.
[30] B. Waddell, “Influence of STEM Lessons on Critical Thinking,” Lincoln, 2019.
[31] S. Maistry, “School-university CPD partnerships: Fertile ground for cultivating teacher communities of practice,” *South African J. High. Educ.*, vol. 22, no. 2, 2008.
[32] L. Nadelson, A. Seifert, A. Moll, and B. Coats, “i-STEM Summer Institute: An Integrated Approach to Teacher Professional Development in STEM.,” *J. STEM Educ. Innov. Res.*, vol. 13, no. 2, pp. 69–83, 2012.

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

# Analysis of Student Learning Barriers in Solving Context Problems Related to the Matrix

**Nurlaela Rahmawati[1*], Yoppy Wahyu Purnomo[2]**

[1]Department of Mathematics Education, Universitas Muhammadiyah Prof. Dr. HAMKA
Jl. Tanah Merdeka, Kp Rambutan, Pasar Rebo, East Jakarta 13830

[2]Department of Mathematics Education, Universitas Negeri Yogyakarta
Jl. Colombo No.1 Yogyakarta 55281

*Correspondence email: nurlaelarahmawatipoenya@gmail.com

## ABSTRACT

Matrix is one of the mathematical content that has an important position both in its application in everyday life and as basic to learn advanced mathematics. The purpose of this research are analyzed (the obstacle in learning matrix for high school students) by providing a contextual questions. This research method is descriptive qualitative. The research location is in SMAN 6 Kota Tangerang Selatan. The research was conducted on September in the academic year 2019/2020. The subjects were the 36 students of SMAN 6 Kota Tangerang Selatan grade XI MIPA-1. The data were obtained by the results of the test, post-test interview, and documentation. In conclusion: (1) students experiencing epistemology obstacles and (2) the error made by students in general because of unfamiliarity with the contextual questions (in the form of essays).

**Keywords:** Learning obstacles, matrix, contextual

## INTRODUCTION

Mathematics is used, whether directly or indirectly in everyday life. This can be seen by the applications of mathematics in our daily life, for example in calculating the profit and loss, the cost of production, checking the speed of a vehicle, establishing the calendar, determining the height of a cliff and the depth of the trough, a population census, and many more. As Ruseffendi said that mathematics is an important basic knowledge to study, because the mindset of mathematics can help students to think in logic, analytic, systematic, critical, and creative, not to mention train students to cooperate with others [1].

One of the material in mathematics at the high school is a matrix. The role of the matrix in the curriculum is very important for students to understand advanced mathematics, including the systems of linier equations, vector and geometry transformation. Moreover, the matrix is very useful for studying other sciences, such as Physics and Economics, and is also frequently applied in everyday life, such as flight schedules, producing yield tables, and tables score at sporting events. In contrast with the urgency, the matrix has been very challenging and difficult for students at high school level, students have not been able to apply the concept of matrix to solve real problems, provide real-world examples, and rarely know the benefits matrix in everyday life. As stated by Horton and colleagues [2] that students learn the procedures on how to solve the matrix problems but do not know why they are learning it.

Students can represent math if they understand the mathematical concepts and interpret it in both verbal and nonverbal ways into more concrete situations. The concept will be embedded if it can be imagined by the student and or is obvious in everyday life[3], [4] and found by the students themselves [13]. In other words, context-based learning becomes essential to build students' conceptual knowledge in matrix.

The principles of realistic mathematics education according to Freudenthal includes three things, they are namely guided reinvention and didactical phenomenology (students find their own strategy in learning to solve a problem based on the cognitive level), progressive mathematization (formulation into the mathematics language in the form of abstract concepts through mathematical model), self -develop models (models that are used, in this case they are made by teachers or students). The first order of the mathematical models is situational model (the real objects or can be imagined by the students), the

second is a model-of (pictures or modelling without object). Then, a model-for (mathematical symbols, such as plus, minus, multiplication and division). The last one is a formal model.

In learning, students often have problems or learning obstacles. According to Brousseau [8], there are three factors that may cause learning obstacles, which are experienced by students during the learning process, they are ontogeny obstacles, didactic obstacles, and epistemology obstacles. Ontogeny obstacles are limitations in learning concept when students experience developmental process. Didactic obstacles are misconceptions which inappropriate with the readiness of the students. While the epistemological obstacle is the limited application that is done by the students.

In the research conducted by Suastika, et al. [9], found that 21.25% of the students do not understand the concept of matrix. Incomprehension associated with matrix algebra student associated with squaring matrix and settlement system of linear equations by reduction lines. Furthermore, a research by [10], Reported that students' conceptual understanding is low. Students with high basic ability is only able to classify objects in the operating matrix by nature and able to provide examples and is not an example of the concept. Students with a basic ability is being able to give an example and not an example of the concept, and that with a low basic capabilities are not able to express the concept, is not able to classify objects in the operating matrix according to certain qualities, and not able to give an example and not an example.

Additionally, Setyanto conduct research module development approach matrix material Realistic Mathematic Education (RME) for class X SMK Muhammadiyah 1 Sukaharjo, found that based on the quality assessment module by subject matter experts and practitioners declared valid with an average score of 4.14 with a percentage of 83 % were categorized as good. While based on the student questionnaire responses, modules developed to be feasible with an average score of 4.11 with a percentage of 82% are included in both categories [10].

Research on realistic mathematics education has been done. But the focus to analyze learning obstacles high school students to the material matrix by providing a contextual matter is still rare. Based on the introduction that has been explained by the researcher, the problem in this research is how the results of analysis of high school students' learning obstacles on matrix by giving the contextual questions? This study was aimed to analyze the learning obstacles of high school students in learning matrix by providing a contextual question.

## RESEARCH METHOD

The research took place in SMAN 6 Kota Tangerang Selatan, during its first semester of the academic year 2019-2020. This study was conducted on September 2019. This research is classified as a qualitative descriptive study which describe the analysis of learning obstacles of high school students in learning matrix by providing the contextual question. Data were obtained by the results of the test, post-test interview, and documentation.

The subjects were the 36 students of SMAN 6 Kota Tangerang Selatan grade XI MIPA-1. Thirty three out of the 36 students took the tests. The research instruments include test and non-test. The test instrument includes the question of matrix and non-test instrument is an interview guidance. The test given was previously tested the validity of its contents. The results of the content validity will be used as a reference in improving the research instruments that are considered less appropriate or less proper by experts. The method of calculating the Content validity used in this study using CVR (Content Validity Ratio). The formula used is as follows [11].

$$\boldsymbol{CVR = \frac{\left(n_e - \frac{N}{2}\right)}{\frac{N}{2}}}$$

Information:
CVR = Content Validity Ratio
ne = the number of assessors who declared about essential items
N = the number of assessors

This content validity of using CVR has been done on each item. If the value of the CVR was statistically insignificant as determined by the CVR minimum table presented by Lawshe [11] then the item is declared invalid. Based on the calculation, the result, the questions are valid.

Data collection methods used in this study include: 1) test that is used to determine the errors of the students in solving a matrix; 2) interviews were used to obtain data about the cause of error.

## RESULTS AND DISCUSSION

Researcher conducted tests on 33 students grade XI MIPA-1 and interviewed based on the results of tests of 9 students. The Results of tests and interviews showed that students' learning obstacles on epistemology obstacles. The Problem that is given consisted 5 questions. The first question was asking students to compile the data of the contextual problem into the form of tables, and then from the table into the matrix. In the first case, only one out of 33 students who answered correctly, the three students gave the wrong answers, and the others did not answer.

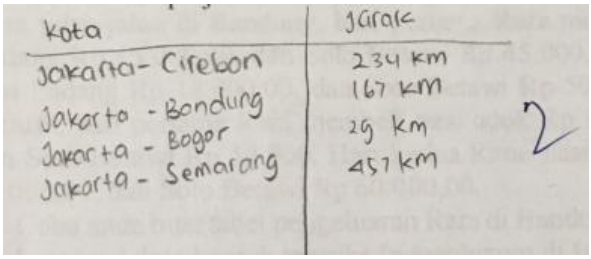



**Figure 1:** The Example of the Wrong Answers made by Student in Creating Table No. 1

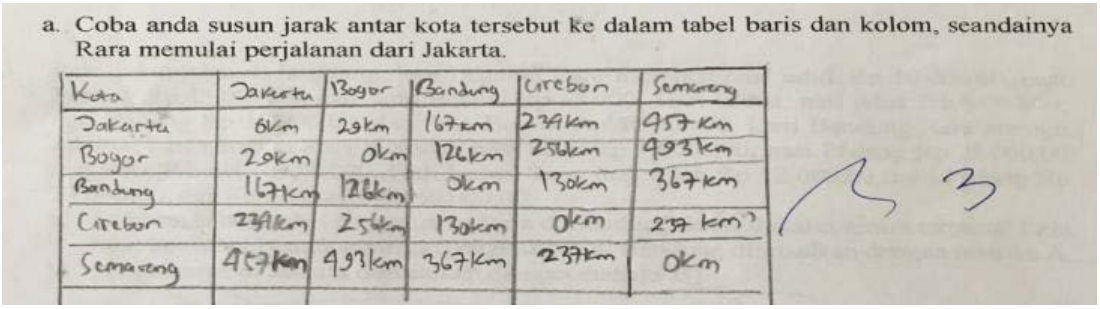
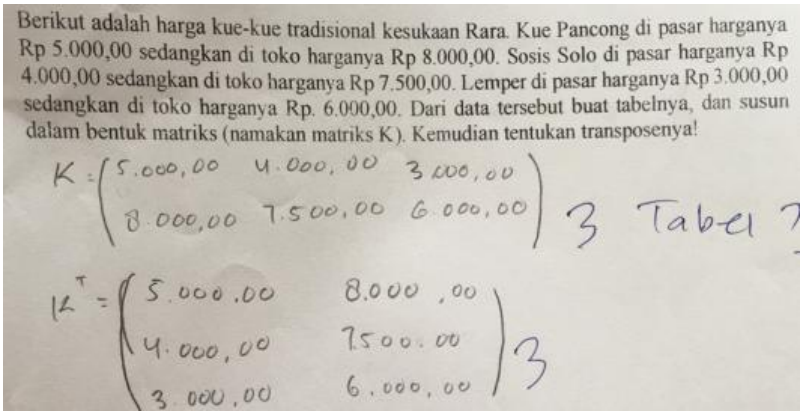



**Figure 2:** The Student's correct answer for question No. 1

Question number two about ~~on~~ the matrix transpose, with contextual issues of the cakes price at the market ~~price~~ and in the store. In this question, most of the students were able to create the table, but have not been able to compile them into a matrix. Only three Students who were able to arrange into a matrix (which included the top group). While others have problems as much as 90.91%.



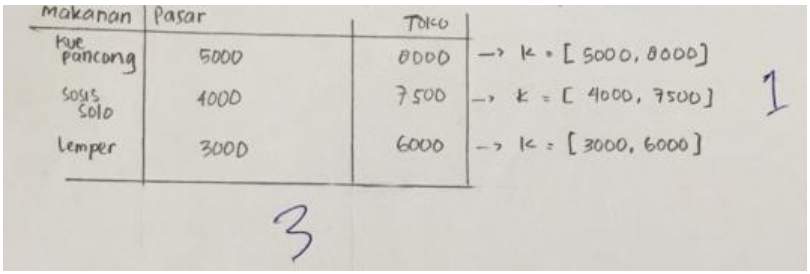



**Figure 3:** Some Student's answers for Question No. 2

All students have problems in the matrix addition. Students could not give the right answer for question number three, they said the question was confusing. There are students who are able to perform matrix addition, but since the tables and matrices that were arranged was still incorrect, then the result is incorrect. Students are already accustomed to the question that directly ask the addition or subtraction, without the need to understand the contextual issues.

Students who experience obstacles in a matrix scalar multiplication were 87.88%. In question number four, there are three students who have been able to answer using the matrix concept. Students who responded using the matrix concept from the first question was able to compile the data into the matrix.

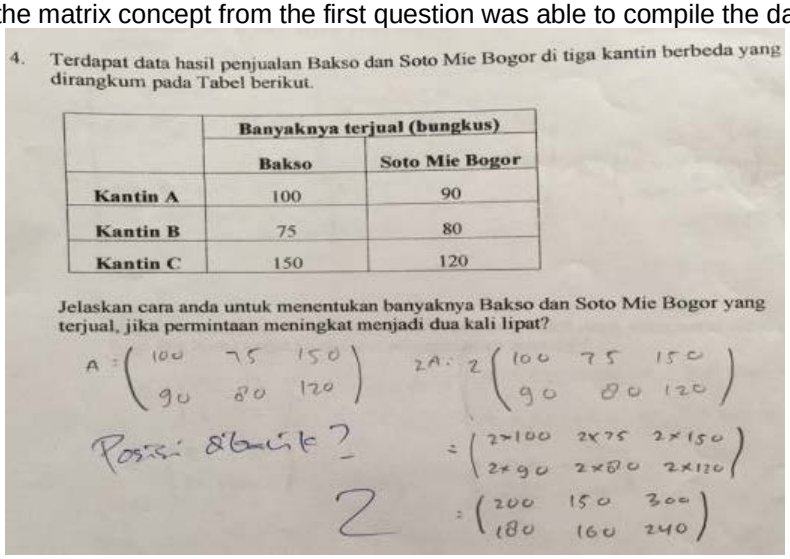



**Figure 4:** Student's answer using Matrix Method for Question No. 4

There is also the correct answer although did not apply the matrix concept. They used logic in answering questions. In addition, there are also many who did not answer.

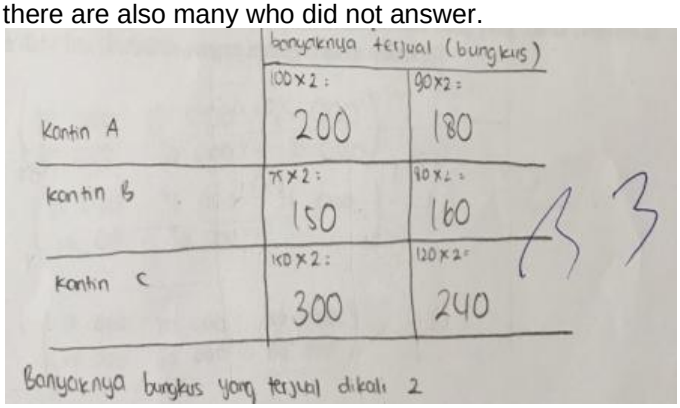



**Figure 5:** Student's Answer using Matrix Method for Question No. 4

Students who experience obstacles in the matrix multiplication using matrix were 90.91%. Only one person who answered correctly, even it was improper in the writing. Two people answered correctly by logic. While others answered, but incorrect, and most of them did not answer.

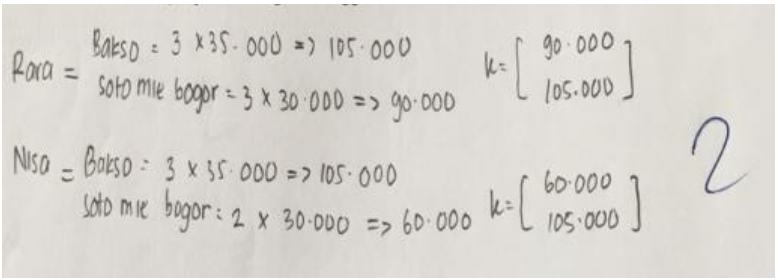



**Figure 6:** Correct Answer but Incorrect Writing for Question No. 5

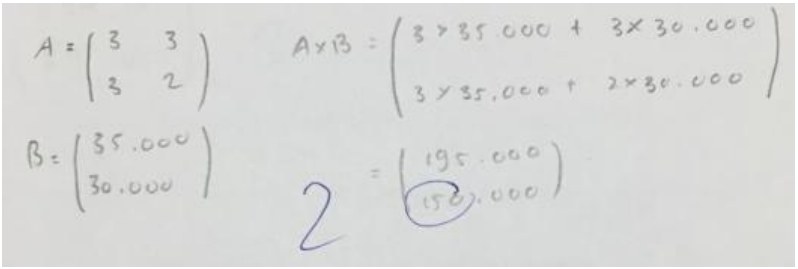



**Figure 7: Incorrect** answer but Student Already Used Matrix for Question No. 5

Based on the test results it can be concluded that most of the students have not had an understanding and knowledge of the concept of matrix yet. Students are already accustomed to questions which ~~a~~ directly ask addition, subtraction, or multiplication without giving the contextual issues. While the questions given in this test requires conceptual knowledge, while students are familiar with procedural knowledge. Mathematical procedural knowledge refers to the ability of students to apply, compute, and use symbols and algorithms to solve the problem, efficiently, and accurately. While conceptual mathematical knowledge refers to the ability of students to make a connection or relationship between mathematical concepts and integration for contextual situation [12]. The findings of this study revealed that most of the students have not been able to do the third principles of realistic mathematics education according to Freudenthal [13], that is self-develop model. By applying of realistic mathematics education, it is expected to increase the students' conceptual knowledge , because research by Hidayat shows that with a realistic mathematics learning the students' understanding becomes better [14].

## CONCLUSIONS

The students' errors in solving problems about the matrix through the contextual questions caused by the lack of understanding of the concept, pre concept and misconceptions. Students' learning obstacles are epistemology obstacles and the errors in general because of unfamiliarity with the contextual matter (in the form of essay). As for the errors committed by students include: 1) do not understand the problem in question; 2) do not understand how to change the contextual issues into the table and matrix; 3) do not understand the matrix operations (addition, scalar multiplication with the matrix, and the multiplication of two matrices); and 4) carelessness in the problem solving process.

## REFERENCES

[1] E. T. Ruseffendi, *Pengantar kepada Membantu Guru Mengembangkan Kompetensinya dalam Pengajaran Matematika untuk Meningkatkan CBSA*. Bandung: Tarsito, 1992.
[2] R. Horton, E. Wiegert, and J. Marshall, "Squaring Matrices: Connecting Mathematics and Science," *Source Math. Teach.*, vol. 102, 2008.
[3] A. Wijaya, "Design Research in Mathematics Education: Indonesian Traditional Games as Means to Support Second Graders Learning of Linear Measurement," Universiteit Utrecht, 2008.
[4] M. Van Den Heuvel-Panhuizen, "The Didactical Use of Models in Realistic Mathematics Education: An Example from a Longitudinal Trajectory on Percentage," *Educ. Stud. Math.*, vol. 54, no. 1, pp. 9–35, 2003.
[5] A. Wijaya, M. van den Heuvel-Panhuizen, and M. Doorman, "Teachers' teaching practices and beliefs regarding context-based tasks and their relation with students' difficulties in solving these tasks," *Math. Educ. Res. J.*, vol. 27, no. 4, pp. 637–662, 2015.
[6] Y. W. Purnomo, Kowiyah, F. Alyani, and S. S. Assiti, "Assessing number sense performance of Indonesian elementary school students," *Int. Educ. Stud.*, vol. 7, no. 8, pp. 74–84, 2014.

[7] P. Pramudiani, A. F. Oktafiani, T. A. Aziz, and Y. W. Purnomo, "Enhancing Conceptual Knowledge about Shape through Realistic Mathematics Education," *J. Inov. Pendidik. Dasar*, vol. 3, no. 1, pp. 31–38, 2017.

[8] I. Puspitasari, R. Purwasih, and A. Nurjaman, "Analisis Hambatan Belajar Mahasiswa pada Mata Kuliah Program Linier," *J. Ilm. Pendidik. Mat.*, vol. 6, no. 1, pp. 39–46, 2017.

[9] Suastika, T. John, and T. Utami, "Penelusuran Miskonsepsi Mahasiswa tentang Matriks Menggunakan Certainty of Response Index," *Pros. Semin. Nas. Fis. SNF 2015*, vol. IV, no. Oktober, 2015.

[10] Y. Setyanto, "Pengembangan Modul Materi Matriks dengan Pendekatan Realistic Mathematics Education (RME) untuk Kelas X SMK Muhammadiyah 1 Sukaharjo," Universitas Muhammadiyah Surakarta, 2017.

[11] C. H. Lawshe, "A Quantitative Approach To Content Validity," *Pers. Psychol.*, vol. 28, pp. 563–575, 1975.

[12] Y. W. Purnomo, C. Widowati, and S. Ulfah, "Incomprehension of the Indonesian Elementary School Students on Fraction Division Problem," *Infin. J.*, vol. 8, no. 1, pp. 57–74, 2019.

[13] S. Revina, "Influence of Culture on the Adaptation of Realistic Mathematics Education in Indonesia," Universitas Sriwijaya, 2011.

[14] R. Hidayat and Z. H. Iksan, "The Effect of Realistic Mathematic Education on Students' Conceptual Understanding of Linear Progamming," *Creat. Educ.*, 2015.

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

# Comprehension of Biology Concept in the Human Respiratory System Based on STEM

**Ria Almareta[1*], Paidi[1]**

[1]Yogyakarta State University, Jl. Colombo No.1, Karang Malang, Caturtunggal, Kec. Depok, Kabupaten Sleman, Yogyakarta and 55281, Indonesia

*Correspondence email: rialmareta@gmail.com

## ABSTRACT

Comprehension of concept is very important for student in learning biology, because the subject of biology is conceptual. The subject of biology is interconnected with one another which requires students to comprehension of biology concept in order to learning continue. Comprehension of biology concept is needed so that students remember the biology concept longer so that biology subject are more meaningful for the student. In addition, the purpose of this research is to comprehension of biology concept in the human respiratory system based on STEM. This research is descriptive with 64 student respondents who have studied human respiratory system material. The indicators comprehension of biology concept are interpreting, exemplifying, classifying, summarizing, inference, comparing, and explaining. The instrument of research used 15 essay test questions. The validity test by expert judgment and empirical. Analysis data using SPSS software. The result of comprehension of biology concepts for student showed a mean is 82. There are three categories of comprehension of biology concept consist that is understand, misconception, and not understand. The result showed 81% of student understand, 14% misconceptions, and 5% not understand about concept of biology in the human respiratory system.

**Keywords:** Comprehension, biology concept, human respiratory, STEM

## INTRODUCTION

The mastery of science and technology, especially in the fields of science, technology, engineering, and mathematics, has an important role in the world of education [1]. The integration of these scientific fields is expected to be the key to success in developing a country, especially in the context of 21st century career/skill career development competition at the global level. The STEM was launched by the United States National Science Foundation in the 1990s as the theme of the education reform movement in the four disciplinary fields to increase the number of human resources who master of STEM [2]. The component of STEM consist are Science, Technology, Engineering, and Mathematic. *Science* is the study of natural phenomena involving observation and measurement, as a vehicle to objectively explain the ever-changing nature. *Technology* refers to human innovations that are used to modify nature to meet human needs and desires, so as to make life better and safer. Technology makes humans able to travel quickly, communicate directly with people in distant places. Technology includes not only the products, but also the knowledge and processes needed to create and operate these products. Most modern technology is a product of science and engineering, and technological equipment is used in both fields.

*Engineering* is the knowledge and skills to acquire and apply scientific, economic, social and practical knowledge to design and construct machines, equipment, systems, materials and processes that benefit people economically and environmentally friendly. The engineering is defined as knowledge about the design and creation of human work products and a process to solve problems in the constraints of time, funds, materials, and environmental regulations. Engineering uses concepts in science and mathematics as well as technological devices [3]. Technology and engineering are different but closely interrelated. The difference between technology and engineering is that engineering can be seen as a process with regard to creating or designing, whereas as a reverse technology it can be seen as a product of that process [4]. Engineering activities result in the transformation of matter, energy, or information, energy, or information, while technology can be seen as things that result from engineering [5]. In addition, *mathematics* deals with patterns and relationships, and provides relationships for technology, science, and engineering [6]. Through STEM evaluation, it is expected to be able to create human resources (HR) who are able to reason and think critically, logically, and systematically, as well as improve communicative, collaborative and problem solving abilities. With increasing human

resources competences, it is hoped that our country can face global challenges and be able to improve the economy, as well as to realize Indonesia's projections as the seventh largest economy in the world in 2030 [7].

Science, technology, engineering, and mathematics (STEM) is a new part in the development of the world of special education in the biology. The STEM was formed on the integration of several scientific unit. STEM approach is a blend of science, technology, engineering, and mathematics into one curriculum as a whole [8]. The development of the science curriculum is carried out in order to achieve the dimensions of knowledge competence, scientific work, and scientific attitudes as daily behavior in interacting with the community, the environment and using of technology. Knowledge competency assesment is carries out in the mastery of factual, conceptual, procedural, and metacognitive knowledge [9]. The concepts are collections of meanings that capture order (similarities and differences), patterns, or relationships between object, event and other concepts. If the new concept learned by students are in accordace with the concepts they have learned, students will apply the knowledge to new situations, whereas if the new concept is completely different from what they have, students need to change it so that a concept change process occurs. Students' comprehension of scientific concepts in depth requires a change in thinking patterns from applying conventional learning to innovative learning [10]. Thereforem in science learning teachers must be able to act as a guide to guide students to begin the learning process. Learning involves the process of student interaction with educators and learning resources in the learning environment [11].

Conceptual change have occurred in students taught by experienced teachers and students taught by teachers who practice. Differences in teachers experience can trigger misconceptions adopted by students. For example, picture of organs in the respiratory system in biology textbooks are reconstructed drawings, not original images of organs. This comprehension can be fostered, among others, by STEM-based learning through modeling the structure of respiratory system organs using materials that are easily obtained in the surrounding environment so that students' comprehension is more correct [12]. The human respiratory system was chosen because there are several important concepts involved in daily life. Starting from the respiratory organs to the rate of respiration that occurs every second [13]. The reseacrh based on STEM learning in Indonesia has not been done much especially those realting to changes in students' conceptions. Based on these explanationsm comprehension of biology concept for students is very important to support problem solving realted to subject matter and the truth of concepts and phenomena that actually occur.

According to Anderson and Krathwohl indicators of comprehension of biology concepts consist of seven, namely are interpreting, examining, classifying, summarizing, inference, comparing, and explaining [14]. Comprehension the concept is also a foundation for students to proceed to the next material of biology. Therefore in the research about comprehension of biology concept in the human respiratory system will be use STEM so students really understand and misconceptions do not occur, because in the STEM approach a biology concept will be linked to science, technology, engineering, and mathematics [15]. So it is not only limited to ordinary concepts, there is proof of concept so that students comprehension more [16]. Education of STEM gives educators the opportunity to show students how concepts, principles and techniques from science, technology, engineering, and mathematics are used in an integrated way in the development of products, processes and systems used in their daily lives. Therefore, the definition of STEM education was adopted as an interdisciplinary approach to learning to improve comprehension of biology concepts [17].

In STEM-based learning students use science, technology, engineering, and mathematics in real contexts that connect between school, the world of work, and the global world, in order to develop STEM literacy that enables students to be able to compete in a new knowledge-based economic era [18]. If students are expected to study STEM well, it must be done by reducing the material currently covered in the curriculum. The connection with the implementation of learning based on STEM, students in basic education need to be encouraged to connect science and engineering [19]. Furthermore, at the level of higher education challenges need to be given to perform authentic engineering tasks as a complement to science learning through project activities that integrate science, engineering, technology, and mathematics [20]. STEM-based science learning needs to be carried out in problem-based learning units, in which students are challenged critically, creatively, and innovatively to solve real problems, which involve collaborative group (team) activities [21].
STEM-based science learning in class is designed to provide opportunities for students to apply academic knowledge in the real world [22]. STEM education based learning experience is expected to

develop students' understanding of science content, innovation abilities and problem solving, soft skills (including communication, collaboration, leadership) [23]. The integration of STEM education in biology can be done through gradual habituation related to learning, starting from the emphasis on habit of asking questions, through inquiry training models, scientific inquiry with scientific processes, to the application of scientific literacy, technological and engineering literacy [24]. STEM education literacy through DDO empowerment, cross cutting concepts to multiple intelligences, soft-skills and engineering practice design, both assisted by IT or ICT, as well as entrepreneurship. It is time for undergraduate and graduate student research to be directed to contribute to the development of STEM education [25].

## RESEARCH METHOD

This type of research is quantitative descriptive research. The sampling technique used in this study is simple random sampling, this technique is used to provide equal opportunities to each member of the population to be sampled. The research respondents were 64 students in the grade 11. This research instrument use 15 essay tests to measure the understanding of biological concepts in STEM-based human respiratory system material. The test in the form of this essay was conducted to find out the comprehension of biology concept based on STEM. Comprehension of biology concept indicators used consist of 7, namely: interpreting, examplifying, classifying, summarizing, inference, comparing, and explaining. Comprehension of biological concepts is divided into several categories, namely understanding, misconception and not understanding then converted into percentages. Procedures for data collection of test instruments were validated by experts (expert judgment), then the validity and reliability of the instruments were tested using SPSS. Test instruments were used to obtain information about comprehension of biology concepts in STEM-based in the human respiratory system material. The data that has been obtained will then be analyzed using SPSS and Microsoft Excel to see the level of achievement based on percentage. The formula used for valuation is the total score of the correct questions divided by the maximum score of the test is then multiplied by 100

## RESULTS AND DISCUSSION

The instrument test used in the form of essays totaled 15 questions. The instrument consists of several indicators there are interpreting, examplifying, classifying, summarizing, inference, comparing, and explaining for interpretation the comprehension of biology concept. The validity of the instrument uses validity by experts judgment namely biology material experts on human respiratory system materials and STEM experts in education. Then the empirical validity is done and analyzed using the SPSS program. It is known that of the 15 questions only 13 questions were declared valid with a significance value ≥ 0.2461. Whereas 2 invalid question numbers were fixed. So the test instruments used in this study still totaled 15 questions.

**Table 1.** Validity the validity of instruments comprehension of biology concepts

| Significant | Information | Item number | Total |
|---|---|---|---|
| ≥ 0,2461 | Valid | 1, 2, 3, 4, 5, 7, 9, 10, 11, 12, 13, 14, 15 | 13 |

Descriptive statistical analysis using the SPSS program found that the average was 82, the median was 77.78, the maximum score obtained was 85.65 and the minimum score obtained was 67.79. Data taken through test results (essays) about comprehension of biology concept can be interpreted as high if they have scores more than the total score and are categorized as low if they find scores below the average or less than the average total score used as a sample in the research.

**Table 2.** Descriptive statistics analysis

| Statistic | Comprehension of biology concepts |
|---|---|
| Mean | 82 |
| Median | 77,78 |
| Standar deviation | 10,00608 |
| Skor max | 85,65 |
| Skor min | 67,79 |

The comprehension is the ability of someone to understand or understand something after something is known and desired [26]. In other words, comprehension is knowing something and being able to see it from various aspects. Student comprehension something if they can give an explanation or give a more detailed description about it by using their own words. Therefore comprehension is a level of thinking ability that is one level higher than memory or memorization [27]. According to Anderson and Krathwohl, comprehension of biology concept has 7 indicators namely explaining, comparing, inference, summarizing, classifying, examplifying, and interpreting.

The research results obtained data on the comprehension of biology concepts in human respiratory system material as follows. For explaining as much as 89, for comparing as much as 70, for inference as much as 66, for summarizing as much as 76, for classifying as much as 88, for examining as much as 80, for interpreting as much as 78. Of the seven indicators comprehension of biology concept based on STEM, the highest percentage is obtained explaining that is 89%, this is because students are able to explain the concepts that have been studied based on STEM. Students are able to explain using technology, based on calculations (mathematics) or using engineering.

The lowest indicator of inference is 66%, this is because students find it difficult to deduce concepts they have understood but when explaining they can provide an explanation. the comprehension of biology concept a person's can be influenced by several factors including the ability to think someone, the genetic makeup of parents, the environment, social, economic, cultural, and education. Understanding the concept is often used to explain the characteristics of other concepts, so that more concepts owned by someone will provide an opportunity for him to understand other concepts more broadly so that it can be a capital to solve problems around him [28].

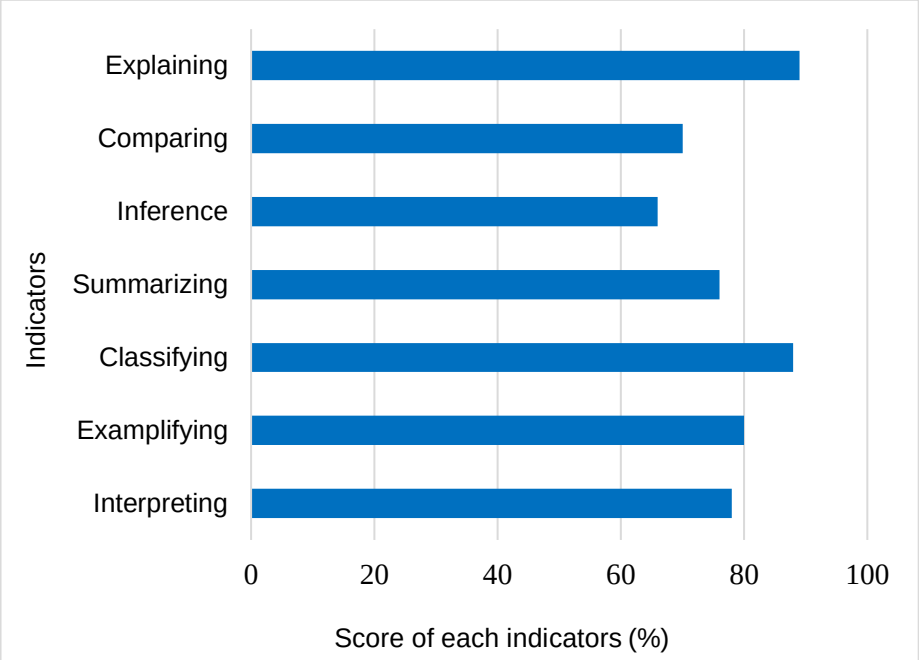



**Figure 1.** Percentage of indicators comprehension biology concepts

This research aims to determine the understanding of students' biology concepts based on STEM. The instruments were made in the form of tests (essay questions), where the questions contained STEM-based approaches. The results of data analysis showed the percentage of three categories of students in comprehension of biology concept. the first category was understand by 81%, the category of misconception by 14%, and the category did not understand by 5%. This can be interpreted that in this research about comprehension of biology concept based on STEM in the human respiratory system is categorized as understand.

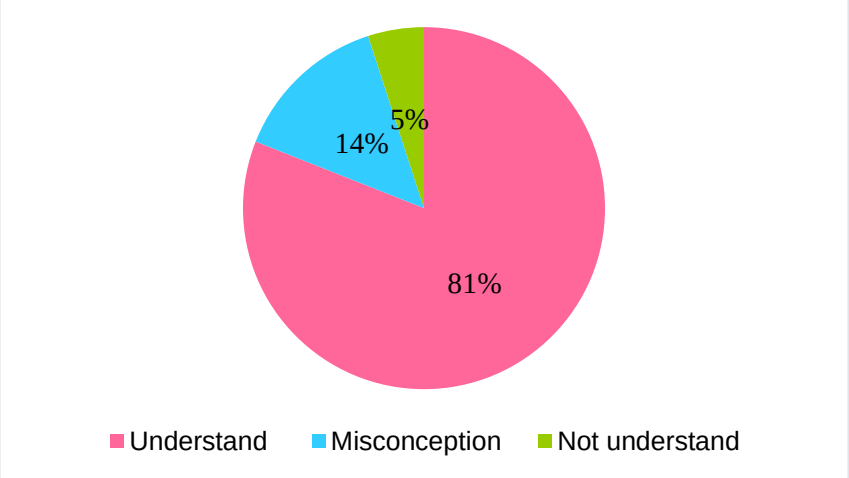



**Figure 2.** The categories of comprehension of biology concept

## CONCLUSIONS

The comprehension of concept is important instilled in students as a basis for understanding a lesson, so students are able to solve problems related to concepts in the subject matter and avoid misconception the concepts. the comprehension of biology concept can be done using the STEM approach, in the STEM there is a relationship between science, technology, engineering, and mathematics so that specifically the biology concepts in human respiratory system materials can be directly understood by students for example by providing concrete examples and exist in the environment. The existence of STEM in improving understanding of concepts means understanding of biology concepts (science) can be proven by using technology, engineering from techniques and mathematical calculations. So understanding students' concepts will be stronger.

## REFERENCES

[1] S. Freeman *et al.*, "Active learning increases student performance in science, engineering, and mathematics," *Proc. Natl. Acad. Sci. U. S. A.*, 2014.
[2] M. Sanders, "STEM, STEM education, STEMmania," *Technol. Teach.*, 2009.
[3] A. Zollman, "Learning for STEM Literacy: STEM Literacy for Learning," *Sch. Sci. Math.*, 2012.
[4] L. D. English, "STEM education K-12: perspectives on integration," *International Journal of STEM Education*. 2016.
[5] M. B. Ibáñez and C. Delgado-Kloos, "Augmented reality for STEM learning: A systematic review," *Comput. Educ.*, 2018.
[6] M. Stohlmann, T. Moore, and G. Roehrig, "Considerations for Teaching Integrated STEM Education," *J. Pre-College Eng. Educ. Res.*, 2012.
[7] T. R. Kelley and J. G. Knowles, "A conceptual framework for integrated STEM education," *International Journal of STEM Education*. 2016.
[8] L. S. Nadelson, J. Callahan, P. Pyke, A. Hay, M. Dance, and J. Pfiester, "Teacher STEM perception and preparation: Inquiry-based stem professional development for elementary teachers," *J. Educ. Res.*, 2013.
[9] C. L. Greenleaf *et al.*, "Integrating literacy and science in biology Teaching and learning impacts of reading apprenticeship professional development," *Am. Educ. Res. J.*, 2011.
[10] K. Illeris, "Towards a contemporary and comprehensive theory of learning," *Int. J. Lifelong Educ.*, 2003.
[11] K. Illeris and K. Illeris, "A Comprehensive Understanding of Human Learning," in *Learning, Development and Education*, 2019.
[12] D. F. Treagust, G. Chittleborough, and T. L. Mamiala, "Students' understanding of the role of scientific models in learning science," *Int. J. Sci. Educ.*, 2002.
[13] D. Kuhn, "Teaching and learning science as argument," *Sci. Educ.*, 2010.
[14] D. R. Krathwohl and L. W. Anderson, "Merlin C. Wittrock and the revision of bloom's taxonomy," *Educ. Psychol.*, 2010.

[15] H. Firman, "Pendidikan Sains Berbasis Stem: Konsep, Pengembangan, Dan Peranan Riset Pascasarjana," in *Seminar Nasional Pendidikan IPA dan PKLH*, 2015.
[16] M. A. Honey, G. Pearson, and H. Schweingruber, *STEM integration in K-12 education: status, prospects, and an agenda for research*. 2014.
[17] J. D. Basham and M. T. Marino, "Understanding STEM Education and Supporting Students through Universal Design for Learning," *Teach. Except. Child.*, 2013.
[18] S. Olson and J. Labov, *STEM learning is everywhere: Summary of a convocation on building learning systems*. 2014.
[19] L. Thibaut *et al.*, "Integrated STEM Education: A Systematic Review of Instructional Practices in Secondary Education," *Eur. J. STEM Educ.*, 2018.
[20] T. J. Kennedy and M. R. L. Odell, "Engaging Students In STEM Education," *Sci. Educ. Int.*, 2014.
[21] K. Billiark, J. Hubelbank, T. Oliva, and T. Camesano, "Teaching STEM by design," *Adv. Eng. Educ.*, 2014.
[22] Y. Xie, M. Fang, and K. Shauman, "STEM Education," *Annu. Rev. Sociol.*, 2015.
[23] J. Brown, "The Current Status of STEM Education Research.," *J. STEM Educ. Innov. Res.*, 2012.
[24] H. Kanematsu and D. M. Barry, *STEM and ICT Education in Intelligent Environments*. 2016.
[25] F. Scheuermann and F. Pedró, *Assessing the effects of ICT in education: Indicators, criteria and benchmarks for international comparisons*. 2010.
[26] D. C. Rice, J. M. Ryan, and S. M. Samson, "Using Concept Maps to Assess Student Learning in the Science Classroom: Must Different Methods Compete?," *J. Res. Sci. Teach.*, 1998.
[27] V. Rajlich and N. Wilde, "The role of concepts in program comprehension," in *Proceedings - IEEE Workshop on Program Comprehension*, 2002.
[28] N. Afifah *et al.*, "Kemampuan Berpikir Kritis Dan Pemahaman Konsep Ipa," *Unnes J. Biol. Educ.*, 2013.

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

# Student (Prospective Mathematics Teacher) Perception of Cheating Reviewed by Multiple Intelligence, Mathematical Resilience and Grade Point Average (GPA)

**Wahidin[1*], Nanang Priatna[2]**

[1]Faculty of Teacher Training and Education, University of Muhammadiyah Prof. Dr. Hamka
Jl. Tanah Merdeka, Kp Rambutan, Pasar Rebo, East Jakarta 13830

[2]Universitas Pendidikan Indonesia
Jl. Dr. Setiabudi No.229, Isola, Kec. Sukasari, Kota Bandung, Jawa Barat 40154

*Correspondence email: wahidinmtk@uhamka.ac.id

## ABSTRACT

This study aims to examine perceptions of prospective mathematics teacher (students) on cheating based on multiple intelegence, mathematical resilience and GPA. The sample of this study was conducted on 30 students at third semester in Faculty of Education and Teacher Training (FKIP), University of Muhammadiyah Prof.DR.Hamka (UHAMKA). This research used qualitative method which applied case study and phenomenology. The results of this research illustrates that students' cheating perception in high-medium-low category are at moderate level of multiple intelligences, mathematical resilience and GPA. There are eight reasons why student cheats, 10 ways that someone does cheating and 11 attempts to overcome cheating.

**Keywords:** Cheating, multiple intelligence, mathematical resilience

## INTRODUCTION

Research by [1] found that teacher's experiences in managing stress due to dealing with students can increase their resilience. According to [2] found that cheating can be indetified based on type of study program being learned or study period. Cheating in written examination are dominantly influenced by personal and situational factors. Cheating strategies use notes, writing on body parts and ordinary objects, copying identity and other students'work, exchanging books, and leaving notes in lavatory. Cheating reduction strategies are divided by two categories, namely, manual instruction, offenders' suspension and results'cancellation, improvement on supervisor training, supervisor's motivation, CCTV usage. [3], at physiology department, we have concens that students change written test and submit them back for higher scores; thus, it depleted integrity of our main assessment.

In this research, researchers extend previous research by paying attention to cheating ways by observing, interviewing why cheating, listing participant's suggestion on how to overcome cheating based on multiple intelligence, mathematical resilience and GPA of prospective mathematics teachers (students).

- **Cheating**

Cheating is a fraud in examination through information usage that comes from outside illegally [4]–[8]. Cheating can be defined as all kinds of fraud that happened in the test by using contradictive ways with regulation in obtaining a benefit, in this case, the benefit is that obtaining answers for getting higher scores than doing with own ability. The forms of cheating behavior: (1) giving or receiving information from outside; (2) Using tools that are allowed; and (3) Utilizing the weakness of other people, procedures or the process of conducting test to gain a benefit [9].

- **Multiple Intelligence**

Multiple Intelligence theory is the highest validation concept that individual differentitation is important, and in the theory, people was born with own intelligence, unless in one of specific levels [10]. Multiple Intelligence is an individual's ability which shown as a an abstract skill/thinking in solving faced problems or creating something new [11]–[16].

According to Gardner [10], [17]–[25], human intelligence has ten dimensions, they are :

a) *Linguistic intelligence*, is sensitivity to the meaning and arrangement of words and variety of language usage
b) *Logical-mathematical intelligence*, is an ability to work with long sequence of logic and recognize pattern and arrangement of reality.
c) *Musical intellingence*, is sensitivity to music pattern, melody and tone.
d) *Spatial intelligence*, is an ability to feel visual world accurately and recreate, transform or modify realistics aspects based on perception
e) *Bodily-kinesthetic intelligence*, is an ability of using body parts well and handling objects
f) *Interpersonal intelligence*, is an ability to build good relationship with other people.
g) *Intrapersonal intelligence*, is an ability to access own internal life.
h) *Naturalis intelligence*, is ability to recognize and categorize species, flora and fauna in surrounding environment.
i) *Spiritual intelligence*, is an ability to actualize transcendent things or awareness of faith values and belief in the Greatness of God.
j) *Existensial intelligence*, is an ability in some life problems and existential human aspect and in-dept experience of life.

- **Mathematical Resilience**

Students experience obstacles, difficulties, fears, and anxiety in learning mathematics. Anxiety of mathematics leads to students' dislike of mathematics [26]–[32]. In addition, students try to avoid learning and doing mathematics. Obstacle (Learning difficulties) can cause student get failure in reaching learning goals, so it requires more effort to overcome the problem. To overcome anxiety and fear in facing challenges and difficulties, it requires hard work and good language skills, students need to have a determined and tough attitude that is contained in mathematical resilience [33].

Dweck reveals that mathematical resilience consist of diligent or persistent ability in dealing with difficulties, work or collaborative learning among students, having language skill to state mathematical understanding, and mastering mathematical learning theories [34]. Mathematics resilience is a quality attitude in learning mathematics which includes; confidence of his success through hard effort; showing perseverance in solving problem; having a desire to discuss, reflect and research [34]. Mathematical resilience helps students to overcome difficulties in mathematics problem solving [35]. Mathematical resilience concept is a positive adaptive attitude towards mathematics that student has opportunities to continue learning mathematics despite problems [36].

According to [36], There are four factors which is correlated with resilience, namely : (1) Value: the belief that mathematics is a valuable subject and should be learnt; (2) Struggle: Recognition that struggling in mathematics is universal even with people who have high level of mathematics ability; (3) Growth: the belief that everyone can develop their mathematics skills and distrust that some people are born with or without learning ability and (4) Resilience: Orientation to situation or negative difficulties in mathematics learning that produces positive responses.

- **Learning Achievement**

Synthesizing from the view of some experts, learning is a change in human beings after interacting with their environment [37]. Is one who is devoutly obedient during periods of the night, prostrating and standing (in prayer), fearing the Hereafter and hoping for the mercy of his Lord, (like one who does not)? Say, "Are those who know equal to those who do not know?"Only they will remember (who are) people of understanding (QS. Az-Zumar: 9). Learning achievement in this research can be seen from GPA of students during lecture.

## RESEARCH METHOD

This type of research design is a case study and phenomenology, this type is based on the desire of researchers to produce a picture of how cheating is, why cheating, and how efforts to overcome cheating which is associated with multiple intelligences, mathematical resilience, and GPA of prospective mathematics teacher students. Data was collected intensively in this research, the researchers will choose only one University, namely, UHAMKA. Sample choice strategy is done by choosing particular case and phenomenology, then sampling procedure in this research used purposive sampling technique. Data sources were obtained from questionnaires (perception of cheating-multiple

intelligence-mathematical resillience) and GPA. Data was run using qualitative method with these steps (1) Explore common data definition, (2) Coding data and (3) Determine the followed theme [38]. Rechecking and confirmation obtained data in this research was validated by reserachers, expertises and participants.

## RESULTS AND DISCUSSION

- **Data Presentation**

Student perception questionnaire on cheating that was completed by 34 respondents and scored, so that results 4 students (R8, R19, R34, and R33) who had high perception which means that showing student's disagreement to cheating behavior, and 4 students (R4, R25, R5, dan R15) who had low perception which means that showing student's agreement to cheating behaviour. These eight respondents were further explored information about cheating based on 20 items of questionnaire statements and 5 items of open questions, on the aspects of cheating reasons, how to cheat, and overcoming cheating.

**Table 1.** Student's perception on cheating

| | High | Medium | Low | Overall |
|---|---|---|---|---|
| **N** | 4 | 26 | 4 | 34 |
| **Score** | 3.50 | 2.83 | 2.35 | 2.86 |
| **Persentage** | 87.50 | 70.87 | 58.75 | 71.40 |

The higher perception score shows the high rejection of cheating behavior. Students' perception on cheating obtained a score of 2.86 in medium level which means that their attitude refused cheating behavior by 71.40%, the remaining 28,60% were still able to accept cheating behavior.

**Table 2.** The average of student perception on cheating based on KM and RM

| | | Multiple Inteligence | | | | | | | | $\overline{PM}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Ling | Mat-Logis | Rg-Visual | Kinestetik | Musikal | Inter-P | Itra-P | Naturalis | |
| | T | - | 2.75 | - | 3.00 | - | - | 2.60 | - | 2.78 |
| RM | S | 2.95 | 2.70 | 3.00 | 3.00 | 2.75 | 2.65 | 2.80 | 2.90 | 2.84 |
| | R | 2.60 | 3.15 | - | - | 2.95 | 3.05 | 3.20 | 2.45 | 2.90 |
| | | | | | | | | | | 2.86 |
| $\overline{PM}$ | | | | | | | | | | |
| | | 2.78 | 2.87 | 3.00 | 3.00 | 2.85 | 2.85 | 2.87 | 2.68 | |

Student who had low mathematical resilience, had the best perception on cheating compared to student who had medium and high resilience. The same result for students who had visual-space and kinestetics intelligence, had the best perception on cheating. All of them are in the perception of cheating at medium level which means they show a normal attitude towards cheating behavior amaong students.

**Table 3.** Cheating perception category, KM, RM and GPA

| Category | Cheating perception | Multiple Intelligence | Mathematical Resillience | GPA |
|---|---|---|---|---|
| High | > 3.19 | > 3.19 | > 3.43 | > 3.77 |
| Medium | 2.52 < PM ≤ 3.19 | 2.54 < KM ≤ 3.19 | 2.91 < RM ≤ 3.43 | 3.18 < IPK ≤ 3.77 |
| Low | ≤ 2.52 | ≤ 2.54 | ≤ 2.91 | ≤ 3.18 |

**Table 4.** Cheating perception based on KM, RM, and GPA

| Respondent | Cheating perception | Multiple Intelligence | Mathematical Resillience | GPA |
|---|---|---|---|---|
| High perception | 3.50 | 2.97 | 3.12 | 3.55 |
| Medium perception | 2.83 | 2.87 | 3.19 | 3.48 |
| Low perception | 2.35 | 2.88 | 3.10 | 3.37 |

Based on Table, student perception on cheating in high-medium-low category is on medium of multiple intelligence, mathematical resilience and GPA level.

**Explored Case: "The reason of cheating"**

Questionnaire Statement

**Table 5.** Student perception on cheating, related to case "the reason of cheating".

| No. | Statement | R8<br>R4 | R19<br>R25 | R34<br>R5 | R33<br>R15 | |
|---|---|---|---|---|---|---|
| 6 | Supports the adage that states "position determines achievement" because it makes easily work together | 3<br>2 | 2<br>1 | 3<br>2 | 3<br>2 | 2.75<br>1.75 |
| 7 | Reasons for cheating is that student do not want to get low score of exam results | 4<br>2 | 4<br>1 | 3<br>2 | 2<br>2 | 3.25<br>1.75 |
| 8 | The reason of cheating is that student are fear of cannot pass grade of school | 4<br>2 | 4<br>1 | 4<br>2 | 4<br>2 | 4.00<br>1.75 |
| 9 | Are you satisfied with your cheating examination results? | 4<br>4 | 4<br>3 | 4<br>3 | 4<br>2 | 4.00<br>3.00 |
| 10 | Do you feel unconfident with your answers then you ask your friend? | 4<br>2 | 4<br>2 | 2<br>1 | 3<br>2 | 3.25<br>1.75 |
| | High perception | 3.80 | 3.60 | 3.20 | 3.20 | |
| | Low perception | 2.40 | 1.60 | 2.00 | 2.00 | |

**Open Question**

a) Why did you or people cheat?

**Table 6.** Reasons why people cheat

| Respondent | | Response | Code |
|---|---|---|---|
| High Perception | R8 | Have not understood yet towards tested material | am1 |
| | | Forget about the material | am2 |
| | R19 | Unconfident | am3 |
| | | Lack of preparation in facing test | am4 |
| | | Lack of character morals | am5 |
| | R34 | I am be able answering questions | am6 |
| | | Did not study | am7 |
| | R33 | I had lack of mastery the given material | am1 |
| Low Perception | R4 | Unconfident | am3 |
| | | I did not master the material | am1 |
| | R25 | The material that has been studied is not accordance with the exams that came out | am8 |
| | | Exam questions are difficult | am9 |
| | | Unconfident | am3 |
| | | I did not master the material | am1 |
| | R5 | I was afraid that the answer is not right | am10 |
| | | Unconfident | am3 |
| | | I did not master the material | am1 |
| | R15 | Lack of study | am7 |
| | | Lack of preparation | am4 |

There are ten categories in student responses towards "the reason of cheating" case, which coded from am1 to am10. If student's response is reduced based on similarty of intent, then;

**Table 7.** Data reduction of why student cheats

| Reasons of cheating | Code | Result |
|---|---|---|
| Lack of preparation = do not study | am4 = am7 | am1: have not understood yet the material<br>am2: Forget the material<br>am3: Lack of confidence<br>am4: Lack of preparation<br>am5: Character<br>am6: Incorrect answer |
| Cannot answer = incorrect answer = difficult question | am6 = am10 = am9 | |
| Personality morals are replaced by the word of character | am5 | |
| Incompatible material with the question can be removed, because clearly the question does not meet the content validity. This is very rare, if it happens, then this is a teacher negligence. | am8 | |

Based on the data processing, there are 5 reasons why someone cheated during an exam, namely: (1) character problems; (2) lack of confidence in facing exams; (3) do not understand the material being tested; (4) lack of preparation before the exam; (5) forgetting the material being tested; and (6) not correctly answering exam questions

b) What did you or someone expect from cheating?

**Table 8.** Someone's cheating expectation

| Respondent | | Response | Code |
|---|---|---|---|
| High Perception | R8 | Hopefully getting punishment | hm1 |
| | R19 | Getting good score in a bad way | hm2 |
| | R34 | Good score | hm2 |
| | R33 | Getting a good result | hm2 |
| | | Although cheating is not good and allowed to be applied | |
| Low Perception | R4 | Be able answering questions | hm3 |
| | | Then gaining a good score | hm2 |
| | R25 | Being able comparing between own answer and friend's answer | hm4 |
| | R5 | Gaining a good score | hm2 |
| | R15 | Getting answer easily without thinking | hm5 |

There are 5 categories of student's response on "cheating expectation" case, which is coded from hm1 to hm5. If student's response is reduced over equal meaning, then;

**Table 9.** Data reduction on someone's cheating expectation

| Cheating expectations | Code | Result |
|---|---|---|
| Punishment is deleted since it is irrelevant | hm1 | hm1: getting good score |
| Can answer the question = getting easily answer | hm3 = hm5 | hm2: getting answer<br>hm3: comparing answer |

**Explored phenomenon "the way of cheating"**

1. Quetionnaire statement

**Table 10.** Student's perception on cheating, related to phenomenon of "the way of cheating".

| No. | Statement | R8<br>R4 | R19<br>R25 | R34<br>R5 | R33<br>R15 | |
|---|---|---|---|---|---|---|
| 11 | You will use particular codes for sharing anwers among your friends in the examination | 4<br>2 | 4<br>2 | 4<br>2 | 3<br>2 | 3.75<br>2.00 |
| 12 | You will Share your answer by using tissue in the examination | 4<br>3 | 4<br>3 | 4<br>3 | 3<br>2 | 3.75<br>2.75 |
| 13 | Table and chair are tools for writing cheat sheet in the examination | 4<br>3 | 4<br>2 | 4<br>3 | 3<br>2 | 3.75<br>2.50 |
| 14 | Choosing the rearmost position in the class is the way to see freely notes in the closed book examination | 4<br>3 | 4<br>3 | 4<br>3 | 4<br>2 | 4.00<br>2.75 |
| 15 | Tossing paper is one of the cheating tricks that oftenly done | 3<br>3 | 4<br>3 | 4<br>3 | 4<br>2 | 3.75<br>2.75 |
| | High perception | 3.80 | 4.00 | 4.00 | 3.40 | |
| | Low perception | 2.80 | 2.60 | 2.80 | 2.00 | |

2. **Open question**

c) If you have cheated, how did you do it?

**Table 11.** Someone's cheating way

| Respondent | | Response | Code |
|---|---|---|---|
| High perception | R8 | Switching filled question | cm1 |
| | R19 | Just asking point, then I say it by myself | cm2 |
| | R34 | Do not know | |
| | R33 | Making answers on paper | cm3 |
| Low perception | R4 | Poke a friend | cm4 |
| | R25 | Poke a friend to look at me | cm4 |
| | R5 | Poke a friend | cm4 |
| | | Asking | cm2 |
| | R15 | Asking friend's answer | cm5 |

d) If you have seen your friend who is cheating, What do you usually do?

**Table 12.** someone's cheating way

| Respondent | | Response | Code |
|---|---|---|---|
| High perception | R8 | Using own code | cm6 |
| | R19 | Giving zero score | |
| | R34 | I did, wrote on paper or tissue | cm3 |
| | | | cm7 |
| | R33 | Throwing paper | cm3 |
| | | Put a note book in the class | cm8 |
| | | Using finger to give answer of multiple choice question | cm9 |
| Low perception | R4 | Poke a friend | cm4 |
| | R25 | Whispering | cm10 |
| | R5 | Seeing friend's answer | |
| | R15 | Asking answer | cm5 |
| | | Taking friend's answer sheet | cm11 |

There are 11 categories on student's response towards "cheating way" phenomenon, which is coded from cm1 to cm11. If student's response is reduced over equal meaning, then;

**Table 13.** Data reduction of someone's cheating expectation

| Chetaing ways | Code | Result |
|---|---|---|
| Exchanging questions already filled = ask friend for answers = take a friend's answer sheet | cm1 = cm5 = cm11 | cm1: Exchanging answers<br>cm2: Asking answers<br>cm3: Writing answers on paper |
| Using own code = using finger | cm6 = cm9 | cm4: Poke a frien |
| Writing the answer on tissue is replaced by writing answer on other objects | cm7 | cm5: Using code<br>cm6: Writing answers on other objects |
| Bringing a note book is replaced by seeing a note book | cm8 | cm7: Seeing a note book<br>cm8: Whispering |

**Open question**

e) In your opinion, How do overcome cheating? Then it is noMenurut Anda, bagaimana cara mengatasi menyontek? So that it is not entrenched among students.

**Table 14.** Solutions to overcome cheating

| Respondent | | Response | Code |
|---|---|---|---|
| High perception | R8 | Increase student's material understanding | mm1 |
| | R19 | Studying well | mm2 |
| | | Diligent | mm3 |
| | | Keeping integrity in the examination | mm4 |
| | R34 | Giving punishment | mm5 |
| | | Not getting score | mm5 |
| | R33 | Parents should actively contribute to their children when is studying | |
| Low perception | R4 | Teacher can explain the material clearly and correctly | mm6 |
| | | Giving clue of exam material | mm7 |
| | R25 | Increase teacher's capability to help students in understanding and mastering materials, therefore student will not cheat | mm6 |
| | R5 | Teacher should explain clearly material and ensure that students understand the explanation | mm6<br>mm7 |
| | | Giving the questions' overview | |
| | R15 | Building students' religious character | mm4 |
| | | Incresase supervision | mm8 |

There are 8 categories on student's response on "Overcoming cheating"phenomenon which is coded from mm1 to mm8. If student's response is reduced over equal meaning, then;

**Table 15.** Data reduction to overcome cheating

| Cheating ways | Code | Result |
|---|---|---|

| | | |
|---|---|---|
| Increase understanding = studying well = dilligent | mm1 = mm2 = mm3 | mm1: Study diligently<br>mm2: Integrity |
| Mandate and religious character can be complemented by integrity | mm4 | mm3: Giving punishment<br>mm4: Learning quality |
| Teacher's capability and teaching ways are similar with learning quality | mm6 | mm5: Examination overview<br>mm6: Examination supervision |

- **Interview**

Interviews were conducted face-to-face directly to one student, one teacher and one lecturer. Meanwhile, online interview was done for three teachers and two lecturers by using whatsapp.

**Table 16.** Reduction results of interview on cheating perception

| Student | Teacher | Lecturer | Reduction result |
|---|---|---|---|
| 1) Why do people cheat in the exam? | | | |
| ▪ Unconfidence with own ability<br>▪ Good teacher<br>▪ Teachers focus on their phone when supervising | ▪ Gaining high score<br>▪ Lack of preparation prior to examination<br>▪ Being afraid of parents' anger when obtaining low score<br>▪ Knowing nothing the answer<br>▪ Not able answering the test question since the question is hard<br>▪ Forgetting the answer | ▪ Passion, so that feeling missing something if<br>▪ Do not understand the subject<br>▪ Do not study<br>▪ Unconfident<br>▪ Habit | ▪ Habit<br>▪ Unconfident<br>▪ Lack of strict supervisor<br>▪ Getting high score<br>▪ Not readt for examination<br>▪ Not able answering the questions<br>▪ Do not understand the subject |
| 2) What ways commonly used in cheating during the test? | | | |
| ▪ Searching all side of the desk<br>▪ Making notes on the table<br>▪ Making notes on small paper | ▪ Exchanging paper<br>▪ Seeing a paper<br>▪ Asking a friend<br>▪ Seeing the phone<br>▪ Seeing students' answer<br>▪ Seeing the answer in toilet<br>▪ Using finger code or body language<br>▪ Writing the answer of multiple choice question on eraser | ▪ Cooperation with internal person or supernatural person<br>▪ Using phone for searching in google<br>▪ Small notes<br>▪ Writing on strategic place<br>▪ Asking a close friend<br>▪ Looking at a friend's answer | ▪ Making a small notes<br>▪ Exchanging a paper<br>▪ Seeing notes<br>▪ Seeing phone<br>▪ Asking a friend<br>▪ Glancing and seeing a friend's answer<br>▪ Writing the answers on other objects<br>▪ Seeing the answer in toilet<br>▪ Using finger code or body language |
| 3) How to overcome someone from cheating? | | | |
| ▪ Supervisor said "I leave the supervision directly to God, if you try to cheat, the punishment is also directly from God"<br>▪ At the top of the question there is written "by God I | ▪ Putting a book on the table, aoutomatically a student feels shy if he is the only one who cheating<br>▪ Giving advice<br>▪ Taking notes<br>▪ Giving a punishment by not | ▪ Eliminating exam/test<br>▪ Create various of question types (variety series of questions for each person)<br>▪ Adjusting the sitting position (exchange row and column) and distance<br>▪ Strict supervision<br>▪ Increase test reliability | ▪ Using a sentence and sel-evaluation activity<br>▪ Strict supervision<br>▪ Arrangement sitting position<br>▪ Giving punishment and warning<br>▪ Providing variety question test |

| | | | |
|---|---|---|---|
| do not cheat in this test" | evaluating the answer<br>▪ Remidial or retest<br>▪ Saying “it is permitted to cheat as long as no one knows | ▪ Providing many questions<br>▪ Saying “If you are wathing supervisor menas that you are cheating”<br>▪ Taking an answer sheet<br>▪ Left from exam room<br>▪ Providing four chairs which are near whiteboard, if there is a student cheat, the student will be asked to move to the front chair | ▪ Increase the amount of questions<br>▪ Increase test reliability |

### 1.1. Discussion

According to research results, student’s perception on cheating based on multiple intelligence and mathematical resilience, dividev into three categories, namely, cheating reasons, cheating ways, and the overcoming cheating.

**Cheating reasons**

Based on open questions that filled by respondent, interviewed to student-teacher-lecturer, it can be seen that why someone cheats in the exam, there are:

**Table 17.** Confirmation of cheating reasons

| Open Questions | Interview | Confirmation |
|---|---|---|
| 1) Character problems<br>2) Lack of confidence in dealing with exam<br>3) Do not understand yet examination contents<br>4) Lack of preparation before examination<br>5) Forgetting exam contents<br>6) Giving wrong answer in the test | 1) Habit<br>2) Unconfident<br>3) Unstrict supervisor<br>4) Gaining a high score<br>5) Not ready facing the exam<br>6) Cannot answer the questions<br>7) Do not understand the exam contents | Students continuously do plagiarism or cheating because of low punishment [39].<br>Cheating on written test tends to be influenced by personal and situational factors [2].<br>Students change written test and submit them back to gain a higher score; lack of integrity [3]. |

Based on the table, it can be seen that someone’s cheating reasons are (1) habit, (2) Unconfident, (3) Do not understand the exam content (4) Forgetting the exam content (5) Not ready facing the exam, (6) Unable anwering the exam questions, (7) Gaining a high score, and (8) A light punishment.

**Cheating ways**

Based on open questions which filled by respondent and interviewd to student-teacher-lecturer, it can be concluded cheating ways in the examination are:

**Table 18.** Confirmation of cheating ways

| Open Questions | Interview | Confirmation |
|---|---|---|
| 1) Asking the answers (giving clues, asking the answers for all questions or half questions)<br>2) Writing the answers on paper (giving to the friends by throwing)<br>3) Switching the answer sheets<br>4) Poking a friend<br>5) Using codes (fingers) | 1) Making notes on a small paper<br>2) Swithing papers<br>3) Looking at a paper<br>4) Looking at a phone<br>5) Asking to a friend<br>6) Glancing and seeing a friend | Strategi kecurangan utama diidentifikasi sebagai penggunaan catatan kecil menulis pada bagian tubuh dan benda-benda biasa, peniruan identitas, bertukar buku pemeriksaan, menyalin karya orang lain dan |

| | | |
|---|---|---|
| 6) Writing the answers on other objects<br>7) Opening note books (other refrences)<br>8) Whispering | 7) Writing the answers on other objects<br>8) Looking at the answers in the toilet<br>9) Using codes namely fingers or body parts | meninggalkan catatan di toilet (Taderera, Nyikahadzoi, Matamande, & Mandimika, 2014). |

Based on table, the reason why someone cheat are (1) Asking the answers, (2) Writing the answers on the small paper, (3) Exchange the answer sheets (4) Poking a friend, (5) Using body parts as a code, (6) Writing the answers on the other objects, (7) Opening a note book, (8) Whispering, (9) Looking at a phone, and (10) Looking at the answers in the toilet

**Solving a cheating problemMengatasi Menyontek**
According to open questions data that filled by respondent, interviewed to students-teachers-lecturers, efforts to overcome cheating during exams are obtained, namely:

**Table 19. Confirmation of overcoming cheating**

| Open Questions | Interview | Confirmation |
|---|---|---|
| 1) Study hard<br>2) Integrity<br>3) Giving punishment<br>4) Learning quality<br>5) Overview of exam contents<br>6) Examination supervision | 1) Use of sentences and self-evaluation activities<br>2) Restricted supervision<br>3) Seating arrangement<br>4) Giving warning and punishment<br>5) Making variety exam questions<br>6) Adding more question items<br>7) Increasing reliability of test | Opportunities to reduce the incidence of plagiarism by providing students with accurate information about plagiarism in their school are discussed in the context of social norm theory [40]<br>The strategy to reduce cheating is divided into two categories, namely manual instruction, suspension of violators and cancellation of results, as well as improvements to supervisor training, motivation of monitoring staff, use of CCTV [2]. |

Based on the table, the reason obtained by someone cheating are (1) Integrity, (2) Study hard, (3) Giving advice and punishment (4) The quality of learning, (5) Overview of exams content, (6) Examination supervision, (7) The use of sentences and self-evaluation activities, (8) Seating arrangements, (9) Varying questions, and (10) Multiplying items, and (11) Incresing the realibility of the questions.

**Data Validity Cheching**
Discussion with colleagues that discuss scoring on perception scale of cheating. The need for other aspects such as multiple intelligences and GPA. Since this research is qualitative method, this research use everything that is interesting to study and support the research aims, namely students' perceptions of cheating.

Triangulation is carried out on methods and sources, namely changes in data collection techniques using questionnaires, interviews, open questions, document review such as multiple intelligences and students' GPA. Researchers'limitations in expertise and time, then assisted by fellow researchers in terms of data collection both trough questionnaires, open questions manually and online, as well as scoring cheating perception scale.

**Table 20.** Data Triangulation

| Respondent | | Mathematical Resilience | Multiple Inteligence | | GPA |
|---|---|---|---|---|---|
| High Perception | R8 | Medium | Medium | Naturalist | Medium |
| | R19 | Medium | High | Musical/Naturalist | Medium |
| | R34 | Medium | Medium | Visual-space | Medium |
| | R33 | Medium | Low | Intrapersonal | Medium |
| Low Perception | R4 | Low | Low | Naturalist | Medium |
| | R25 | High | Medium | Intrapersonal/Naturalist | Medium |

| | | | | |
|---|---|---|---|---|
| R5 | Medium | Medium | Kinestetic/Interpersonal/ Naturalist | Rendah |
| R15 | Medium | Medium | Naturalist | Medium |

Observing the table, there is an interesting phenomenon, that students who have high perceptions and low perceptions of cheating, most are in medium mathematical resilience, medium compound intelligence, and medium GPA. Therefore it is necessary to be explored more deeply on the phenomenon of student positions at a medium level that is associated with their perceptions of cheating.

Of course there are appropriate cases, namely R4 with low mathematical resilience and low compound intelligence in line with giving a low perception of cheating. R5 with a low GPA gives a low perception of cheating. R19 with high multiple intelligence gives a high perception of cheating. Also a contradictory case, namely R25 with high resilience, but gives a low perception of cheating.

With regard to multiple intelligence, most students who have a high response or a low response to cheating, are in naturalist intelligence. This phenomenon also needs to be examined more deeply on aspects of naturalist intelligence indicators that are associated with students' responses to cheating. Two cases for R34 and R33 which cannot be classified into naturalist intelligence.

## CONCLUSIONS

This study examines the perceptions of mathematics teacher prospective students about cheating, which is associated with multiple intelligences, mathematical resilience, and their GPA. The results of the study illustrate that students' cheating perceptions in the high-medium-low category are at the level of multiple intelligences, mathematical resilience, and moderate GPA. There are 8 reasons someone cheats, 10 ways that someone does cheating, and 11 attempts to overcome cheating.

The findings of this short study cannot be generalized, because it is based on the number and involvement of respondents, validation of research instruments that have not been rigorous, data collection techniques, or referral processes that have not been strong. But at least it can provide an illustration for us about cheating and relevant issues in higher education. Another limitation of this study is the reliance on students' questionnaires and open-ended questions about their perceptions and behavior related to cheating. It is possible that some respondents were deliberately dishonest or they did not respond accurately to the instruments provided.

## REFERENCES

[1] D. Schussler *et al.*, “Stress and Release: Case Studies of Teacher Resilience Following a Mindfulness-Based Intervention,” *Am. J. Educ.*, vol. 125, no. 1, pp. 1–28, 2018.
[2] E. Taderera, L. Nyikahadzoi, W. Matamande, and E. Mandimika, “Exploring management strategies to reduce cheating in written examinations: case study of Midlands State University.,” *J. Case Stud. Educ.*, 2014.
[3] K. Ottaway, C. Murrant, and K. Ritchie, “Cheating after the Test: Who Does It and How Often?,” *Adv. Physiol. Educ. (ERIC Number EJ1147961).*, vol. 4, no. 3, pp. 368-374 ., 2017.
[4] Y. Sujana and R. Wulan, “Hubungan antara Kecenderungan Pusat Kendali dengan Intensi mencontek,” *J. Psikol. Univ. Gadjah Mada*, vol. 2, pp. 1–8, 1994.
[5] Y. Indarto and Masrun., “Hubungan Antara Orientasi Penguasaan dan Orientasi Performansi dengan Intensi Mencontek,” *Sosiosains*, vol. 17, no. 3, pp. 411–421, 2004.
[6] C. M. Kilian and D. E.M., “Do Accounting Student Cheat? A Study Examining Undergraduate Accounting Students’ Honesty and Perceptions of Dishonest Behavior. J,” *ournal of Accounting, Ethics & Public Policy*, vol. 5, no. 3, pp. 375 – 393, 2006.
[7] Anderman, E. M., and T. B. Murdock., *Psychology of Academic Cheating*. New York: Academic Press, 2006.
[8] KBBI, “Kamus Besar Bahasa Indonesia,” 2018. .
[9] R. L. Ebbel and D. A. Friesbie, *Essential of Educational Measurement.* New Jersey: Prentice Hall Inc, 1986.
[10] J. Jasmine, *Metode Mengajar Multiple Intelligence*. Bandung: Nuansa Cendekia, 2012.
[11] M. A. Samsudin, N. H. Haniza, C. Abdul-Talib, and H. M. Mhd Ibrahim, “The Relationship between Multiple Intelligences with Preferred Science Teaching and Science Process Skills,” *J. Educ. Learn.*, vol. 9, pp. 53–59, 2015.

[12] A. Amir, "Pembelajaran Matematika dengan Menggunakan Kecerdasan Majemuk (Multiple Intelligences)," *Logaritma*, vol. I, no. 01, pp. 1–14, 2013.
[13] K. Davis, J. Christodoulou, S. Seider, and H. Gardner, "The Theory of Multiple Intelligences The Theory of Multiple Intelligences," no. January, 2011.
[14] U. Rohmah, "Tes intelegensi dan pemanfaatannya dalam dunia pendidikan," *Cendekia J. Educ. Soc.*, vol. 9, pp. 125–139, 2011.
[15] A. K. Alqatanani, "Do Multiple Intelligences Improving EFL Students' Critical Reading Skills?," *Arab World English J.*, vol. 8, no. 1, pp. 309–321, 2017.
[16] M. A. Samsudin, N. H. Haniza, C. Abdul-Talib, and H. M. Mhd Ibrahim, "The Relationship between Multiple Intelligences with Preferred Science Teaching and Science Process Skills.," *J. Educ. Learn.*, vol. 9, pp. 53–59, 2015.
[17] H. Gardner, *Frames Of Mind: The Theory of Multiple Intelligences*. New York: BasicBooks, 1983.
[18] Hoerr and T. R., *Becoming a Multiple Intelligences School*. Virginia, USA: Association for Supervision and Curriculum Development., 2000.
[19] A. Ngermanto, *Quantum Quotien, Cara Praktis Melejitkan IQ, EQ, dan SQ*. Bandung: Nuansa Cendekia, 2008.
[20] K. Davis, J. Christodoulou, S. Seider, and H. Gardner, "The Theory of Multiple Intelligences.," *Researchgate*, 2011.
[21] E. W. English, *Mengajar dengan Empati*. Bandung: Nuansa Cendekia, 2012.
[22] N. Khodijah, *Psikologi Pendidikan (1st ed.)*. Depok: PT Rajagrafindo Persada, 2014.
[23] A. Hamzah, "Teori Multiple Intelligences dan Implikasinya terhadap Pengelolaan Pembelajaran.," *Tadris J. Pendidik. Islam*, vol. 4, pp. 251–261, 2009.
[24] R. Kandeel, "Multiple Intelligences Patterns of Students at King Saud University and Its.," 2016.
[25] T. R. Hoerr, S. Boggeman, and C. Wallach, *Celebrating Every Learner : Activities and Strategies for Creating a Multiple Intelligences Classroom (1st ed.)*. San Francisco: Jossey-Bass, 2010.
[26] M. Ashcraft, *Math Anxiety: Personal, Educational, and Cognitive Consequences". Directions in Psychological Science.* America: Blackwell Publishing Inc-American Psychological Society. 181-185. http://www.mccc.edu/~jenningh/Courses/documents/math_anxiety.pdf, 2002.
[27] I. Anita, "Pengaruh Kecemasan Matematika (Mathematics Anxiety) terhadap Kemampuan Koneksi Matematis Siswa SMP. Infinity," *J. Ilm. Progr. Stud. Mat. STKIP Siliwangi Bandung*, vol. 3, no. 1, pp. 125–132, 2014.
[28] D. Astuti, *Anxiety: Apa dan Bagaimana?. Prosiding Seminar Nasional Pendidikan Berkemajuan dan Menggembirakan (The Progressive & Fun Education Seminar), ISBN: 978-602-361-045-7, 495-499.* Surakarta: Muhammadiyah University Press. https://publikasiilmiah.ums.ac.id/handle/11617/7854, 2016.
[29] S. Hartatik and F. K. Fitriyah, "Identifikasi Kecemasan Matematika pada Mahasiswa Program Studi Pendidikan Guru Sekolah Dasar," *J. Bimbing. Konseling Indones.*, vol. 2, no. 2, pp. 31–33, 2017.
[30] I. Puspitasari, R. Purwasih, and A. Nurjaman, "Analisis Hambatan Belajar Mahasiswa pada Mata Kuliah Program Linier," *J. Ilm. Pendidik. Mat.*, vol. 6, no. 1, pp. 39–46, 2017.
[31] L. Ariyanto, T. Herman, U. Sumarmo, and D. Suryadi, "Developing Mathematical Resilience of Prospective Math Teachers.," in *International Conference on Mathematics and Science Education (ICMScE), IOP Conf. Series: Journal of Physics: Conf. Series 895*, 2017.
[32] L. Zanthy, "Kontribusi Resiliensi Matematis terhadap Kemampuan Akademik Mahasiswa pada Mata Kuliah Statistika," *J. "Mosharafa,"* vol. 7, no. 1, 2018.
[33] H. Hendriana, E. E. Rohaeti, and U. Sumarmo, *Hard Skills dan Soft Skills Matematik Siswa*. Bandung: Refika Aditama, 2017.
[34] S. Johnston-wilder and C. Lee, "Developing Mathematical Resilience.," in *BERA Conference 1st - 4th September 2010, University of Warwick*, 2010.
[35] S. Maharani and M. Bernard, "Analisis Hubungan Resiliensi Matematik terhadap Kemampuan Pemecahan Masalah Siswa pada Materi Lingkaran.," *JPMI – J. Pembelajaran Mat. Inov.*, vol. 1, no. 5, pp. 819–826, 2018.
[36] J. Kooken, M. Welsh, D. Mccoach, S. Johnson-Wilder, and C. Lee, "Mathematical Resilience: An application and exploration of motivational constructs related to resilience in the study of mathematics," *Am. Educ. Res. Assoc. 2013 Annu. Meet.*, pp. 1–34, 2013.
[37] I. El Khuluqo, *Belajar dan Pembelajaran, Konsep Dasar, Metode dan Aplikasi Nilai-Nilai Spiritual dalam Proses Pembelajaran*. Jakarta: Uhamka Press, 2017.
[38] J. W. Creswell, *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, 4th ed. London: Sage Publication Ltd, 2014.
[39] D. Starovoytova and S. Namango, "Viewpoint of Undergraduate Engineering Students on

Plagiarism," *J. Educ. Pract.*, vol. 7, no. 31, pp. 48–65, 2016.
[40] R. Fish and G. Hura, "Students' Perceptions of Plagiarism.," *J. Scholarsh. Teach. Learn.*, vol. 13, no. 5, pp. 33–45, 2013.

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

# Population Dynamics of Prosboscis Monkey in Kuala Barito River Delta

**Agus Pambudi Dharma[1], Maryanti Setyaningsih[1], Meitiyani[1], Muhammad Rayhan Fathurrahman[1], Muhammad Hafiz[1], Adi Bakti Prayogo[1], Muhammad Fikri Firdaus[1]**

[1]Biology Education Department University of Muhammadiyah Prof. Dr. HAMKA
Jl. Tanah Merdeka, Kp Rambutan, Pasar Rebo, East Jakarta 13830, Indonesia

*Correspondence email: agus.pambudi@uhamka.ac.id

## ABSTRACT

Proboscis monkey (*Nasalis larvatus* van Wurmb, 1787) is entered endangered species, Appendix I CITES and endemic on the island of Borneo. Bakut Island Nature Tourism Park (NTP) is located in the Barito Kuala River Delta in South Kalimantan which is used as a natural habitat for re-release from the evacuation of conflict with humans or the result of community surrender. Monitoring of proboscis monkeys in Bakut Island NTP has been carried out since 2010 with baseline data on 29 individual proboscis monkeys. Data on population development over the past 9 years shows a fluctuating trend. This study aims to determine the dynamics of the proboscis monkey population in Bakut Island NTP of each year. This research was conducted in February to March 2020 in Bakut Island NTP. Bekantan population data collection using census survey methods directly by down the river using a boat in the morning and evening. The results of this study the development of the proboscis population within 10 years between 2010 and 2020 in the Bakut Island NTP experienced a change in the number of individuals from 29 to 90 individuals. Hunting of proboscis monkeys by the community does not occur at Bakut Island NTP because this location is included in a conservation area which is guarded by officers from morning to evening. Bekantan population density of 5.696 ind/ha with the number of individuals in a group between 25 to 39 individuals dominated by young age structure.

Keywords: Dynamics, populations, prosboscis monkey

## INTRODUCTION

Proboscis monkeys (*Nasalis larvatus* van Wurmb, 1787) belong to family Cercopithecidae, sub-family Colobinae [1]–[8]. The proboscis monkey entered an endangered species and was included in CITES Appendix I [2], [6] because its population has declined by more than 50% over the last 3 generations (36-40 years) [2].

Population proboscis monkeys in Kalimantan in 1994 with a population of 114,000 individuals and in 2004 of 15,000 individuals, the population decline in the last 10 years reached an average of 10% per year. This shows that proboscis monkey is sensitive to habitat fragmentation [9]. proboscis monkeys in 2004 of PHVA (Population and Habitat Viability Analysis) symposium report with an estimated population of 25,000 individuals and 5,000 individuals in conservation areas. Serious degradation of proboscis monkey habitat occurred on the island of Kaget, South Kalimantan in 1996 with a total of 228 individuals [9], which as a result in 1999, monkey proboscis in the Kaget Island Nature Reserve has become extinct due to 90% of agricultural land clearing [10].

Proboscis monkey can be found endemic on the island of Borneo [11] as in Brune [2], [3], [12] in Malaysia, among others Sabah [3], [7], [13]–[15], Sarawak [3], [12], [16]–[18], Berhala, and Sebatik [3]; and in Indonesia include East Kalimantan, West Kalimantan, Central Kalimantan, North Kalimantan and South Kalimantan [4], [8], [19]–[22].

In South Kalimantan, proboscis monkey habitat was found not only in mangrove forests, peat swamp forests, and riparian forests (near the coast or affected by tides), but also found in galam forests (*Melaleuca cajupti*), rubber forests (*Hevea brasiliensis*), secondary forests on limestone hills [23], and dryland forests upstream of the river [21]. Proboscis monkeys as leaf-eating primates (colobinae) require quite high minerals [9]. Proboscis monkey prefer to eat young leaves for food sources, this is because the buds contain high protein but low fiber and anti-nutrients [19]. Proboscis monkey in South Kalimantan can be found outside conservation areas, including: in the East Coast Mangrove Forest [116_02 / 3_16 S]; Muara Muning [114_50 / 2_50 S]; Sea Island [116_13 / 3_48 S]; Island Areca nut [115_03 / 3_05 S]; Pleihari Martapura [114_56 / 3_56 S]; River Kacang [115_10 / 2_40 S]; River Country [114_56 / 2_47 S]; River Tapin [115_15 / 2_55 S] [10]. Within the conservation area, proboscis monkey

can be found in almost all areas including the Nature Reserve (CA) Sea Strait, CA Pamukan, CA Mount Kentawan, Wildlife Reserve (SM) Kuala Lupak, SM Kaget Island, SM Pelaihari Tanah Laut, Kembang Island Nature Tourism Park (NTP), and Bakut Island NTP [24].

Bakut Island NTP in Barito Kuala Regency is one of the mangrove forests used as proboscis monkey habitat in South Kalimantan, which is a location for releasing back probes from evacuated conflict or the result of community surrender. Monitoring of proboscis monkeys in TWAPB has been carried out since 2010 with baseline data on 29 individual proboscis monkeys. Data on population development occurring over the last 9 years shows a fluctuating trend [24], [25], so this study aims to determine the dynamics of proboscis monkey population in Bakut Island NTP each year.

## RESEARCH METHOD

The study was conducted in February – Maret 2020 at Bakut Island NTP, South Kalimantan. Geographically, it is located at coordinates 114,555 ˚ BT - 114,560 ˚ BT and 3,213 ˚ LS - 3,220 ˚ LSm [24]. Bekantan population data collection uses direct census survey methods [14], [26], by river-boat rides in the morning and evening [13], [26]–[29]. The parameters observed were number of individuals, sex ratio, and group density [27], [30].

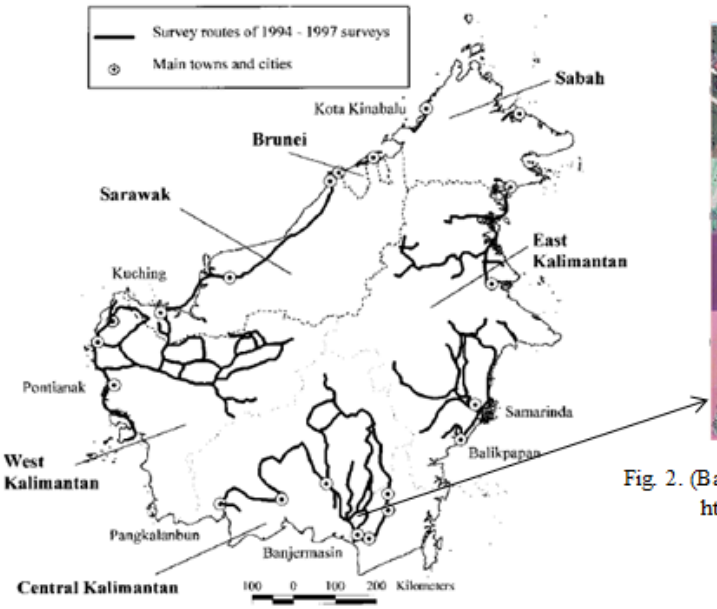



Fig. 1. (River Barito, South Kalimantan, Meijaard and Nijman 2000)

Fig. 2. (Bakut Island NTP, South Kalimantan) http://bksdakalsel.com, 2020)

## RESULTS AND DISCUSSION

The number of proboscis individuals in the Barito Delta region such as in Bakut Island NTP is 90 individuals [31], 14 individuals of Curiak Islands [32], Kembang Island NTP by 48 individuals [33], and the number of proboscis monkeys in Kaget Island in 1997 was 304 individuals [23] and decreased in 2007 to 100 individuals [34]. The number of proboscis monkeys outside the conservation area in other areas of South Kalimantan such as in gelam swamp forests Tapin Regency amounted to 192 individuals [35], 53 individuals in the Batu Sawar mount [36], and at the conservation location ex PT Indocement Tarjun Kotabaru District there were 6 individuals [37]. The existence of proboscis monkey is influenced by the presence of food and competition for food sources [38]. TWAPB habitat in the south is dominated by *Sonneratia caseolaris* while in the north it is dominated by rengas (*Gluta velutina*) and fires (*Aglaia cucullata*) [24].

In Table 1. it can be seen that the development of the proboscis population in the 10 years between 2010 and 2020 in the Bakut Island NTP experienced a change in the number of individuals from 29 to 90 individuals [24], [25], [31]. Population of proboscis monkey can develop, stable or decrease, in accordance with the conditions of environmental changes. Changes in population size that are irregular according to the time scale (irregular) is called fluctuation. Fluctuations can be caused by three factors

including 1) a change in weather, 2) a change in the availability of feed, or 3) the influence of hunting by humans [39]. In addition, there is also competition between primate species and predators.

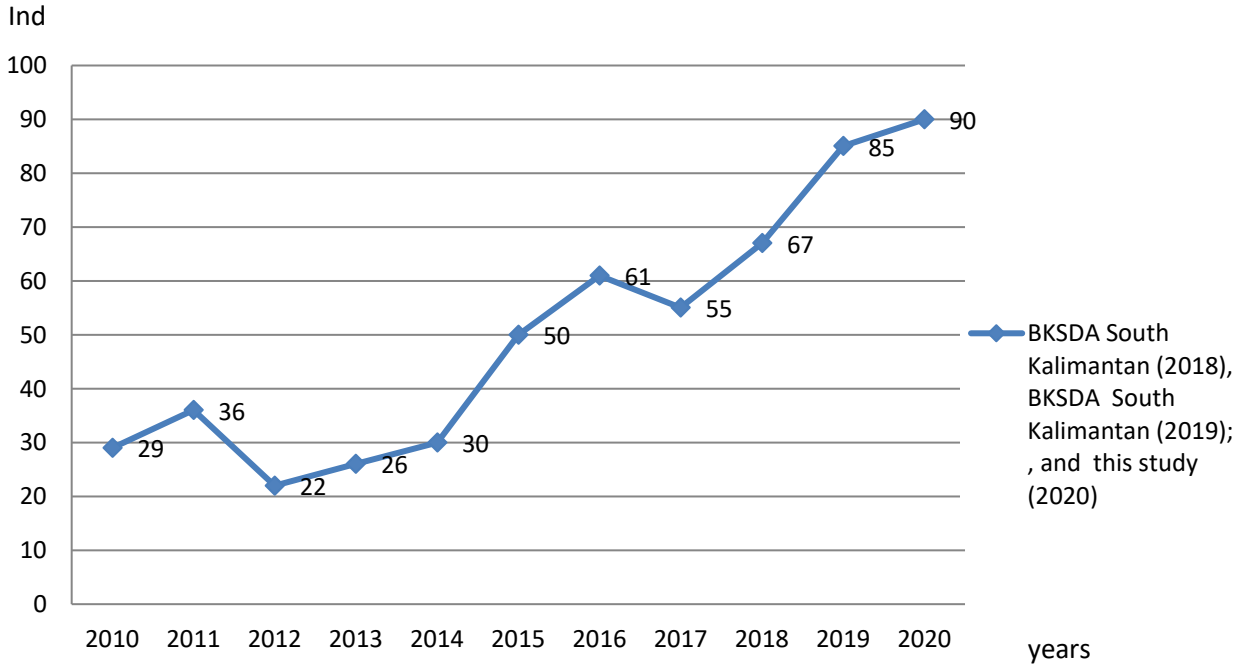



Fig 3. Proboscis monkey population dynamics of Bakut Island NTP

The influence of seasonal conditions that change constantly every year, for example the dry season and the rainy season which causes forage productivity also changes constantly (cyclically). This state of forage productivity is followed by the development or decline of herbivorous populations [39], including proboscis monkeys as leaf-eating primates (sub-family Colobinae) requiring quite high minerals [7], [9], [36], [40]. Therefore, the adequacy of feed is one of the determining factors for the success of animal reproduction [24] Proboscis monkey will choose the preferred feed of leaves, shoots and flowers [39], which has high nutrition and provides energy for individual reproduction [41], group size, and survives for the next generation [18].

Bakut Island NTP is guarded by officers from morning to evening, so there is no possibility of poaching and destruction of the habitat of *Nasalis larvatus* on this island. [36] Mentioned the proboscis monkey in the area of Mount Batu Sawar Timur, Hulu Sungai Tengah District, the occurrence of proboscis monkey hunting was done by local residents but the proboscis monkey was not hunted for consumption but to be traded and made into pets.

At the time of observation, *Macaca fascicularis* was seen at Bakut Island NTP by crossing the river by passing the iron under the Barito Kuala bridge. The presence of M. fascicularis can cause interspecies competition with proboscis monkey. [13] Mentioned that *M. fascicularis* is an omnivorous primate that can be any kind of feed such as leaves, fruit, flowers, tubers, or human food scraps so that it can survive and the population will increase. If *M. fascicularis* is allowed to continue living in Bakut Island NTP each year, it can have a negative impact on proboscis monkeys, namely the reduction of home range and the impact on the depletion of food sources which can consequently interfere with reproductive success.

*M. fascicularis* in Bakut Island NTP has the potential to become a competitor that can suppress the proboscis monkey population if the population is not controlled. In addition, there are several predatory animals in pulau bakut such as buaya sapit (*Tomistoma schlegeli*), ular sawah (*Phyton reticulatus*), elang bondol (*Haliaeetus indrus*), elang laut perut putih (*Haliaeetus leucogaster*), biawak (*Varanus salvator*) [31]. and dogs. The number of predators such as dogs so that many proboscis monkeys who move the place by swimming [42] because the proboscis monkey character is very sensitive and difficult to adapt [43]. Proboscis monkey good swimmers because they have long metacarpus and metatarsus that provide support when walking on mangrove swamp mud and swimming in rivers [44], [45].
One group of proboscis monkeys in the Bakut Island NTP is between 25 - 39 individuals. The difference in the number of individuals in the group is influenced by the habitat environment [46] and affects the

distance of the daily movement of proboscis monkeys [47]. High quality habitat can support a larger group size than the same area as low quality habitat [41]. In the afternoon the proboscis monkeys go to a sleeping tree on the riverbanks of the Bakut Island NTP, up to a distance of ≤ 50m from the riverbank and shore at the mouth of the river and at an altitude of 0-15 m [20], [48].

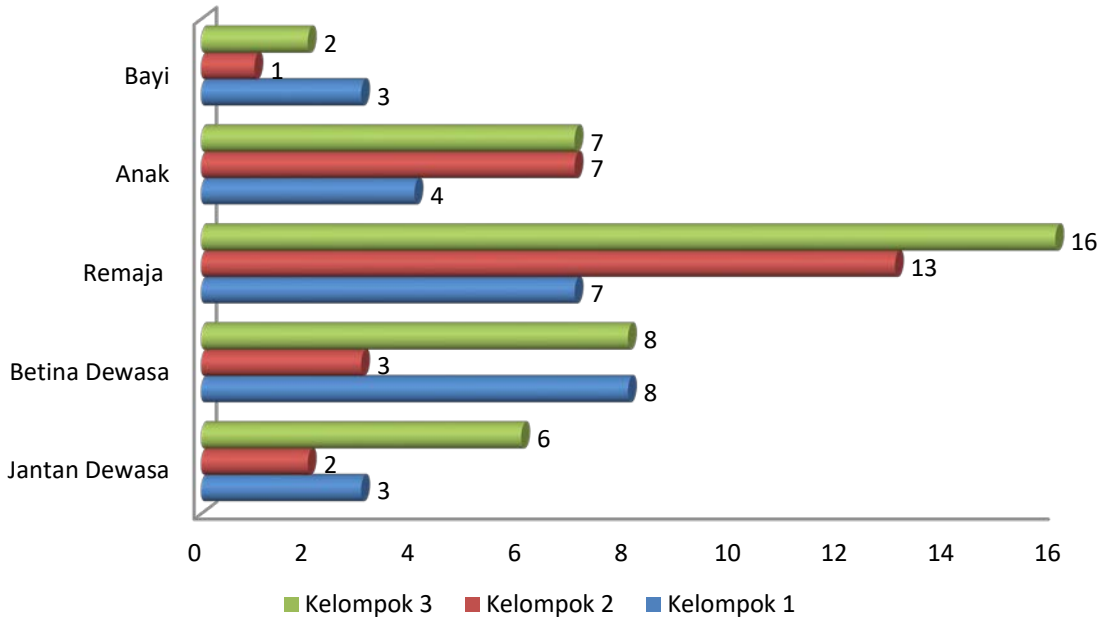



Fig. 4. Sex ratio proboscis monkey in Bakut Island NTP

This research, proboscis monkey, there are three groups divided into five age structures namely infants, children, adolescents, adult females, and adult males. Proboscis social system is more directed to a multi-male group system, namely in a group of proboscis monkeys there are more than one adult male [47]. Bekantan sex ratio in TWA Bakut Island is 1: 1.73 (Fig. 4); in the Rubber Plantation of Pararawen Hamlet in Central Kalimantan for 1: 2 [47]; in the Samboja Koala River for 1: 4 [27].

The number of adolescents, children and infants combined into 60 individuals, then the number is more than the number of female and adult individuals by 30 individuals so that it can be interpreted that the reproductive power of proboscis in Bakut Island NTP is good because it has babies in each group. Regeneration of adult individuals, can sooner or later be sure to be replaced by young individuals [47]. The age structure of the population is said to be declining, if it is a situation where the number of proboscis monkey children is less when compared to the number of adults and young people [36].

Habitat inhabited by proboscis monkey in the Bakut Island NTP area has an area of 15.8 ha with a population density of proboscis monkey of 5.696 ind/ha; 0.50 to 2.82 ind/ha in the Kepuluk River area [29]. Batu Sawar mountain area of 0.088 ind/ha [36]. A daily average movement of 483 m (Nowak 1999). *N. larvatus* is known to spread over the lowlands with an altitude of fewer than 200 meters and is reported to have been found at an altitude of 350 meters [49].

Proboscis density at this location is greater than in mountainous areas with the characteristics of limestone (marble) in the Batu Sawar Mountain area of 0.088 ind/ha [36]. Habitat condition is a factor that greatly influences population growth. Low population density is likely due to population control factors such as poaching, high level of competition, low productivity and availability of food [36], timber utilization, and agricultural land clearing [29]. If the carrying capacity of the habitat cannot keep up with the rapid population growth, the proboscis monkey population in this area will decrease dramatically. This condition will potentially make the proboscis monkey population endangered [36].

## REFERENCES

[1] J. R. Napier and P. H. Napier, *A Hand Book of Living Primates*. London: Academic Press, 1967.
[2] E. Meijaard, V. Nijman, and J. Supriatna, “Nasalis larvatus. The IUCN Red List of Threatened Species 2008,” 2008.

[3] C. Roos *et al.*, "An updated taxonomy and conservation status review of asian primates," *Asian Primates J.*, vol. 4, no. 1, 2014.
[4] T. Atmoko, A. Mardiastuti, and E. Iskandar, "Struktur Kelompok dan Penyebaran Bekantan (Nasalis larvatus Wrumb.) di Kuala Samboja, Kalimantan Timur," in *Seminar Ilmiah Nasional Ekologi dan Konservasi – Makassar, 20-21 November 2013.*, 2013.
[5] J. G. Fleagle, *Primate Adaptation and Evolution 3rd Edition*, Chapter 7: Academic Press, 2013.
[6] R. M. Nowak, *Walker's Primates of the World.* Baltimore and London.: The Johns Hopkins University Press., 1999.
[7] R. Boonratana, "The Ecology And Behaviour Of The Proboscis Monkey (Nasalis larvatus) In The Lower Kinabatangan, Sabah," Mahidol University., 1994.
[8] C. P. Yeager, "Proboscis monkey (Nasalis larvatus) Social Organization: Group Structure.," *Am. J. Primatol.*, vol. 20, pp. 95–106, 1990.
[9] M. Bismark, "Biologi Konservasi Bekantan (Nasalis larvatus). Pusat Penelitian dan Pengembangan Hutan dan Konservasi Alam. Bogor.," 2009.
[10] E. Meijaard and V. Nijman, "Distribution and conservation of the proboscis monkey (Nasalis larvatus) in Kalimantan, Indonesia," *Biol. Conserv.*, vol. 92, pp. 15–24, 2000.
[11] I. Padeta, R. Widayanti, H. B. Santoso, A. Rezeki, and B. T., "The Profile and Morphology of Proboscis Monkey's Blood Cells in South Kalimantan," in *Proc. of the 20th FAVA CONGRESS & The 15th KIVNAS PDHI*, 2018, pp. 178–180.
[12] M. Kawabe and T. Mano, "Ecology and Behavior of the Wild Proboscis Monkey, Nasalis larvatus (Wurmb), in Sabah, Malaysia," *PRIMATES*, vol. 13, no. 2, pp. 213–228, 1972.
[13] J. C. M. Sha, H. Bernard, H. Bernard, and S. Nathan, "Status and Conservation of Proboscis Monkeys (Nasalis larvatus) in Sabah, East Malaysia.," *Primate Conserv.*, vol. 23, no. 1, pp. 107–120, 2008.
[14] H. Bernard and Z. Hamzah, "Population Size and Distribution of the proboscis Monkey (Nasalis larvatus) in the Klias Peninsula sabah, Malaysia.," *Malayan Nat. J.*, vol. 59, no. 2, pp. 153 – 163., 2006.
[15] M. R. Ali, H. Bernard, and G. Hanya, "The population size and distribution of Proboscis Monkeys (Nasalis larvatus) based on a brief study in Garama, Klias Peninsula, Sabah, Malaysia," *J. Trop. Biol. Conserv.*, vol. 5, pp. 67 – 70, 2009.
[16] I. Matsuda *et al.*, "Population dynamics of the proboscis monkey Nasalis larvatus in the Lower Kinabatangan, Sabah, Borneo, Malaysia," *Oryx*, pp. 1–8, 2018.
[17] E. L. Bennet and A. C. Sebastian, "Social organization and ecology of proboscis monkey (Nasalis larvatus) in mixed coastal forest in Sarawak.," *Int. J. Primatol.*, vol. 9, no. 3, 1988.
[18] M. B. Kombi and M. T. Abdullah, "A Review Of The Proboscis Monkey (Nasalis larvatus) In Borneo, With Reference To The Population In Bako National Park, Sarawak, Malaysian Borneo," *Trop. Nat. Hist.*, vol. 16, no. 1, pp. 42-56., 2016.
[19] T. Atmoko, A. Ma'ruf, S. E. Rinaldi, and B. S. Sitepu, "Penyebaran Bekantan (Nasalis larvatus Wurmb.) di Teluk Balikpapan, Kalimantan Timur," in *Prosiding Seminar Hasil-Hasil Penelitian BPTKSDA Samboja:*, 2011, pp. 71 – 83.
[20] Suwarto, L. B. Prasetyo, and A. P. Kartono, "Kesesuaian habitat bekantan (Nasalis larvatus Wurmb, 1781) di hutan mangrove Taman Nasional Kutai, Kalimantan Timur," *Bonorowo Wetl.*, vol. 6, no. 1, pp. 12-25., 2016.
[21] Selpa., S. Rifanjani, and Muflihati., "Pendugaan Populasi Bekantan (Nasalis larvatus) Di Taman Wisata Alam Tanjung Belimbing Kecamatan Paloh Kabupaten Sambas," *J. Hutan Lestari*, vol. 7, no. 4, pp. 1581 – 1588, 2019.
[22] T. Atmoko, A. Mardiastuti, and E. Iskandar, "Perilaku Dan Pergerakan Kelompok Bekantan (Nasalis larvatus Wurmb.) Di Samboja, Kalimantan Timur.," *J. Penelit. Kehutan. Wallacea*, vol. 6, no. 2, pp. 169–179, 2017.
[23] M. A. Soendjoto, "Adaptasi bekantan (Nasalis larvatus) terhadap hutan karet: Studi kasus di Kabupaten Tabalong Kalimantan Selatan," in *Disertasi*, Bogor: Program Pascasarjana, Institut Pertanian Bogor., 2005.
[24] BKSDA (Balai Konservasi Sumberdaya Alam South Kalimantan), "Laporan Kegiatan Monitoring Bekantan Di Taman Wisata Alam Pulau Bakut." BKSDA South Kalimantan, Banjarmasin, 2018.
[25] BKSDA (Balai Konservasi Sumberdaya Alam South Kalimantan), "Laporan Kegiatan Monitoring Bekantan Di Taman Wisata Alam Pulau Bakut." BKSDA South Kalimantan, Banjarmasin, 2019.
[26] C. J. M. Laman and A. F. Aziz, "Population Estimation Of Proboscis Monkey (Nasalis larvatus), With New Analysis Based On Forest Types In Sarawak, Malaysian Borneo," *J. Sustain. Sci. Manag.*, vol. 14, no. 2, pp. 89 – 99, 2019.
[27] H. S. Alikodra, "Populasi Dan Perllaku Bekantan (Nasalis larvalus) di Samboja Koala, Kalimantan Timur. , V(): .," *Media Konserv.*, vol. 2, pp. 67–72, 1997.

[28] S. Lhota, "Population survey, socioecological study and conservation of proboscis monkeys (Nasalis larvatus) in Balikpapan Bay, Indonesia," 2008.
[29] M. Rizal, B. Nurdjali, and H. Prayogo, "Populasi Bekantan Nasalis Larvatus, Wurm Di Kawasan Hutan Sungai Kepuluk Desa Pematang Gadung Kabupaten Ketapang Kalimantan Barat," *J. Hutan Lestari*, vol. 4, no. 4, pp. 564 – 569, 2016.
[30] D. J. Stark, V. Nijman, S. Lhota, J. G. B. Robins, and B. Goossens, *Modeling population viability of local proboscis monkey Nasalis larvatus populations: conservation implications*. 2012.
[31] BKSDA, *Taman Wisata Alam Pulau Bakut*. 2020.
[32] Zainudin and A. Rezeki, "Struktur Populasi Bekantan (Nasalis larvatus) Di Pulau Curiak Kabupaten Barito Kuala Kalimantan Selatan," *Pros. Symbion (Symposium Biol. Educ. Prodi Pendidik. Biol. FKIP, Univ. Ahmad Dahlan*, pp. 1–9, 2016.
[33] R. Prawitaningrum, *Populasi Bekantan Bertambah di TWA Pulau Kembang Kalsel*. 2018.
[34] H. Purwanto, *Bekantan di P Kaget Kalsel Tersisa 100 Ekor*. 2007.
[35] S. Iskandar, M. Bismark, and A. P. Kartono, "Status Populasi dan Konservasi Bekantan (Nasalis larvatus Wurmb. 1787) Di Habitat Rawa Gelam, Kalimantan Selatan," *J. Penelit. Hutan Dan Konserv. Alam*, vol. 14, no. 2, pp. 123–132, 2017.
[36] N. Fauzan, Kaspul., and A. Naparin, "Struktur Populasi Bekantan (Nasalis larvatus) di area Gunung Batu Sawar Kecamatan Hulu Sungai Tengah," in *Seminar Nasional XII Pendidikan Biologi FKIP UNS*, 2015, pp. 721–726.
[37] T. I. Basoeki, Y. F. Arifin, Moehansyah., and A. Fithria, "Kajian Perilaku Bekantan (Nasalis larvatus) Pada Konservasi Eks Situ Di PT Indocement Tarjun," *Enviroscienteae*, vol. 11, pp. 175–186, 2015.
[38] J. J. A. K. G. Pandong, *Habitat use and population density of Proboscis monkeys (Nasalis larvatus) at Samunsam Wildlife Santuary*. Serawak: Universiti Malaysia Serawak, 2005.
[39] H. S. Alikodra, *Ekologi Konservasi Pengelolaan Satwaliar*. Bogor: IPB Press, 2019.
[40] D. J. Chivers, "Southeast Asian Primates: Socio-Ecology And Conservation," *Raffles Bull. Zool.*, vol. 29, pp. 177–185, 2013.
[41] A. J. Marshall, "Chapter 9 Effect of Habitat Quality on Primate Populations in Kalimantan: Gibbons and Leaf Monkeys as Case Studies. In: S. Gursky-Doyen and J. Supriatna (eds.), Indonesian Primates, Developments in Primatology," in *Progress and Prospects*, 2010, pp. 157 – 177.
[42] A. Syarif and F. Maulana, "Keanekaragaman Jenis Tumbuhan Sebagai Alternatif Konsumsi Bekantan (Nasalis larvatus) di Desa Lawahan Kabupaten Tapin," *J. Pendidik. Hayati*, vol. 5, no. 4, pp. 180–186, 2019.
[43] N. Arinta, *Bekantan, Tergeser dan Tergusur dari Rumahnya Sendiri*. p. 2018.
[44] N. Rowe, *The Pictorial Guide to The Living Primates*. Pogonias Press, 1996.
[45] L. E. Harding, "Nasalis larvatus (Primates: Colobini)," *Mamm. Species*, vol. 47, no. 926, pp. 84–99, 2015.
[46] M. Bismark, "Ekologi makan dan perilaku bekantan (Nasalis larvatus Wurmb) di Hutan Bakau Taman Nasional Kutai, Kalimantan Timur," in *Disertasi*, Bogor: Sekolah Pascasarjana Institut Pertanian Bogor, 1994.
[47] I. N. Riyawan, "Karakteristik Habitat dan Populasi Bekantan (Nasalis Larvatus Wurmb. 1787 Di Kebun Karet Dusun Pararawen Kalimantan Tengah," in *Skripsi*, Bogor: Institut Pertanian Bogor, 2014.
[48] K. L. Feilen and A. J. Marshall, "Multiple Ecological Factors Influence the Location of Proboscis Monkey (Nasalis larvatus) Sleeping Sites in West Kalimantan, Indonesia," 2017.
[49] Wardatutthoyyibah., S. Pudyatmoko, S. A. Subrata, and M. A. Imron, "The sufficiency of existed protected areas in conserving the habitat of proboscis monkey (Nasalis larvatus)," *BIODIVERSITAS*, vol. 20, no. 1, pp. 1–10, 2019.

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

# The Effect of Collaborative Teamwork Learning Model on Work and Energy Matter Based of Multi Representations on Physics Learning Outcomes

**Syifa Khairillah[1] and Tri Isti Hartini[1]**

[1]Physics Education Faculty of Teacher Training and Education, University of Muhammadiyah Prof. Dr. Hamka (UHAMKA)
Jl. Tanah Merdeka, Kp Rambutan, Pasar Rebo, East Jakarta 13830

*Correspondence email: khairillahsyifa@gmail.com

## ABSTRACT

This study aims to determine how the effect of the Collaborative Teamwork Learning Model on Work and Energy Matter Based of Multi Representations on Physics Learning Outcomes. The research method used is a quantitative research method with None Quivalent Control Group Design research design. The sampling technique used was purposive sampling. The sample used was 25 students in each class, both the experimental class and the control class. The instrument used was an essay instrument based on multi-representation as many as 5 questions that had passed the validity, reliability, difficulty level, and distinguishing power. The results of this study were tested using the z-test because the data were not normally distributed but homogeneous. Based on the calculation, the value of –Z_hitung < -Z_tabel or -1.79 < -1.96 is obtained so that it can be concluded that there is a significant effect of the Collaborative Teamwork Learning Model on business material and energy based on Multi Representation on Physics Learning Outcomes. This is also supported by an increase in student learning outcomes using a higher Multi Representation-based Collaborative Teamwork Learning model. This happens because when the learning process takes place students are more active in discussing both group discussions and class discussions and students are also more enthusiastic about learning physics concepts which are represented in several forms of representation by educators.

**Keywords:** Collabrative Teamwork Learning, Multi Representations, Learning Outcomes, Physics

## INTRODUCTION

Improving the quality of education is a must to meet the needs of schools and communities [1]. Improving the quality of education is carried out through various policies that are carried out continuously by the government, starting from curriculum development and improvement, to improving educational support facilities and infrastructure. Apart from the above policies, another step that is no less important in the effort to improve the quality of education is the improvement in the teaching and learning process which includes teaching methods, models, and approaches used during the learning process.

The learning process is the core of the entire educational process which has the goal of changing children's behavior [2]. The teaching and learning process can be measured through a test of learning outcomes obtained by students. This test is usually carried out in the form of an assessment of learning outcomes whose implementation is aimed at the results obtained by students after participating in the teaching and learning process in class, which is then manifested in the form of changes in behavior [3]. Behavior changes in students that are obtained from learning outcomes can be observed and measured through cognitive, affective, and psychomotor changes. These changes can be interpreted that students experience an increase and development for the better than before.

Based on the results of observations to educators In the 3rd Apprenticeship activity from August to October 2019 which was carried out by researchers at SMA Negeri 5 Tambun Selatan, it was found that the physics learning achievements of class X and XI students at school This is still low due to the lack of understanding of the physics concepts possessed by students. This is supported by the finding of many students who get low learning outcomes or below the minimum completeness criteria set by the school for physics subjects. On the other hand, the low mastery of concepts is also caused by the difficulty of students in understanding physics concepts which are classified as abstract [4].

[5]stated that Physics is the most fundamental science, because it deals with the behavior and structure of objects. Physics deals with the discovery and fundamental understanding of the laws that drive matter, energy, space and time. [6] stated that the purpose of learning physics is to help students build

knowledge of physics, help students build problem solving skills both quantitatively and qualitatively, and introduce students to scientific culture.

Based on this explanation, a learning model is needed that is able to make teaching and learning activities optimal, so that it can improve students understanding and learning outcomes [7]. Various learning activities do not always have to be carried out by students themselves but can also collaborate in a group with peers to solve physics problems that are considered difficult [8]. In general, students can more easily understand a concept and solve problems if they can exchange ideas in a team.

One learning model that can be used as an alternative to improve student learning outcomes is Collaborative Teamwork Learning (CTL). This CTL is a learning model that allows students to develop the ability to work collaboratively in teams [7]. That is, the Collaborative Teamwork Learning model is a learning model that allows students with diverse background abilities to work collaboratively with each other in a team so that the learning process is expected to get maximum results. One of the advantages of this CTL learning model is that students can develop a critical and rational way of thinking by discussing with their peers so that it is expected to make it easier to understand the physics concepts of students.

Physics learning includes many concepts and principles that are generally very abstract. Because of this, students often find difficulties in learning physics [9]. Therefore, educators must be able to visualize physics concepts into representations that students can understand well. Because in physics learning, students are not only required to be able to master concepts, but also have to understand mathematics, there are even some subjects that require students to understand a picture or diagram to be able to solve problems well. One of them is in the material of work and energy, where in this material students will be presented with more problems in mathematical form but it does not deny that students will find problems in the form of graphics, pictures or maybe also verbal. So that to be able to solve problems properly, students must be able to understand the material, either mathematically, images, graphs or diagrams, as well as verbal. In other words, in providing physics material, educators must be able to provide a representation of each subject in a different format so that it can be understood well by students both individually and in teams.

Multi-representation based learning can be used as a solution in learning physics. Multi-representation is a learning approach that represents the same concept in different formats, in the form of verbal, diagrams or pictures, graphics, and also mathematics. These various representations can make it easier for students to understand the overall concept of physics not only verbally or mathematically. Multi-representation learning helps students who have different intelligence backgrounds, because different representations can provide optimal learning opportunities for each type of intelligence.

Physics learning strategy with a multi-representation based CTL model is expected to maximize students' understanding of physics concepts both individually and in groups so that it can improve the learning outcomes obtained by each student.

Based on the description above, it can be concluded that this study aims to determine how "The Effect of Collaborative Teamwork Learning Model on Work and Energy Matter Based of Multi Representations on Physics Learning Outcomes".

## RESEARCH METHOD

The type of research used is Quasi Experiment Design. It is said to be Quasi Experiment Design, because this design has a control group, but it cannot fully function to control external variables that affect the implementation of the experiment. This is because in fact it is difficult to find a control group that can be used in the study.

The research design used in this study is None Quivalent Control Group Design. This research design pattern can be described by [10] in Table 1.

**Table 1.** Research Design

| Group | Initial Test | Treatment (independent variable) | Final Test |
|---|---|---|---|
| Experiment Class | $Y_1$ | X | $Y_2$ |
| Control Class | $Y_3$ | - | $Y_4$ |

Information:

Y1: Pretest Value of Experimental Class (Before being given treatment)
Y3: Pretest Value Control class (Before being given treatment)
Y2: Posttest Value of Experiment Class (After being given treatment)
Y4: Pretest Value of Experimental Class (After being given treatment)
X: The treatment given by educators to students using a Multi Representation based Collaborative Teamwork Learning model.

This research was conducted at SMA Negeri 5 Tambun Selatan. The sampling technique used in this study was purposive sampling. Samples are selected based on groups, regions or groups of individuals through certain considerations that are believed to represent the existing unit of analysis [11].

The sample used in this study is based on certain considerations. The considerations made in selecting this sample were taking into account the similarity of the average end of semester assessment results in odd semesters between students in the experimental class, namely class X MIPA 3 with students in the control class, namely class X MIPA 1.

The process carried out in this study consisted of three stages, namely the pretest, treatment, and posttest stages, all of which were carried out online. At the pretest stage, students, both the experimental class and the control class, were given 5 multi-representation based essay questions on work and energy materials with an allocation of 1 lesson time through the Zoom Meeting application. The next stage is the treatment stage, at this stage treatment is given in the form of the application of the Multi Representation-based Collaborative Teamwork Learning model for the experimental class, and the Discovery Learning learning model for the control class through the Zoom Meeting application, Google Classroom, and WhatsApp Messenger. To measure the learning outcomes of students, the educator conducts a posttest with 5 multi-representation based essay questions on work and energy materials with an allocation of working time, namely 1 lesson hour through the Zoom Meeting application. The results of the pretest and posttest will be used as data on student learning outcomes.

After the learning outcomes were obtained, the normality test and the homogeneity test were carried out as a prerequisite test for analysis with the results of the data being not normally distributed but homogeneous so that hypothesis testing was carried out using the Mann Whitney test. to see the effect of the Collaborative Teamwork Learning model on work and Energy material based on Multi Representation on the learning outcomes of students in both the experimental class and the control class.

## RESULTS AND DISCUSSION

The purpose of this study was to determine how the effect of Collaborative Teamwork Learning model on work and energy matter based of multi representations on physics learning outcomes. The data obtained in this study are the learning outcomes of students. Before students were given treatment in both the experimental class and the control class, they were given a pretest to determine the students' initial abilities. The results of the students' pretest are shown in Table 2.

**Table 2**. Student Pretest Results.

| Description | Pretest | |
|---|---|---|
| | Experiment Class | Control Class |
| Number of Students | 25 | 25 |
| Average | 34.28 | 29.32 |
| The highest score | 60 | 60 |
| Lowest Value | 19 | 11 |

The table above can be graphed as in Figure 1 below

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

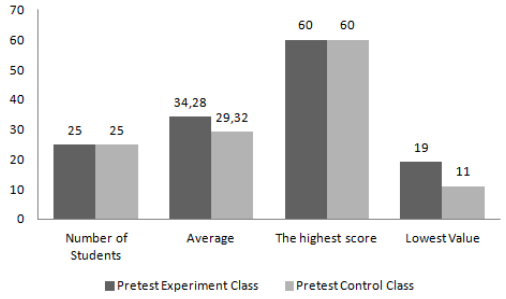



**Figure 1.** Student Pretest Results

Based on the table and graph of the results of the pretest conducted by the two classes above, it can be seen that there is a difference that is not too big. This difference can be seen from the average pretest results obtained by each class, namely the experimental class of 34.28 and the control class of 29.32. The difference between the two classes' average is 4.96. This average difference is not too big because the distribution of the learning outcomes of students from the two classes is almost the same and has not been treated. The results of the pretest of both classes were calculated for normality using the chi square test and homogeneity using the F test. After calculating, the value was obtained $\chi^2_{hitung}$ the experimental class and control class respectively 11.88 and 3.21 with a significant level $\alpha$ = 5% obtained $\chi^2_{tabel}$ is 7.81. The data is said to be normally distributed if $\chi^2_{hitung} < \chi^2_{tabel}$, due to the pretest results of the experimental class $\chi^2_{hitung} > \chi^2_{tabel}$, it can be said that the data is not normally distributed. Meanwhile, the F test on the pretest data obtained a value $F_{\text{hitung}}$ of 1.2 and $F_{\text{tabel}}$ at the 5% significant level of 1.98. Due to $F_{\text{hitung}} < F_{\text{tabel}}$ or $1{,}2 < 1{,}98$, it can be concluded that the two variances are homogeneous for the pretest scores. Then for the students' posttest results are shown in Table 2.

**Table 3.** Student Posttest Results

| Description | *Posttest* | |
|---|---|---|
| | Experiment Class | Control Class |
| Number of Students | 25 | 25 |
| Average | 78.48 | 58.76 |
| The highest score | 100 | 85 |
| Lowest Value | 45 | 32 |

The table above can be graphed as in Figure 3 below

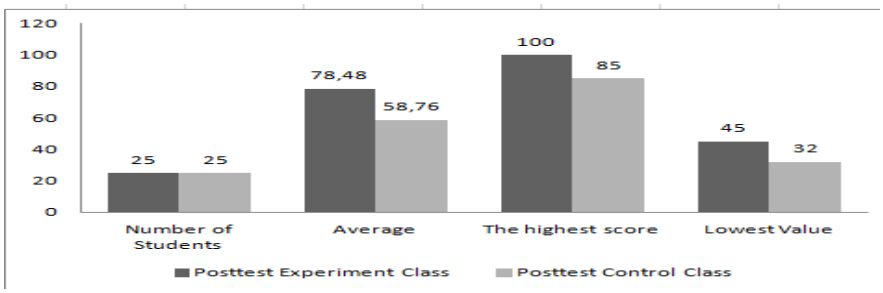



**Figure 2.** Student Posttest Results

Based on the tables and graphs of the results of the posttest conducted by the two classes above, it can be seen that there is a significant difference. This difference can be seen from the average posttest results obtained by each class, namely the experimental class of 78.48 and the control class of 58.76. The difference between the means for the two classes is 19.72. The difference in average is due to the different treatment given by educators between the experimental class and the control class. The results of the posttest for both classes were calculated for normality using the chi squared test and homogeneity using the F test. After calculating the values were obtained $\chi^2_{hitung}$ the experimental class and the control class respectively 31.54 and 8.32 with a significant level $\alpha$ = 5% obtained $\chi^2_{tabel}$ was 7.81. The data is

said to be normally distributed if $\chi^2_{hitung} < \chi^2_{tabel}$, because the posttest results of the two classes produce it $\chi^2_{hitung} > \chi^2_{tabel}$, it can be said that the two data are not normally distributed. Whereas for the F test on the posttest data the value $F_{\text{hitung}}$ was 1.42 and at the 5% significant level $F_{\text{tabel}}$ was 1.98. Due to $F_{\text{hitung}} < F_{\text{tabel}}$ or $1{,}42 < 1{,}98$, it can be concluded that the two variances are homogeneous for the posttest scores.

After the analysis prerequisite test was carried out with the data results not normally distributed but homogeneous, then the hypothesis testing was carried out using the Mann Whitney test with the results $Z_{hitung}$ amounting to $-1{,}79$. At a significant level of 5%, it is obtained $Z_{tabel}$ of $-1{,}96$, because $-Z_{hitung} < -Z_{tabel}$ or $-1.79 < -1.96$ so it can be concluded that $H_1$ is accepted, which means that there is a significant effect of the Collaborative Teamwork Learning Model on work and energy material based on Multi Representation on Physics Learning Outcomes

## CONCLUSIONS

Based on the results of the research data analysis, it was found that the average learning outcomes of students using the Multi Representation-based Collaborative Teamwork Learning model were higher with an average of 78.48 compared to the Discovery Learning model with an average 58.76. This shows a significant differenceon the learning outcomes of students who experience learning using a Multi Representation-based Collaborative Teamwork Learning model and learning using the Discovery Learning model. The results of the calculation of the hypothesis test carried out using the Mann Whitney statistical test with the value $-Z_{hitung} < -Z_{tabel}$ or $-1.79 < -1.96$ so that it can be concluded that $H_1$ is accepted and it can be concluded that there a significant effect of the Collaborative Teamwork Learning Model on work and energy material based on Multi Representation on Physics Learning Outcomes. This is also supported by an increase in student learning outcomes using a higher Multi Representation based Collaborative Teamwork Learning model. This happens because when the learning process takes place students are more active in discussing both group discussions and class discussions and students are also more enthusiastic about learning physics concepts which are represented in several forms of representation by the educators.

## REFERENCES

[1] B. Rahmad Syah Putra, Murniati AR, “Strategi Peningkatan Mutu Pendidikan Pada Sma Negeri 3 Meulaboh Kecamatan Johan Pahlawan Kabupaten Aceh Barat,” *J. Adm. Pendidik. Progr. Pascasarj. Unsyiah*, vol. 5, no. 3, pp. 161–166, 2018.
[2] A. Kirom, “Peran Guru Dan Peserta Didik Dalam Proses Pembelajaran Berbasis Multikultural,” *Al Murabbi*, vol. 3, no. 1, pp. 69–80, 2017.
[3] Sinar, “Metode Active Learning.” Deepublish, Yogyakarta, 2018.
[4] P. I. Sari, G. Gunawan, and A. Harjono, “Penggunaan Discovery Learning Berbantuan Laboratorium Virtual pada Penguasaan Konsep Fisika Siswa,” *J. Pendidik. Fis. dan Teknol.*, vol. 2, no. 4, p. 176, 2017, doi: 10.29303/jpft.v2i4.310.
[5] K. S. Kallesta and M. Erfan, “Analisis Faktor Penyebab Kesulitan Belajar IPA Fisika pada Materi Bunyi,” *Junal Pendidik. Fis.*, vol. 1, no. 1, 2017.
[6] E. Sujarwanto, “Pemahaman Konsep dan Kemampuan Penyelesaian Masalah dalam Pembelajaran Fisika,” *Difraction*, vol. 1, no. 1, pp. 22–33, 2019.
[7] N. W. S. Darmayanti, W. Sadia, P. Studi, P. Sains, P. P. Sarjana, and U. P. Ganesha, “Pengaruh Model Collaborative Teamwork Learning terhadap Keterampilan Proses Sains dan Pemahaman Konsep Ditinjau dari Gaya Kognitif,” *e-Journal Progr. Pascasarj. Univ. Pendidik. Ganesha*, vol. 3, no. 2, 2013.
[8] I. W. M. Jiwa, N. B. Atmadja, and M. Yudana, “Pengaruh Model Collaborative Teamwork Learning Terhadap Motivasi dan Prestasi Belajar Sosiologi Siswa Kelas X SMA Negeri 1 Amlapura,” *e-Journal Progr. Pascasarj. Univ. Pendidik. Ganesha*, vol. 4, 2013.
[9] A. Solihah, P. Sinaga, and A. Amsor, “Multi representasi momentum dan impuls untuk meningkatkan kognitif dan kemampuan pemecahan masalah siswa SMA,” *Semin. Nas. Quantum*, vol. 25, no. 21, pp. 338–344, 2018.
[10] R. Indrawan and R. P. Yaniawati, *Metodologi Penelitian*. Bandung: PT. Refika Aditama, 2016.
[11] Kusdiwelirawan, *Statistika Pendidikan*. Jakarta: UHAMKA PRESS, 2017.

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

# Character-Based 3D Animation Video Development Using Software Blender in Physics Materials for Newton's Law Subjects

**Very Irawan[1], Imas Ratna Ermawati[1]**

[1]Physics Education Faculty of Teacher Training and Education, University of Muhammadiyah Prof. Dr. Hamka (UHAMKA)
Jl. Tanah Merdeka, Kp Rambutan, Pasar Rebo, East Jakarta 13830

*Correspondence email: veryirawan900@gmail.com

## ABSTRACT

This study aims to determine the feasibility of learning media in the form of character-based 3D animation videos in high school physics material on the subject of Newton law. This research is a research and development (R&D) using the ADDIE model. With 5 stages of research, namely Analysis, Design, Development, Implementation, and Evaluation. In the analysis stage, a needs analysis and literature study were carried out. At the design stage, the initial design of the learning media was carried out in the form of storyboard preparation. At the development stage, animation is made on the software blender. At the Evaluation stage, the media was tested on material experts and media experts and then tested on a small and large scale on students. Then in the implementation stage in the form of using a 3d animation video as a medium for learning physics. The data obtained from the results of needs analysis, validation tests and trials in the form of quantitative data were then analyzed descriptively qualitatively and quantitatively. The average value obtained from material experts was 78.03% with good categories, then the value obtained from media experts amounted to 78.32% in the good category, then from the small-scale test obtained a value of 87.80% in the Very Good category and on the large scale test obtained a value of 80.97% in the good category.

**Keywords:** 3D animation, character

## INTRODUCTION

Education has a very important role in building the quality of a nation. Therefore, the Indonesian nation has placed education as the national goal of the Indonesian nation as stated in the fourth paragraph of the 1945 Constitution which states that one of the national goals of the Indonesian nation is to educate the nation's life. Kunandar emphasized that "education is a long-term investment in human resources that has strategic value for the sustainability of human civilization in the world" [1]. Given the importance of the educational process, the quality of education continues to be improved in accordance with the demands of community development. Efforts to improve the quality of education can be seen from the ongoing reforms from various aspects, including policies, systems, management, curriculum, laws, and government regulations.

Teaching and learning process activities in schools should take place in an interesting manner, so that learning does not feel boring and students are enthusiastic about participating in learning. There are many ways that educators can take to increase students' interest in learning material. One of them is by using the media. Gagne and Briggs in [2] state that the media "education is various components in the student environment that can stimulate students to learn". Learning media is one of the most important factors in the success of learning. So that "The use of learning media appropriately can stimulate and involve students to be active, creative, and create fun learning and will ultimately improve the quality of learning" [2]

Gagne in [3] suggests "there are several types of media that can be used in learning, namely: objects to be demonstrated, printed media, still images, moving pictures, sound films and machine learning". One of the media that can be used to increase students' interest in the learning process is audio-visual media. Ega Rima Wati said that "Audio Visual is a medium that displays sound and picture elements. The combination of these two elements makes audio visuals have better capabilities " [4]. Audio visual media is very supportive of learning physics which requires a real picture of events, natural phenomena, or demonstrations of physics experiments. By presenting audio-visual media, it is hoped that it can

provide an educational effect such as educating students to think critically, providing meaningful experiences, and developing and broadening students' thinking horizons. Audio-visual media can be in the form of video, sound film, and animation.

Education is essentially not only guiding students to be smart, but also helping students to be good. "Realizing that being smart and good are not the same, since the time of the wise community, moral education is the goal of schools. They provide character education which is coupled with intellectual, decency and literacy education, as well as morals and knowledge " [5]. Ramli in [6] states that "character education has the same essence and meaning as moral education and moral education. The goal is to shape the child's personality so that he becomes a good human being and a citizen and a good citizen. Given the importance of the urgency of character education, Character Education is a program contained in the 2013 curriculum content which is currently being implemented in every school. Character values can be developed and instilled in students through the learning process in schools, one of which can be instilled through the use of learning media. Based on the current conditions in the field, it can be seen that there are still very few educators using character education-based learning media.

Theoritical Review

a. 3D Animated Videos
According to Munir in [7] "Animation comes from English, animation from the word to anime, which means animating. Animations are still images that are sequentially compiled and recorded using the camera". Meanwhile, according to Syahfitri in [8] "Animation is an activity of animating, moving stationary objects. A still object is given a boost of strength, enthusiasm and emotions to become alive and moving or just to have the impression of being alive".

Then Djalle Zaharuddin in [9] defines "Animation as the process of creating motion effects or the effects of changing shapes that occur for some time. Animation is also a technique of displaying sequential images in such a way that the audience feels motion illustrations in the displayed image".

Then "3D is a dimension that has space. When referring to a 3D object, it means that the object has volume space. 3D objects also have locations at coordinates X, Y and Z. " this understanding is stated by James Chronister in [10].

b. Character
According to Wyne in [11] "In terminology, the term character comes from the Latin character, which means character, character, psychological traits, character, personality and morals. The term character is also adopted from the Latin language khharz and xharaz means tool for marketing, to engrave, and pointed stak ". Then another opinion about character was conveyed by Takdirotun Musfiroh in [6] "character refers to a series of attitudes, behaviors, motivation (motivation), skills). The character comes from Greek which means tomark or mark and focus how to apply the value of goodness in the form of actions or behavior.

Furthermore, the definition of character according to the Ministry of National Education in [12] "character is a person's character, character, morals, or personality which is formed from the internalization of various virtues which are believed and used as a basis for point of view, thinking, attitude, and act ".

From the description of the definition of character put forward by some of the experts above, it can be concluded that, character is the character, character, psychological traits, manners, moral personality and skills that are inherent in a person and become a characteristic that the person has that has been formed within him. that someone

## RESEARCH METHOD

The method used in this research is development research method. "Research and development methods or in English, Research and Development is a research method used to produce certain products, and to test the effectiveness of these products. To produce certain products, research is used that is needs analysis and to test the effectiveness of these products "[13].

This study uses the ADDIE development model with 5 stages of research. According to [8] the ADDIE model has 5 stages, namely: Analysis (analysis), Design (design), Develop (development), Implement (implementation), Evaluate (evaluate). The choice of this model is based on the consideration that this model is easy to understand, then the ADDIE model is developed systematically and rests on the theoretical foundation of the developed learning media design. This model is arranged programmatically with systematic activities in an effort to solve learning problems related to learning media that are in accordance with the needs and characteristics of students.

The first stage carried out is the analysis stage, at this stage in the form of a needs analysis carried out on students. The data from the needs analysis were obtained through a questionnaire filled out by students. The questionnaire contains questions that are asked in order to find out the needs of students for the media to be developed. The questionnaire given is also equipped with a suggestion column for the development of animated video media.

Then the media development planning is carried out in the form of collecting information through library research and needs analysis, then determining the basic competencies and learning materials that will be included in the character-based 3d animation video that will be developed, determining the character values that will be displayed in the animation video, and compiling story board. after creating a storyboard then starting to develop a 3d animated video based on the storyboard, then doing a feasibility test, and doing a trial run.

After the developed media went through several processes, starting from design, development, due diligence by material and media experts, small group trials, and large group trials, the media was revised. After the researcher made several revisions based on the input and suggestions from the respondent, the media was refined. Media that is deemed appropriate can be implemented as learning media.

## RESULTS AND DISCUSSION

In this study, a character-based 3d animation video media has been developed that has received good assessment criteria by media experts and material experts so that the media is suitable for use as a learning medium.

Needs Analysis Results.
The results of the needs analysis show that students need character-based 3d animation video media with content in the form of material exposure and examples in everyday life on high school physics material on the subject of Newton law.

Developed Media Outcomes.
After obtaining data through needs analysis, the next step is to develop learning media. Media can be seen on the youtube link https://youtu.be/xkOow-vPMh4.

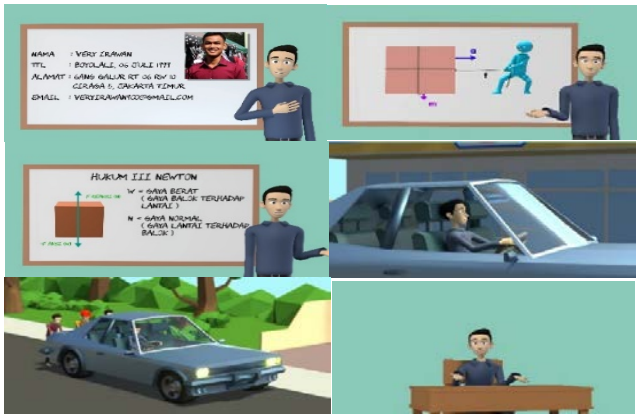



**Figure 1.** The results of the media that have been developed

Feasibility Test Results.
Learning media can be said to be suitable for use in the learning process if it has been assessed through the due diligence process by experts then tested on students. In this study, the feasibility of the media was assessed by six experts who were competent in their fields, namely two media experts from lecturers and one media expert from subject teachers then two material experts from lecturers and one material expert from subject teachers. The results of the assessment obtained through material experts and media experts are:

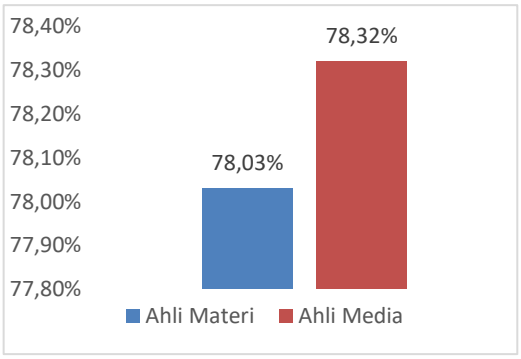



**Figure 2.** The results of the assessment of media experts and material experts

Figure 2 shows that the percentage of eligibility given by material experts is 78.03% (Good), and the percentage of eligibility given by media experts is 78.32% (Good). Based on these results, it can be concluded that the character-based 3d animation video learning media on the physics subject matter of Newton's law is feasible in terms of material and media. Apart from being tested for its feasibility, learning media was also responded to by students in small-scale and large-scale tests. Small scale test results can be seen in Figure 3.

**Small Scale and Large Scale Trial Results.**
After going through the feasibility test by the experts, the learning media that had been developed by the researcher were tried out on the students. The following are the results of a small-scale trial:

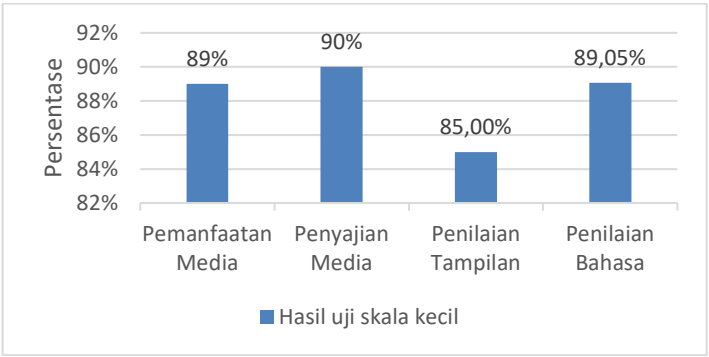



**Figure 3.** Small Scale Trial Results

These results indicate that the percentage of feasibility in the media utilization aspect is 89.00% (Very Good), the Media Presentation aspect is 90% (Very Good), the display assessment aspect is 85.00% (Good), and at aspects of language assessment of 89.05% (Very Good). If the average of all four aspects is calculated, it will produce a percentage of 87.80% and is included in the Very Good category. The following are the results of a large-scale trial:

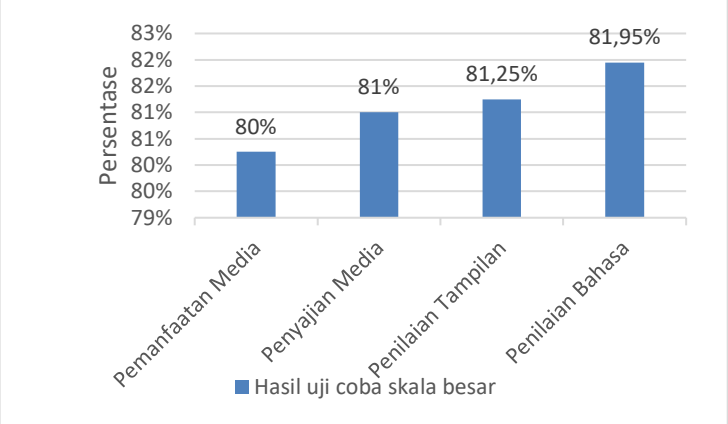



**Figure 4.** Large Scale Trial Results

These results indicate that the percentage of feasibility in the media utilization aspect is 80.00% (Good), the Media Presentation aspect is 81% (Good), the display assessment aspect is 81.25% (Good), and the assessment aspect language as big as 81.95% (Good). If the average of all four aspects is calculated, it will produce a percentage of 81.05% and is included in the Good category.

**The self-assessment of students' attitudes on small and large scale tests.**

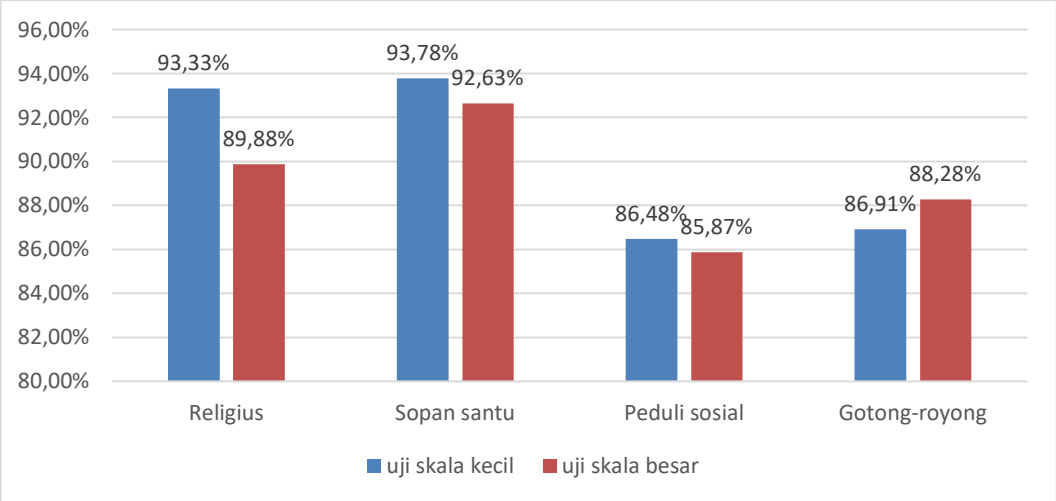



**Figure 5.** Student Character Assessment in small and large scale tests.

From **Figure 5.** We can conclude that in the aspect of religious value in the small-scale test, the percentage was 93.33% (very often), in the large-scale test the percentage was 89.88% (very often). In the aspect of the value of courtesy in the small-scale test, the percentage was 93.78% (very often), in the large-scale test the percentage was 92.63% (very often). In the aspect of the value of social care, in the small-scale test, the percentage was 86.48% (very often), in the large-scale test, the percentage was 85.87% (often). And on the aspect of the value of Mutual Cooperation in the small-scale test, the percentage was 86.91% (very often), in the large-scale test, the percentage was 88.28% (very often).

## CONCLUSIONS

Based on the results of this study, it can be concluded several things regarding the development of learning media developed by researchers, namely:

a. The final result of this development is a character-based 3d animation video media in high school physics material. The subject of Newton's law with content in the form of material exposure and examples in everyday life of Newton's law material.

b. The media developed has also passed the due diligence stage by material experts and media experts. Assessment by material experts obtained a percentage of 78.03% with a good category. Assessment by media experts obtained a percentage of 78.32% with a good category. Based on the material and media expert's assessment, the media developed is suitable for use.
c. In addition to being assessed by material experts and media experts, the media developed by researchers was also tested on students. Small-scale trials were carried out on 27 students. In a small scale trial, obtained a percentage value of 87.80% with the predicate very good.
d. Then a large-scale trial was also carried out on a total of 115 students. The results of large-scale trials obtained a percentage of 81.05% in the good category. This means, the media developed by researchers can be said to be suitable for use.

In the self-assessment of attitudes by students on small and large scale tests, they have received a satisfactory assessment. Students practice character values in everyday life. However, the results obtained are not 100% of students who practice these values.So with the development of character-based 3d animation media, it is hoped that students can get value recognition, understand the importance and then can instill the character values contained in the animation video learning media. The character values that appear in the animated video are religious values, courtesy, social care and mutual cooperation.

## REFERENCES

[1] Janawi, *metodologi dan pendekatan pembelajaran (N. Huda (ed.)*. Penerbit Ombak, 2018.
[2] N. Suryani, A. Setiawan, and A. Putria, *Media Pembelajaran Inovatif dan Pengembangannya (Pipih Latifah (ed.)*. Remaja Rosdakarya, 2018.
[3] Daryanto, *Media Pembelajaran (Perannya sangat penting dalam mencapai tujuan pembelajaran) (1st ed.)*. Gava Media, 2016.
[4] E. R. Wati, *Ragam Media Pembelajaran (Visual-Audio Visual- Komputer-PowerPoint-Internet-Interactive Video)*. Kata Pena, 2016.
[5] T. Lickona, *Pendidikan Karakter (Panduan Lengkap mendidik siswa menjadi Pintar dan Baik) (I. M. Zakie (ed.); 4th ed.)*. Nusa Media, 2018.
[6] H. Gunawan, *Pendidikan Karakter (Konsep dan Implementasi) (A. Saepulrohim (ed.); 1st ed.).* Penerbit Alfabeta, 2012.
[7] N. Hendracipta and N. Pamungkas, A. A. N. S., Hendracipta, "Pengembangan Media Pembelajaran Video Animasi Hand Move Dengan Konteks Lingkungan Pada Mapel IPS.," vol. 1, pp. 34–48, 2019.
[8] R. Agustien, N. Umamah, and S. Sumarno, "Pengembangan Media Pembelajaran Video Animasi Dua Dimensi Situs Pekauman di Bondowoso Dengan Model Addie Mata Pelajaran Sejarah Kelas X IPS," *J. Edukasi*, vol. 5, no. 1, p. 19, 2018, doi: https://doi.org/10.19184/jukasi.v5i1.8010.
[9] V. Waeo, A. S.M. Lumenta, and B. A. Sugiarso, "Implementasi Gerakan Manusia Pada Animasi 3D Dengan Menggunakan Menggunakan Metode Pose to pose," *E-Jurnal Tek. Inf.*, vol. 9, no. 1, pp. 1–8, 2016.
[10] Rori, J., S. Sentinuwo, S. Karouw, and I. Pendahuluan, "Perancangan Aplikasi Panduan Belajar Pengenalan Ortodonsia Menggunakan Animasi," vol. 8, no. 1, pp. 3–7, 2016.
[11] A. Z. Fitri, *Pendidikan Karakter Berbasis Nilai & Etika Sekolah (1st ed.)*. AR-RUZZ Media, 2012.
[12] I. R. Ermawati, A. B. Anomeisa, and H. Saputra, "Pengaruh Ketrampilan Proses Sains Terintegrasi Karakter Terhadap Hasil Belajar Fisika," *J. Pedidikan Fis. Univ. Muhammadiyah Metro*, vol. 7, pp. 106–115, 2019.
[13] Sugiyono., *Metode Penelitian Pendidikan (Pendekatan Kuantitatif, Kualitatif, dan R&D) (25th ed.)*. Alfabeta, 2017.

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

# The Effect of Learning cycle 7E Model on Student Biology Learning Outcomes in Senior High School

**Yusrianto Nasir[1], Slamet Suyanto[2]**

[1]Biology Education, Postgraduate Program, Yogyakarta State University, Jl. Colombo No. 1, Yogyakarta 55281, Indonesia

[2]Biologi Education, Faculty of Mathematics and Natural Science, Yogyakarta State University, Jl. Colombo No. 1, Yogyakarta 55281, Indonesia

*Correspondence email: nyusrianto89@gmail.com

## ABSTRACT

This study aims to determine the effect of the Learning Cycle 7e model on biology learning outcomes on the cognitive aspects of students in high school. This type of research is a quasi-experimental research using a pre-test post-test control group design. The study population was all X MIA grade students in SMA Negeri 1 Pamboang. The research sample consisted of two classes obtained by cluster random sampling technique, namely class X MIA3 (experimental class) and class X MIA2 (control class). Data collection techniques using the test instrument in the form of essays. Based on the results of post-test data analysis of student learning outcomes on the cognitive aspects, the average value of student learning outcomes in the cognitive aspects of the experimental class was 68.56 and the control class was 60.32. Data obtained in the test for normality and homogeneity. Both classes are normally distributed and homogeneous. Hypothesis testing used test-independent sample *t test* with a significance level of 0.05. Based on the hypothesis test, showed sig. (2-tailed) is 0.005 < (α = 0.05) hence Ho is rejected and Ha is accepted. So it can be concluded that there are significant differences in student learning outcomes in the cognitive aspects, the learning cycle 7e model has a greater influence than conventional learning models on student learning outcomes in the cognitive aspects of ecosystems material.

**Keywords:** Learning, senior high school, cycle 7e.

## INTRODUCTION

The learning system for teaching and learning activities currently it specifically demands that students do not only act as listeners. Students' active involvement in the learning process is needed for interactive learning (reciprocal interaction between teachers and students), so learning process is not just one-way (focus on students only) [1]. Students are also required in the learning process to actively search, independently or in groups, all information related to the subject matter. [2] said that curriculum development aims to improve the quality of education, in regards to current development and future trends.

In fact, most teachers today still face many obstacles in the learning process, especially transferring subject matter to students. According to [3] from the results of her research revealed that teachers are less able to carry out learning and guide students to be active in learning activities because of the lack of creativity in applying methods, models, and media that can trigger students' interest to be more active and creative in class. [4] Also added that the application of conventional learning models creates boredom and cannot provide a good understanding of biological material because the explanation is hard to comprehend. Actions and breakthroughs in teaching and learning activities are needed to be able to improve the symbiotical relationship between teachers and students so that learning objectives optimally achieved.

Some researchers' findings conducted on preliminary observations at SMA Negeri 1 Pamboang Majene Regency acknowledged that biology teachers have not been able to carry out a whole learning process that is more student-centered. Students are still very dependent on information delivery from biology teachers without any initiative to solve problems independently, students do not have the freedom to

build or develop their own knowledge because they always rely on knowledge delivered by biology teachers.
As regards to problems above, it is necessary to do an update in the implementation of the learning process by applying a learning model or approach that can actively involve students in learning and can improve student learning outcomes. Learning Cycle 7e learning model is a constructivism-based learning model which is an approach to teaching and learning based student own construction or in other words students learn new information with knowledge that students already know [5].

Learning Cycle 7e learning model is a student-centered learning process with a series of stages of activities organized in such a way that students can master the competencies that must be achieved in learning [6]. The stages of the learning cycle 7e model according to [7], namely shown in table 1:

**Tabel 1.** The stage of learning cycle 7e model

| Stage | Teacher Activity |
|---|---|
| Elicit | Teacher shown more adept about prior understanding in ascertaining what students know prior to a lesson. |
| Engage | Teacher explains learning objectives and material needed and motivates students to involve in critical thinking of choosen problem solution. |
| Explore | Teacher guides students to define and organize the assigment related to the problem. |
| Explain | Teacher supports students to gather suitable information, do experiment, and to find explanation and problem solution. |
| Elaborate | Teacher guides students in designing and preparing the work. |
| Evaluate | Teacher help students to share the assigment with their friends, evaluate and compare their understanding with their know prior. |
| Extend | Teacher guides students to extend and to do reflection about concept. |

The stages of Learning Cycle 7e model will certainly have a positive impact in every learning activity. This assumption is reinforced by the results of research conducted by [8] saying that the critical thinking skills of students who learn to use Learning Cycle 7e models based on local culture are better than students who learn to use the Discovery Learning model. [9] also said that the Learning Cycle 7e model was effective in improving students' scientific literacy abilities. Another opinion according to [10] revealed that students who were taught using the Learning cycle 7e model had higher generic science skills than students who were taught using the discussion method. Furthermore [11] also said that the use of the Learning Cycle 7e model will make students have a more sophisticated reasoning ability, and better process skills.

Based on findings above, the researcher needs to conduct research on the Learning Cycle 7e model with the aim of knowing the effect of the Learning Cycle 7e model on student biology learning outcomes on the cognitive aspects of ecosystem subject in high school so as to provide new information in the world of education about the Learning Cycle 7e model.
The rest of this paper is organized as follow: Section 2 describes the proposed research method. Section 3 presents the obtained results and following by discussion. Finally Section 4 concludes this work.

## RESEARCH METHOD

This research is a quantitative research using quasi-experimental methods. The research design used was a pre-test post-test control group design. The population in this study were all students of class X MIA of SMA Negeri 1 Pamboang consisting of 3 classes with a total of 90 students. The sample was gained by cluster random sampling technique. So the sample obtained by class X MIA 3 amounted to 25 students as the experimental class and class X MIA 2 totaled 25 students as the control class. The study was conducted at SMA Negeri 1 Pamboang, Majene Regency, West Sulawesi Province.

The instrument used in this study to measure students' cognitive abilities was a test instrument in the form of 5 essay questions that had been previously tested to determine its quality. Thus, instrument validation by expert judgments was carried out.

The data source in this study is the overall value of student learning outcomes in the cognitive aspects of the experimental class and the control class. The data taken is the initial test data (pre-test) and the final test (post-test), which will then be hypothetically tested using t-test independent sample t test with

the help of SPSS for Windows version 25. Requirement that must be met before conducting the hypothesis test is that the data are tested for normality and variance homogeneity. Statistical tests were performed at a significance level of 5%.

## RESULTS AND DISCUSSION

The result of the study is quantitative data derived from cognitive aspects of learning outcomes using the essay test instrument. The value of pre-test and post-test student learning outcomes are only measured on the cognitive aspects.

*Student learning outcomes of experimental class and control class before treatment*
Statistical tests were carried out by analyzing the pre-test scores of the students' learning outcomes of the experimental class and the control class in order to find out the differences in the learning outcomes of the experimental class and the control class before treatment.

Based on the pre-test scores of students' learning outcomes in the experimental class and the control class, the recapitulation of descriptive statistical values obtained can be seen in table 2 below:

Table 2. Descriptive statistics value of students' learning outcome of experiment and control class

| Students Learning Outcome | Pre-test Result | |
|---|---|---|
| | Experiment Class | Control Class |
| Mean | 17.80 | 17.12 |
| Lowest Score | 10 | 8 |
| Highest Score | 38 | 35 |

Furthermore, to find out the difference in student learning outcomes in the experimental class and the control class before being given treatment, first a pre-requisite test is carried out, namely the normality test (absolute requirement) and the homogeneity test (non-absolute requirement).
*Normality test*
Normality test is carried out to find out whether the data is normally distributed or not with a significance level (α = 0.05) using SPSS for Windows version 25. The results of the analysis are presented in Table 3 below:

**Table 3.** Pre-test data normality test result for experiment and control class

| Class | Shapiro-Wilk | | |
|---|---|---|---|
| | Statistic | Df | Sig. |
| Experiment | .820 | 25 | .001 |
| Control | .864 | 25 | .003 |

Based on the results of the normality test of the pre-test data for experimental class and the control class in table 3 above, the experimental class' value of Sig. (significance) on the Shapiro-Wilk technique is 0.001 and Sig. (significance) for the control class in the Shapiro-Wilk technique is 0.003. Sig value in the experimental class (0.001) and the control class (0.003) are < α (0.05), meaning that the students' pre-test data in the experimental class and the control class were not normally distributed. Then a non-parametric test was performed using the U Mann Whitney test.
*U mann whitney test*
To find out whether there are differences in student learning outcomes before both classes were given treatment, a non-parametric statistical test was carried out using the U Mann Whitney test. The results of the calculation of the U Mann Whitney test can be seen in table 4 below:

**Table 4.** U mann whitney test results for experimental class and control class data

| Class | Number of Sample | Mean rank | Sum of ranks | Asymp. Sig (2-tailed) |
|---|---|---|---|---|
| Experiment | 25 | 25.80 | 645.00 | 0.881 |
| Control | 25 | 25.20 | 630.00 | |

Based on the results of the U Mann Whitney test pre-test data of the experimental class and the control class, the value of Asymp. Sig (2-tailed) > 0.05. So it can be concluded that there is no significant

difference in student learning outcomes between the experimental class and the control class before being given treatment or it can be said that the initial abilities of students are the same.

*Student learning outcomes of experimental class and control class after treatment*

The learning outcomes tests conducted after treatment in the experimental class and control class intended to determine the development of student abilities in each experimental class (learning cycle 7e) and control classes (conventional models).

Data on student learning outcomes after treatment were analyzed using SPSS for Windows version 25. The results of the analysis showed a summary of the descriptive statistical values that can be seen in table 5 below:

**Table 5.** Descriptive statistics on student learning outcomes of experimental class and control class

| Students Learning Outcome | Post-test Result | |
|---|---|---|
| | Experiment Class | Control Class |
| Mean | 68.56 | 60.32 |
| Lowest Score | 46 | 40 |
| Highest Score | 85 | 83 |

Then, the normality test (absolute requirement) and homogeneity test (non-absolute requirement) were used as a pre-requisite to find out the difference between the learning outcomes of the experimental class and the control class after treatment.

*Normality test*

The normality test is then performed as an absolute requirement to find out whether the data is normally distributed with a significance level (α = 0.05) using SPSS for Windows version 25. The results of the analysis are presented in table 6 below:

**Table 6.** The post-test data normality test result of experimental class and control class

| Class | Shapiro-Wilk | | |
|---|---|---|---|
| | Statistic | Df | Sig. |
| Experiment | .935 | 25 | .112 |
| Control | .981 | 25 | .897 |

Data from the normality test of the experimental class and the control class in table 6 above, shows that in the experimental class the Sig. (significance) value on the Shapiro-Wilk technique obtained is 0.112 and the Sig. (significance) for the control class of 0.897. Sig. value (significance) obtained in each class > α (0.05). So it can be concluded that students' post-test data in the experimental class and the control class are normally distributed.

*Homogeneity test*

The homogeneity test results using SPSS for Windows version 25 with a significance level (α = 0.05) can be seen in table 7 below:

**Table 7**. Post-test data homogeneity test results of experimental and control class

| Post-test Data | Levene Statistic | df1 | df2 | Sig. |
|---|---|---|---|---|
| Based on mean | .008 | 1 | 48 | .930 |

Data in table 7 above shows the significance value (Sig) based on mean of 0.930 > α (0.05). So, it can be concluded that the data has the same variance (homogeneous).

After the data is known to be normally distributed and homogeneous, parametric statistical tests were performed using the independent sample t-test to determine the differences in learning outcomes of the experimental class and the control class.

*Independent sample t test*

The t-test used a significance level (α = 0.05). The results of the t-test independent sample t-test calculations using SPSS for Windows version 25 can be seen in table 8 below:

**Table 8.** Independent sample t-test t test results of experimental class and control class

| | | Levene's Test for Equality of Variances | | | | |
|---|---|---|---|---|---|---|
| | | F | Sig. | t | df | Sig. (2-tailed) |
| Students Learning Outcomes | Equal variances assumed | .008 | .930 | 2.963 | 48 | .005 |

The data in table 8 above shows that the results of the independent sample t-test t test data of the experimental class and the control class after the treatment. It is known that sig. (2-tailed) is 0.005 < (α = 0.05) or $H_o$ was rejected and $H_a$ was accepted. So it can be concluded that there are significant differences in student learning outcomes after treatment wherein the learning outcomes of experimental class students (using the Learning cycle 7e model) have an average value of 68.56 higher than the control class (using conventional models) with an average value of 60.32.

The results of the analysis on the hypothesis test using the independent sample t test showed that the learning model of learning cycle 7e had a more positive effect on the learning process. Student learning outcomes on the cognitive aspects that are taught using the learning cycle 7e learning model has an average value higher than the learning outcomes of students who are taught using the conventional model.

The difference in learning outcomes is due to the learning model of learning cycle 7e having stages that require students to be actively involved in building knowledge and understanding independently of the subject matter they were learning. The learning cycle 7e model departs from students' initial understanding of the material to be learned by giving a number of questions relating to concepts in everyday life in the electronic phase. Early understanding is an important component in learning activities. [12] said that initial knowledge was one of the factors that support students in learning both listening and reading.

In the *engage* phase which was the second stage of the 7e learning cycle model students' interest was raised by involving in each student learning activity as to increase knowledge and develop a sense of curiosity. [13] students who have an interest in a particular subject need to give greater attention to the said subject. With students' interest in the learning process, it will be easier for students to accept given material. Direct learning in the *explore* phase was done by observing learning objects that were prepared by the teacher, students wrote down their observations without being directly taught by the teacher. The phase pushed students to be more active in gaining knowledge related to the concepts being learned, working together in their groups. [14] said that students who are active in the learning process can stimulate and develop their skills, think critically, and overcome the difficulties that exist in the learning process.

Direct observation by students then concluded by their own understanding to be presented and explained to each other in *explain* phase. Students were given an understanding of several scientific words to be used in explaining the results of exploration. The observations showed that most students had been able to explain the concept independently and construct the knowledge gained to answer the questions given by the teacher.

In *elaborate* phase, student activity was again enhanced by being confronted with new situations by giving students the opportunity to discuss with classmates to solve problems and be required to apply the knowledge gained to real situations through experiments. This stage went well enough, judged by students who were getting used to looking for information independently through existing information sources. Discussion that occurred from the preparation stage to the *elaborate* stage proved students were able to understand the basic concepts better and students were involved fully in the learning process by requiring students to read, understand the material, express opinions, respond to the opinions of friends and give and accept advice from friends.

The learning process that has been carried out is then evaluated involving students' understanding and skills at the *evaluate* stage. The teachers continuously observed and paid attention to the ability and skills of students to assess the level of knowledge obtained by students. In the *extend* phase, students were guided to apply the knowledge they had acquired by linking the next material or previous material with new concepts. Student activities could be seen when performing the ability to think, search, find

and explain concepts that had been learned.[7] stated that the *extend* stage is the actualization stage of students' abilities in meeting the demands to think, search, discover, and explain the examples of the application of new concepts and skills that have been learned.

The explanation above provides information that the learning cycle 7e model makes students more active in seeking information, expressing opinions, asking questions, answering questions, and enable them to be good listeners at discussion. These conditions enable students to build their own understanding and gain direct learning experiences with the real world hence positively affect student learning outcomes. Improved learning outcomes in the class using the learning cycle 7e model is different from the class using conventional learning models. The conventional learning model made students more inclined to accept material from what the teachers said without any initiative to search independently so that learning became teacher-centered. This was shown as students were less active asking and working together in groups. The conventional model students were required to memorize the material delivered by the teacher and did not relate the material to the current situation (contextualization). These conditions caused students inclined to be busy chatting with other or falling asleep when the teachers explained so the results of their learning were less than optimal.

The results of data analysis using the independent sample t-test indicated that there were significant differences in student learning outcomes in cognitive aspects. Students who were taught using the learning cycle 7e model had higher average scores than classes taught using conventional models. The learning cycle 7e model had a higher positive effect than the conventional learning model. The results of this study were in line with the results of research conducted [6]. It was known that a significant difference shown in the learning outcomes of the experimental class (learning cycle 7e) was higher than the control class (conventional models) of biodiversity subject. [15] also revealed that the learning cycle 7e model was more effective in improving student learning outcomes and scientific attitudes than conventional learning models.

## CONCLUSIONS

Based on the results of research conducted by researchers, it is proved that there are significant differences between student learning outcomes in the cognitive aspects on ecosystem material using the learning cycle 7e model with student learning outcomes using conventional learning model. The learning cycle 7e model has a positive effect on student learning outcomes on the cognitive aspects of ecosystem material. This can be observed by the average value of student learning outcomes after treatment in the experimental class (learning cycle 7e) was 68.56, higher than the control class (conventional learning model) of 60.32.

## REFERENCES

[1] Kemendikbud. *Undang-undang ri nomor 36 tahun 2018 tentang perubahan atas peraturanmenteri pendidikan dan kebudayaan nomor 59 tahun 2014 tentang kurikulum 2013 sekolahmenengah atas/madrasah aliyah* (Jakarta). 2018
[2] Prihantoro and Rudy C. The perspective of curriculum in indonesia on environmentaleducation *International Journal of Research Studies in Education* **4** 77-83. 2015
[3] Sisca V W P S, Budiarti R S and Gardjito. Analysis of the biology teacher' obstacles in theimplementation of curriculum 2013 in grade x mia state senior high school accredited a in jambi city *Journal Biodik* **II** 86-95. 2016
[4] Hera R. Studi kasus permasalahan dalam proses pembelajaran konsep genetika di smanegeri 2 seulimum kabupaten aceh besar *Jurnal Genta Mulia* **3** 53-63. 2017
[5] Bada and Steve O. Constructivism learning theory: a paradigm for teaching and learning*IOSR Journal of Research & Method in Education* **5** 66-70. 2015
[6] Mitrayani, Hidayat S, Novitasari N. Pengaruh model pembelajaran learning cycle 7e terhadap hasil belajar siswa pada materi keanekaragaman hayati kelas x mia di sma negeri 10 palembang *Jurnal Bioedukasi* **9** 14-26. 2018
[7] Eisenkraft A 2003 Expanding the 5e model *The Science Techer* **70** 56-59. 2003
[8] Suardana I N, Redhana I W, Selamat I N. Students' critical thinking skills in chemistrylearning using local culture-based 7e learning cycle model *International Journal of Instruction* **11** 399-412, 2018

[9] Fatimah F M and Anggrisia N F. The effectiveness of 7e learning model to improve scientific literacy *Advances in Social Science, Education and Humanities Research* **277** 18- 22. 2018
[10] Ratnasari A and Maulidah R. Pengaruh model learning cycle 7e terhadap keterampilangenerik sains siswa pada materi pencemaran lingkungan di smp negeri 1 balongan indramayu *Jurnal Mangifera Edu* **3** 1-15. 2018
[11] Ebert II E S, Ebert C, Bentley M L. *The educator's field guide: from organization to assessment (and everything in between)* (United states of america: corwin press). 2011
[12] Hasan A, Gushendra R, Yonantha F. The influence of prior knowledge on students'listening and reading comprehension *IJEE (Indonesian Journal of English Education)* **4** 1- 15. 2017
[13] Slameto. *Belajar dan Fakto-Faktor yang Mempengaruhi* (Jakarta: Rineka cipta). 2015
[14] Wibowo N. Upaya peningkatan keaktifan siswa melalui pembelajaran berdasarkan gaya belajar di smk negeri 1 saptosari *Jurnal Electronics, Informatics, and Vocational Education (ELINVO)* **1** 128-139. 2016
[15] Adesoji F A and Idika M I. Effects of 7e learning cycle model and case-based learning strategy on secondary school students' learning outcomes in chemistry *JISTE* **19** 7-17. 2015

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

# Needs Analysis of Learning Material Development with Mind Map Model in Android Based on Brain Based Learning (BBL) in Physics Learning of High School

**Iktivaiyatul Mawadah[1*] and Nyai Suminten[1]**

[1]Department of Physic Education, University of Muhammadiyah Prof. Dr. HAMKA,
Jl. Tanah Merdeka Kampung Rambutan Jakarta Timur, Indonesia 13830

*Correspondence email: iktivama@gmail.com

## ABSTRACT

Teaching material is one of important part in the learning process, as an educators need to increase creativity in preparing teaching material that wan to conveyed. Teaching materials which used by students need to follow the desires in accordance with the workings of each brain or bbl (brain based learning), so learning can be more enjoyable and students become easier to understand. One of the alternative teaching materials that works with the way of brain works is to use a mind map model developed through an application. in accordance with the industrial revolution 4.0, teaching materials can be through electronic devices such as smartphones that are easily carried to anywhere, so students can repeat the material wherever and whenever. This research is aims to analyze the need for teaching materials based on brain based learning with mind map model in Android on physics learning. This type of research method is a qualitative descriptive study. The sampling technique uses a random sampling technique. The research data were obtained by observation, interview, and questionnaire distribution. Based on the results of the data obtained shows that students do not play an active role when the teacher only explains the material and gives examples of questions because the teaching materials used by students are only textbooks, then students and teachers need bbl based mind map teaching materials on Android.

**Keywords**: Brain based learning, physics learning, mind map android

## INTRODUCTION

As well known today has been entered the 21st century or called the 4.0 era. In this era technology is developing more rapidly and has been widely applied in various fields including industry, health, education and many others. The impact of the technology is very helpful for humans in carrying out various activities in certain fields. Especially in education world, technology can be used as an intermediary media that makes it easy for students to learn. The technology in education field can be specialized in 3 important ways namely creating, using, and managing. All of these three things will become the most important part in the function of educational technology, as learning facilities to improve the ability of students, it also with the ability of teacher. Furthermore, technology in the field of education affects learning patterns that will more demanding students to be more active and creative[1]. Therefore, with the increasingly sophisticated technology, conventional learning is rare to do. So that the public is more expect for technology to help students solve any difficulties in learning. One of the lessons that seems difficult for students is science, which is called physics.

Physics is a science that discusses the process of the occurrence of the universe phenomena. Physics known as a very difficult subject, because of the abstract discussion. Because it's learning related to the physics phenomenon is quite difficult to present in the class directly on the object. So not a few students who just memorize only the formula. These obstacles can come from various aspects, one of which is teaching materials used by students. Teaching materials that used by students is in the form of textbooks from the education department and must be in accordance with the curriculum. Teaching material have an important role in learning process. Monotonous learning resources and teaching materials will reduce student interest.

In this regard, interesting teaching materials can help students understand the material more easily. So the learning process is also can be more fun. One way that can be used to support this is to use teaching materials with a mind mapping model. [2] said mind map is a system that uses the principle of brain management to unlock the full potential and brain capacity thats still hidden. While according to [3] mind map can be define as a visual information management tool used by students in remembering,

organizing, exchanging ideas, and learning information in a special way. So it can be said that mind map is a method that aims to more easily remember and understand the material in the learning process.

The concept of mind map has been known for a long time and has been widely used in the learning process, because it is believed to have a strong memory increase and maximize the potential function of the brain to be better [3]. Thus the use of mind maps in learning can be more effective.

Mind map is chosen as teaching material in the delivery of messages because it can organize and store a lot of information desired by students [4]. Moreover, mind map is easy to develop because it does not require complicated skills so that teachers and students can easily in developing it [5]. In understanding the material in the textbook has been provided, the ability is required to be able to record what is obtained into a writing or memory. Physics textbooks that used by students is generally contain writing, pictures, simple concept maps that only mention the parts of the material in each chapter. Based on the observations of researcher during the implementation of the 3rd internship at SMA Muhammadiyah 1 Jakarta showed that most students did not bring physics textbooks, they only carry notebooks and student worksheets because are considered small and lightweight to carry. Thus, it has been seen that students need teaching materials that are easy to carry and easy to understand. Media learning with technology through applications has been made by many experts. Adjusted to the needs and creativity of each developer. The application is even widely used on various smartphone platforms.

Based on data sourced from eMarketer 2015 states that Android smartphone owners in Indonesia are increasing every year from 2016 to 2019. Android smartphone users this year are around 90 million Indonesian people from various backgrounds ranging from elementary school children to parents. In the 4.0 era, young people were more fond of playing smartphones than other activities.

One of the most digital technology that used among people today is an android based smartphone. The function of this Android-based smartphone is wider than previous communication tools that are limited to phone and send message. Android comes with an internet that can reach a wide range of information to look for. Most of people especially Indonesia is more often use smartphones to surf the virtual world through social media. Likewise with young children who are more often playing social media, till forget the time. Whereas the usability of Android smartphones is more than just that. With its easy to carry form, this Android can also become a media student to learn individually wherever and whenever.

In line with the definition of mind map in the opinion above, than the writer conclude the mind map is a model that can maximize the function of potential brain, Then to develop it to be better by approach with brain based learning can be contained it in. Nowadays, it is definitely a potential brain that has given much learning from child. But it does not close the possibilities, the brain is not optimal in carrying out its functions due to lack of grinding.

*Brain Based Learning* has a sense of learning based on brain empowerment. According to[6] brain based learning model is learning models that are adapted to the workings of the brain and are instinctively designed to learn and prioritize students enjoyment in learning. The advantage of this learning model is can develop the brain when the learning process becomes an environment with new conditions and new challenges.

Based on the explanation above it can be concluded that there is an opportunity to develop teaching materials with the mind map model. This teaching material can be used as a source of learning physics that can be used at anywhere and any time. Moreover the benefits of this teaching material, students can more easily remember and understand the material in the learning process because it is based on a brain based learning approach. For this reason, before it we need the research that aimed to analyzing students needs for teaching materials with a mind map model on Android based on brain based learning in physics learning of high school.

## RESEARCH METHOD

The method used in this research is qualitative methods which focuses on analyzing the need for mind map model teaching materials on Android in high school physics learning. Time of research was conducted on February – March 2020. The subject of this research was taken from four schools are SMA Muhammadiyah 1 Jakarta, SMAN 75, SMA Muhammadiyah 4 Jakarta dan SMAN 92.

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

Research data were collected by observation, interview, and questionnaire distribution. Interviews instrument for teachers are used to obtain the information about teaching materials and methods that used in learning process.

## RESULT AND DISCUSSION

The results of this preliminary study were obtained through literature study and field study results. Literature study is obtained from several references such as books, journals and others. While field studies are obtained from observations, interviews and needs analysis at school. Based on the results of the interview it was concluded that the teacher uses teaching materials in textbook as a learning reference. So it can be said that the teacher only provides material based on writing from textbooks owned by students without developing the desires of the brains working of each student in learning. The observations result is also obtained that students were not actively involved in learning because the methods and teaching materials used by the teacher were monotonous, thus making students more likely to feel bored. Furhermore, the following will be shown the results of needs analysis obtained from 4 schools:
On picture 1 the question is “Whether the teacher learning methods used in the learning process make learners active in class ?”


**Figure 1** Diagram of teacher learning methods

Based on data result in figure 1, the highest percentage shows that students will be active in learning if the teacher uses the question and answer method with a percentage of 35.7%. Then as many as 20.9% of students were not actively involved because the teacher only explained the material and gave examples of questions. These results can be seen in diagram of figure 1.

On figure 2 the question is “Have you ever implemented the desired learning process following the way of your brain works?”

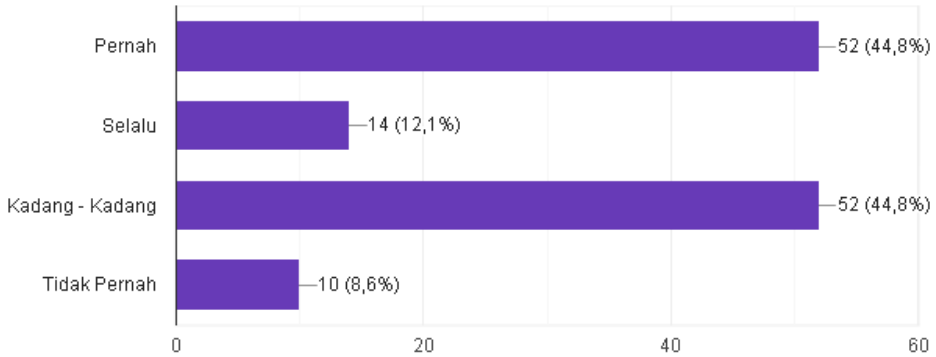



**Figure 2** Diagram of learning process with the way of brain works

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

Based on the obtained result, the highest percentage has shown that students have experienced learning process by following their brain work with a total of 44.8%. That result can be seen on diagram of figure 2.

On figure 3, the question is “Does the teacher ever use teaching materials with mind map models in learning of physics ?”

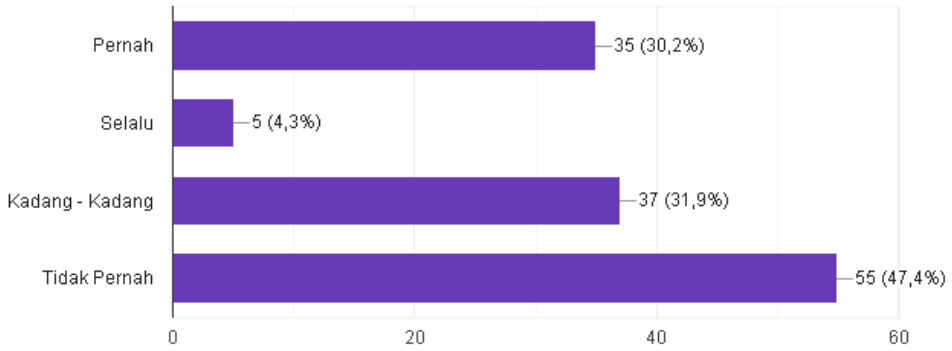



**Figure 3** Indication diagram of using teaching material with wind map model

Based on the data obtained, the highest percentage shows that teachers never use mind map model teaching materials in physics learning. That data can be seen in diagram on figure 3.

The question is further described “If ever, what kind of tools that teacher uses the mind map model teaching materials in the learning?”

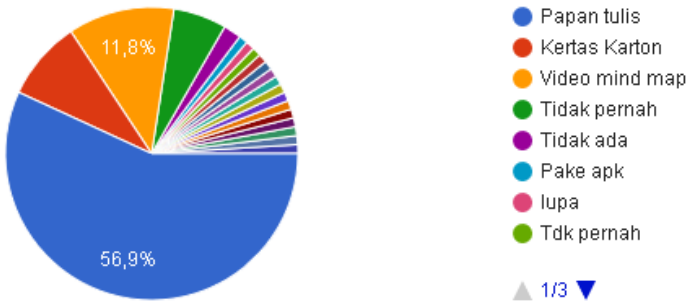



**Figure 4** Diagram of tool that use by teacher to deliver mind map model teaching material

Based on the data obtained the results indicate that in using the material teaching model mind map, teachers use the whiteboard as a tool of delivery with a percentage of 56.9%.

Then if the teacher never used the material teaching with mind map model, then the question is “If not, do you ever make the task of summarizing material with the mind map model ?”

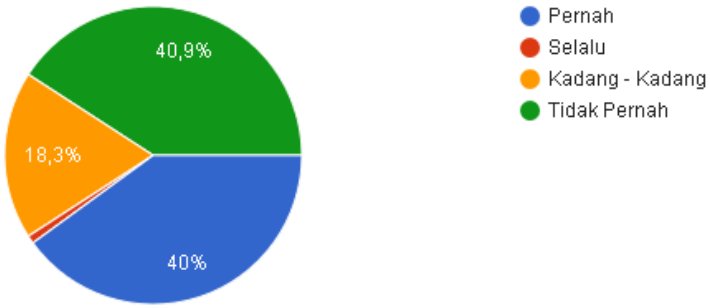



**Figure 5** Diagram of frequency of student task with mind map model

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

The next is the description of the results stating that students who never summarized the material with mind map model as much as 40.9%. But there are also students who have summarized the material with a mind map model of 40%.

On figure 6, the question is about “does the teaching material that delivered by teacher was interested enough from all parts including appearance, content or other supporters so that it is more easy to understand ?”


**Figure 6** Diagram of teaching material that used by teacher today

In accordance with the diagram shown in Figure 6, the student response with a percentage of 36.8% states that the teaching material used by the teacher is less interesting but easy to understand. Other than that, 24.8% stated that teaching materials were very interesting but difficult to understand.

Here are the results of the need analysis about “Does it require the development of the teaching materials you use today ?”

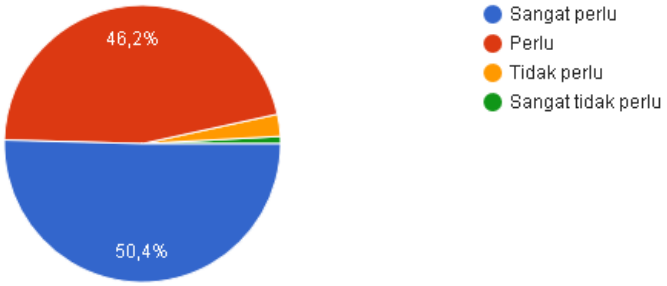



**Figure 7** Diagram of the development needs of the current teaching materials

In Figure 7 can be seen that students need the development of teaching materials that are being used with a percentage of 50.4%.

Here are the result of the need analysis about “Do you know about mind map model of teaching material based on android ?”


**Figure 8** Student knowledge of mind map model teaching material based on android

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

Based on figure 8, it can be stated that students do not know the teaching material of mind map model on android, but have heard with a percentage of 31%.

Here are the results of "How if physics learning by using a smartphone?"

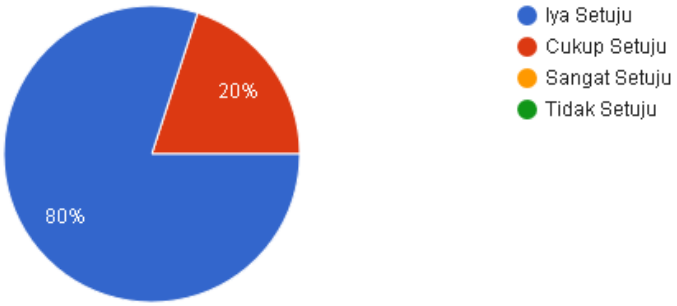



**Figure 9** Diagram of smartphone used in physic learning

Based on the results it shows that students agree with the use of smartphones during physical learning with a percentage of 80%.

The description of the next needs analysis is "How do you think about the development of teaching materials with mind map model on Android based on BBL ?"

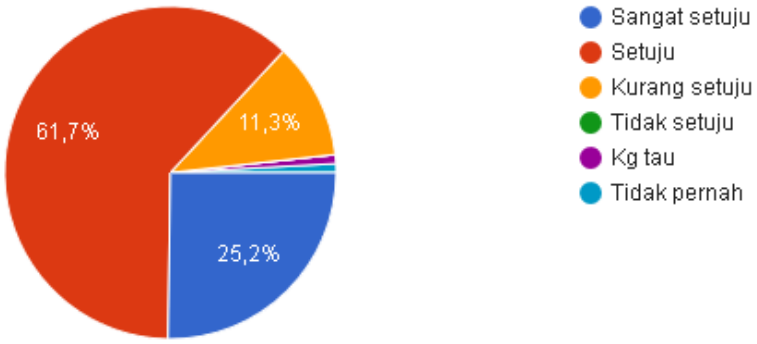



**Figure 10** Diagram of students agreement of the development teaching material with mind map model on android based on BBL

Based on the data in figure 10 stated that the students argue agree about the development of teaching material with mind map model on android based on BBL with a percentage of 61.7%.

## CONCLUSION

The results of the needs analysis of teaching material development with mind map model on android based on BBL showed that students agreed to the researchers to develop it. Based on the needs analysis that have been described, the teaching materials used by the teacher are only focused on the textbook and students stated that the teaching material is less attractive but understandable. Therefore, it is necessary to develop the interesting teaching materials and it can be understood by utilizing an Android smartphone that students have. The teaching material with mind map model on android based on BBL is contains an interesting material display and easy to understand because BBL mean was Brain Based, so that the delivered material will follow the way of the student brain works

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

## REFERENCES

[1] Y. Miarso, *Menyemai Benih Teknologi Pendidikan*. Jakarta: PRENADAMEDIA Group, 2016.
[2] S. Windura, "Be An Absolute Genius !" PT Elex Media Komputindo, Jakarta, 2016.
[3] T. Bates, *7 Easy Steps to Master Mind Mapping Techniques, Note Taking, Creative Thinking &Brainstorming Skills*. LULU COM, 2019.
[4] T. Buzan, *How to Mind Map untuk meningkatkan kreativitas. (Terjemahan Eric Suryaputra)*. Jakarta: Gramedia, 2005.
[5] L. Lukman and I. Ishartiwi, "Pengembangan Bahan Ajar Dengan Model Mind Map Untuk Pembelajaran Ilmu Pengetahuan Sosial Smp," *J. Inov. Teknol. Pendidik.*, vol. 1, no. 2, pp. 109–122, 2014, doi: 10.21831/tp.v1i2.2523.
[6] E. Jensen, *Brain Based Learning*. Yogyakarta: Pustaka Belajar, 2008.

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

# Implementation of Science and Islam Religion Intregation in Facing the Pandemic Covid-19 in West Java

**Eka Kartikawati[1]**

[1]Department of Biology Education, Faculty of Teacher Training and Education Universitas Muhammadiyah Prof. Dr. Hamka
Jl. Tanah Merdeka, Kp Rambutan, Pasar Rebo, East Jakarta 13830

*Correspondence email: eka.kartikawati@uhamka.ac.id

## ABSTRACT

The Covid-19 pandemic has shocked the world, causing panic to all levels of society. The Indonesian government established policy that large-scale social distancing (PSBB) which aims to reduce the number of spread of the corona virus. As a result, paralysis occurs in various fields, one of which is in the religious sector precisely in this topic is Islam. Experts participate in these topics according to perspectives in their fields of expertise. Both of science and religious aspects, each having their respective roles in the rhythm of life. The tendency between science and religious knowledge has attracted interest from various groups such as to see its emphasis, especially on Indonesian society, especially in West Java which has variety of characters and perceptions. The purpose of this study is to analysis implementation of science and religion integration in facing the pandemic Covid-19 in West Java. The method used is descriptive quantitative method using survey techniques and data questionnaires. The results of the data obtained by 89% of the public agree with stopping or prohibiting worship in mosques to break the chain of spreading Covid-19. As conclusion, in general, the society participates in integrating science and religious knowledge that have been established by the government.

**Keywords:** Covid-19, islamic, implementation of science, religion integration

## INTRODUCTION

The Covid-19 pandemic causes anxiety to all levels of society, the number of positive cases and even deaths due to Covid-19 is increasing every day. The government then established a large-scale social distancing (PSBB) policy which aims to reduce the spread of the corona virus. As a result of the existence of government policies on large-scale social distancing, it has resulted in paralysis in all fields such as in the economic, educational, social and religious fields. The activities of mass gatherings in large numbers have been banned or stopped in an effort to prevent the spread of Covid-19. This can be seen in the closure of recreation areas, universities, schools, offices and including places of worship and their activities such as daily congregational prayers, Friday prayers, tarawih prayers, tadarus and other religious activities.

Many experts in the field of health and science discuss the development of Covid-19, starting from the virus, symptoms, spread and prevention as well as several references which are then used as references as the development of Covid-19. Several experts also participated in discussing according to perspectives in their respective fields of expertise, including experts on religion[1]. Science and religion certainly have their respective roles in the rhythm of life, but the tendency between science and religion makes interest from various groups such as to see the emphasis of the two things, connect them or maybe compare the two. In reality, religion is connected to science or vice versa, which has a pattern that is neither easy nor simple [2]. There are very broad elements in various viewpoints of the relationship between science and religion, from an extreme view of conflict to a mixed view [3]Indonesian society has many areas so that the characters and perceptions will also vary, especially in the face of the Covid-19 pandemic. From the various views described above regarding the integration of science and religious sciences, the formulation of the research is how to apply science integration and in dealing with the Covid-19 pandemic in West Java. The goal is to find out the implementation in terms of people's attitudes or behavior in West Java, whether they integrate science and religion as the basis of life in facing this Covid-19 pandemic. So that this research is developed to be investigated more deeply.

## RESEARCH METHOD

The method in this study is a quantitative descriptive method using survey techniques in the West Java region. This method is used to get data results from a natural place [4]. This survey also aims to show the results obtained by comparing the data that has been captured [5]. Samples were taken randomly from 255 well-known respondents from the West Java region. The data analysis technique is a research instrument in the form of a questionnaire, then the data is analyzed and the results are presented using a descriptive method in order to obtain an overview of various facts [6].

## RESULTS AND DISCUSSION

Respondents who filled out a detailed questionnaire were 55% women and 45% men from a total of 255 respondents. The respondents who filled in came from various cities, among others; Jakarta, Bogor, Depok, Tangerang, Bekasi, Karawang, Cikarang, Cirebon, Indramayu, Sumedang, Bandung, Sukabumi, Tasikmalaya, Ciamis, Cianjur, Garut and Pangandaran.

The first questions regarding respondents' knowledge about Covid-19, as many as 90% of respondents knew about the spread of Covid-19, 84% of its prevention, 77,64% of its symptoms and 72,90% who knew the least about its causes. Not many respondents know that Covid-19 is caused by a virus which is a new group of viruses such as Middle East Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome (SARS) which can cause disease in animals or humans. [7]

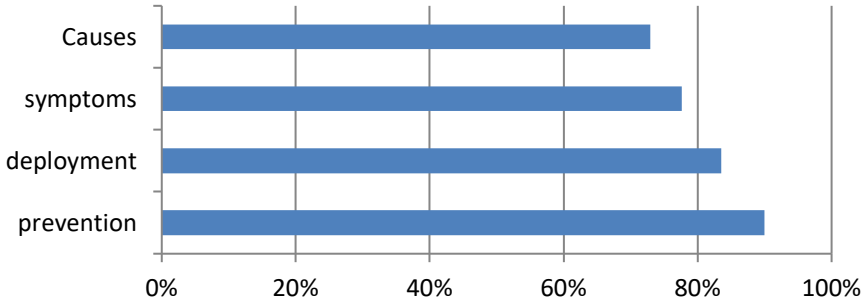



**Figure 1.** Knowlegde Covid-19

Respondents' answers regarding the prevention of the spread of Covid-19 that is often done are with 96,40% of respondents washing their hands, 97,6% of wearing masks and 88,62% stay at home and maintanain a distance 71,76%. Some of these precautions have been implemented by many other countries and have succeeded in slowing the spread of the outbreak in their areas. [8]

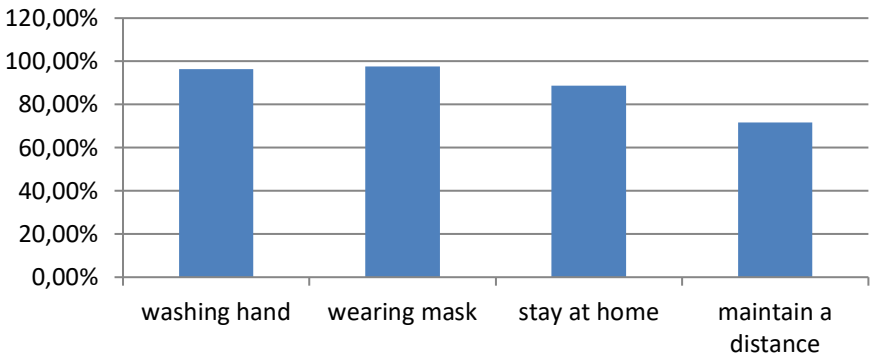



**Figure 2.** prevention from covid-19

Questions regarding activities during the Covid-19 epidemic are recorded in a table which states that even though the government has provided a policy for PSBB, the government also gives authority to each area according to its zone. So that there are still or many mosques that hold congregational worship such as sholat fardu, sholat jumat and tarawih even though the percentage is more that are not.

**Table 1.** Activities in Mousque

| Activities | yes | no |
|---|---|---|
| Shalat fardu | 59,2% | 40,8% |
| Shalat jumat | 38% | 62% |
| Shalat tarawih | 45% | 55% |
| Tadarus & ceramah | 11,3% | 88,7% |
| Adzan | 98% | 2% |

This is reinforced by respondents who stated that mosques or places of worship in their area carry out health protocols in carrying out congregational worship activities such as: 88.6% availability of a place to wash hands before entering a mosque, 77.6% do not shake hands, 67.8% have right spaces left when praying in congregation, praying wearing a mask of 54.1% and a body temperature detector of 45.1%.

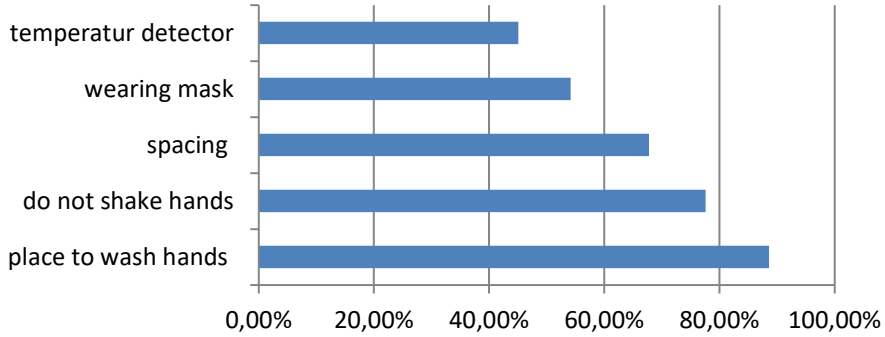



**Figure 3.** Healt Protocol in Mosque

The last question regarding the opinion about the prohibition or stopping of congregational prayers during the Covid-19 pandemic adjusted by government regulations was obtained by 89% of respondents who agreed with most of the arguments to break the chain of spreading Covid-19 quickly and also argued that “the scholars, in fatwa certainly pays attention to all aspects in a deep and comprehensive manner. Consideration of medical experts, fuqoha of course also becomes the basis for issuing fatwas, not just feelings, let alone just brief information in the media. As a Muslim I am obliged to follow the ulama as warosatul anbiya, for me I cannot worship on the basis of belief and wishful thinking, but there must be clear guidance that refers to the Prophet Muhammad SAW.

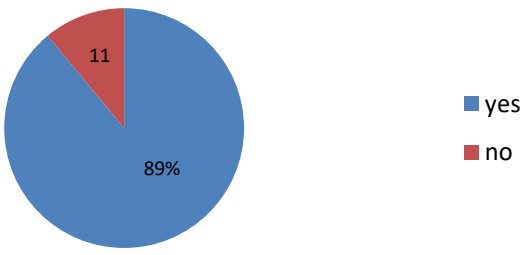



**Figure 4.** Prohibition worship in mosques

Respondents who agree in this matter if it is associated with the theory of the relation between science and religion as a theory of dialogue or contact, in this theory they provide input to one another between science and religion, exchange information so as to broaden their perspective. Even though they exchange views, they don't always have to agree on something with each other. This theory serves as a bridge to find similarities in science and religion.

This theory can also continue to confirm as an integration that provides input between science and religious knowledge to mutually reinforce one another, especially in proving the existence of a scientific theory that is strengthened in and of course without losing their respective identities. In this theory science supports the belief in God as the creator of the world and everything in it and nature that can be further investigated. There are four theories in the relationship between science and

religion that show the development of science, namely in producing the impact of the emergence of a human attitude, in measuring the level of success or success from various sides and supporting religion as a limit to one's freedom. Religious values as a source of behavior in various activities [9]Human nature in the scope of life is obliged to demonstrate to develop and enhance the dignity of humans themselves. Because if then what happens is not a process but the collapse of civilization's decline. So, it takes religion to show its goals, namely; meaning that can distinguish humans themselves from the contents of the universe as a creation of this god. The progress of scientific development both in science and in other fields of science does not make true happiness but causes humans to abandon religious values.

The remaining percentage of 11% of respondents argued that they disagreed with the prohibition or stopping of congregational worship in mosques during the Covid-19 pandemic for several reasons, the response stated that we should not evacuate mosques, the presence of this virus does not make us avoid or away from Allah, on the contrary we have to be closer to Allah, although prayer can be anywhere, it is better to pray in the mosque, but we still have to keep our distance and follow the health protocols. Another reason: Because there are still other alternatives to prevent transmission, the congregational prayers are not long as long as without additional activities such as recitation which take a long time. The important thing is that when praying in congregation adhere to existing health protocols, the latter opinion is because somehow, we still need Allah's help, not being allowed to worship in a mosque is the same as refusing Allah's help. If this opinion is related to the views of science and religion, the direction of the theory is on an independent or contrasting theory. This theory sees that the scientific and religious sciences have their respective capacities. So that both have their own problems and methods so that each is separate and independent. But each view must respect each other[10].

## CONCLUSIONS

The conclusion of this research is that from 89% of respondents chose to agree about the prohibition or stopping of congregational worship during the Covid-19 pandemic which was adjusted by government regulations, this in theory means that the public generally participates in integrating science and religious knowledge that has been established by the government.

## REFERENCES

[1] Waston, “Hubungan Sains dan Agama: Refleksi Filosofis atas Pemikiran Ian G. Barbour,” *PROFETIKA, J. Stud. Islam*, 2014.
[2] A. Aziz, “Paradigma Integrasi Sains dan Agama: Upaya Transformasi IAIN Lampung ke Arah UIN,” *Al-Adyan*, 2013.
[3] R. Adawiyah, “Integrasi Sains Dan Agama Dalam Pembelajaran Kurikulum PAI (Perspektif Islam dan Barat serta Implementasinya),” *Al-Banjari J. Ilm. Ilmu-Ilmu Keislam.*, 2016, doi: 10.18592/al-banjari.v15i1.817.
[4] P. D. Sugiyono, *metode penelitian kuantitatif, kualitatif,dan R&D*. 2016.
[5] A. Suharsimi, *Prosedur Penelitian : Suatu Pendekatan Praktik (Edisi Revisi)*. 2010.
[6] Ramadiani, “STATISTIKA DESKRIPTIF Suprayogi Statistika Deskriptif,” *Stat. Deskriptif*, 2012.
[7] WHO, “COVID-19 COVID-19,” *WHO J. covid 19, Reg. Situational Updat. Africa*, 2020.
[8] Z. Y. Zu *et al.*, “Coronavirus Disease 2019 (COVID-19): A Perspective from China,” *Radiology*. 2020, doi: 10.1148/radiol.2020200490.
[9] J. S. Suriasumantri, *Filsafat Ilmu sebuah Pengantar Populer*. 2013.
[10] R. Kriyantono, “Public Relations and Corporate Social Responsibility in Mandatory Approach Era in Indonesia,” *Procedia - Soc. Behav. Sci.*, 2015, doi: 10.1016/j.sbspro.2015.11.041.

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

# Analysis of the Needs of Traditional Games Based on Android as a Medium for Learning Physics

**Farid Al Amin[1]**

[1]Physics Education Study Program, Prof. Muhammadiyah University. DR. Hamka
Tanah Merdeka Street, Kp.Rambutan, Pasar Rebo, East Jakarta, 13830, Indonesia

*Correspondence email: faridalamin@uhamka.ac.id

## ABSTRACT

This study aims to determine the use of Android-based traditional game physics learning media used by educators in the learning process then to analyze the learning media needed by students and to connect based on the learning media to be developed. This study is a data collection carried out using a questionnaire instrument for students and teachers which was conducted in December-January 2020. The results of the questionnaire obtained included 64 students and 5 high school physics teachers in Jakarta. The results of the preliminary study questionnaire show that; 1) Of the 63 students (78.1%) chose digital educational games needed for the learning process to take place. 2) (75%) agree that educators use educational games as a learning medium in class, 3); As many as (78.1%), students thought that the relationship between educational games as a learning medium in class, and (31.3%) chose laptops as a learning medium in the classroom. The material or subject that is appropriate for the making of these questions is static fluid material. Therefore, the researcher intends to use game media as a discussion of the questions when the material takes place. It is hoped that students can process thinking skills through the given tests.

**Keywords:** *Physics Learning Media, Traditional Games, Android*

## INTRODUCTION

Media is the plural form of medium which comes from the Latin “medius” which means middle. In Indonesian, the word medium is defined as "between" or "medium" [1]. The definition of learning media according to Latuheru (1998: 14) learning media are all tools (aids) or objects used for teaching and learning activities, to convey messages (information) of learning from sources (teachers and other sources) to the recipient (in this case the child) [1]. Students or learning citizens). Based on the expert's opinion, it can be concluded that the learning media is a tool to convey messages from sources to the receiver.

Sadiman (2014: 7) explains that learning media are anything that can be used to transmit messages from the sender to the message recipient. In this case, it is the process of stimulating students' thoughts, feelings, attention, and interests so that the learning process can be intertwined [2].

Based on this statement, it can be concluded that the learning media is a tool used by the teacher as a teaching aid. In learning interactions, the teacher delivers teaching messages in the form of learning material to students.

Based on some of the opinions above, it can be concluded that the notion of learning media as a teaching aid to convey material so that messages are more easily accepted and make students more motivated and active.

Quoted in the instructional media book by Kustandi (2016) that the use of learning media in the teaching and learning process can generate new desires and interests, generate motivation and stimulation of learning activities, and even bring psychological influences on students [3].

One way for students to have a concrete experience is to use learning media in the learning and teaching process [4].

Game is an English word that means a game or match, or it can be interpreted as a structured activity that is usually done for fun.

Based on the description above, it can be concluded that a game or game is a form of activity that is carried out with certain rules.

In the large English dictionary, education means education, meanwhile
According to Sugihartono education comes from the word educate, or educate, which means maintaining and forming exercises [5].

Education is a learning process that is obtained by every human being, in this case, the students, the goal is to make students understand, understand, and be able to think more critically. Education can be formulated as a guide for human growth from birth to physical and spiritual maturity, in the interaction of nature and the community. It can be concluded that education is a learning activity carried out by educators in achieving a goal that has been designed by educators to improve students in character.

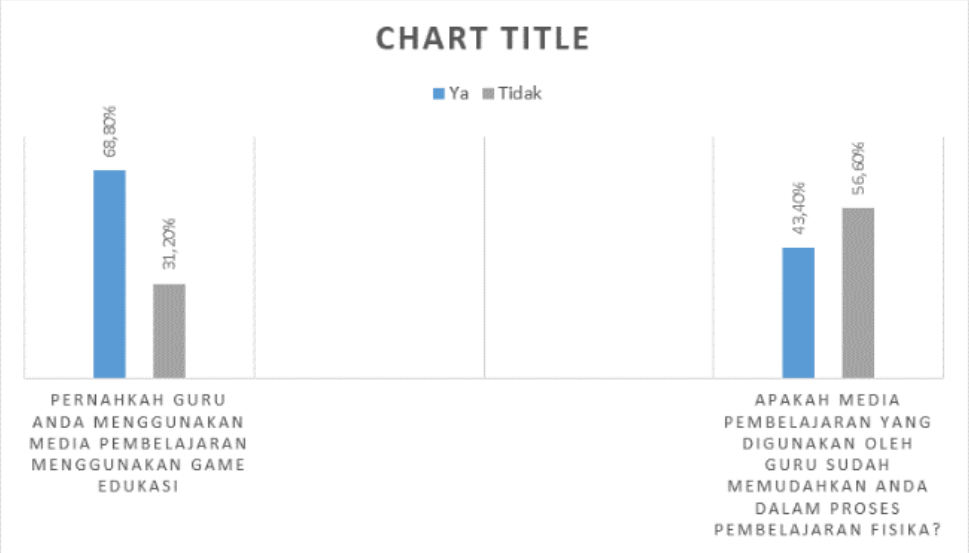
## RESEARCH METHOD

The research design used is development (Research and Development, R&D) which aims to develop physics learning media based on Traditional Engklek Games. Research and Development is a research method used to produce new products. This development model uses Sugiyono with 10 steps of research. This research adopts Sugiyono research and development steps with 10 research steps. Then because of the researcher's needs, the researcher only adopted 8 research steps, namely; 1) Problem Identification; 2) data collection; 3) Product Design 4) Design Validation 5) Design Revision 6) Product Trial 7) Product Revision 8) Usage trial 9) Product revision and 10) Mass production

Information obtained from data collection results from a needs analysis questionnaire conducted at the beginning. The questionnaire contains many questions to explore preliminary information about the use of learning media used by students and then analyzes the form of learning media that students need.

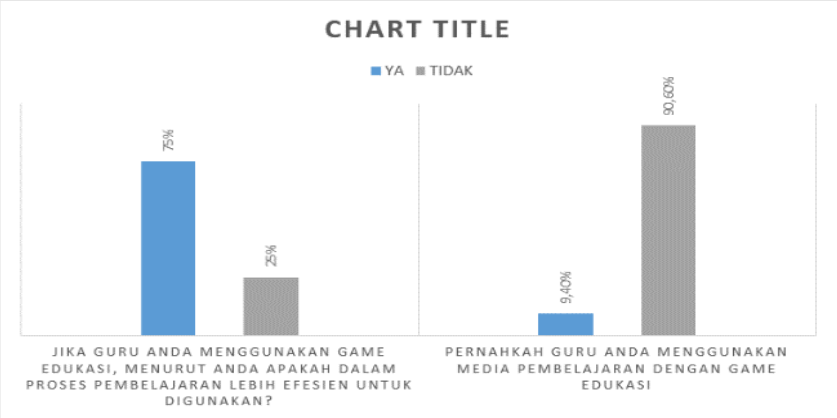
## RESULTS AND DISCUSSION

In this study, the results obtained can be seen in the graph below:



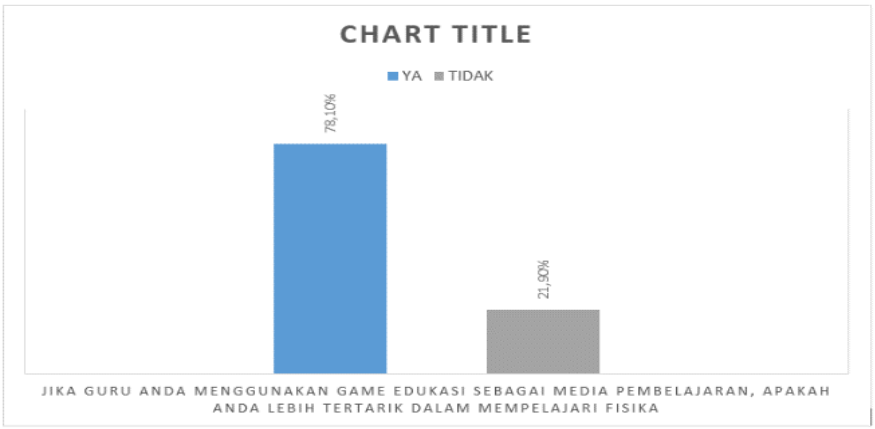

Graph 1. The results of the analysis of student needs regarding the media taught by the teacher and the results of the media being taught

Based on the results of the questionnaire, it is known that out of 64 students (68.8%) used media and only (31.2%) answered no. Based on the results of the questionnaire, it is known that out of 64 students (56.6%) answered no and (43.4) answered yes (Graph 1).




Graph 2. The results of the analysis of student needs regarding learning media for physics educational games

Based on the results of the questionnaire, it is known that as many as (75%) students think that learning efficiency using educational games is needed and (90.6%) student-teacher respondents have never used educational games in the process of learning physics in class.




Graph 3. The results of the analysis of student needs regarding the relationship in learning physics

Based on the results of the questionnaire, it is known that as many as (78.1%) students think that it is related to learning physics if the learning media uses educational games.

## CONCLUSIONS

From the results of the research conducted, students argued that physics is a difficult subject to learn. In physics learning that is carried out usually is monotonous with the use of the lecture method applied by the teacher. Meanwhile, the teaching and learning process activities in schools should be packaged attractively, so that the learning process does not feel boring and students are enthusiastic about participating in learning. And the use of learning media appropriately can stimulate and involve students to be active, creative, and create enjoyable learning and in the end, it will improve the quality of learning.

The physics game media is very supportive of learning physics which requires questions and answers in detail and these questions have a real picture, natural phenomena, or a demonstration of physics experiments. By presenting audio-visual media, it is hoped that it can provide an educational effect such as educating students to think critically, providing meaningful experiences, and developing and broadening students' thinking horizons.

The results of the needs analysis state that students need to develop physics learning media using traditional games based on android.

## REFERENCES

[1] Latuheru. *Learning Media in the Teaching and Learning Process of the Present* (Department). 1998.
[2] Sadiman, A. D. *Educational Media: Definition, Development, and Utilization*. Jakarta: Rajawali Pers. 2014.
[3] Kustandi, B. S. *Manual and Digital Learning Media*. Publisher Ghalia Indonesia. 2011.
[4] Dina, I. *Variety of Teaching Media Aids*. Diva Press. 2011
[5] Sugihartono, et al. *Educational Psychology*. Yogyakarta: UNY Press. 2012

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

# Development of Digital Based Friction Coefficient Practicum Tool in Newton's Law Material

**Hadianti Deliana[1*] and Sugianto[1]**

[1]Physics Education Study Program, University of Muhammadiyah Prof. DR HAMKA
Tanah Merdeka Street, Kp.Rambutan, Pasar Rebo, East Jakarta, 13830, DKI Jakarta, Indonesia

*Correspondence email: serbabu05@gmail.com

## ABSTRACT

This research was conducted which aims to solve the problem of difficult practicum activities and the minimum use of digital-based practicum tools. In addition, for the development of physics learning media in the form of a product, namely a digital-based practicum tool on the material Newton's law with a focus on the Friction Force on an Inclined Plane. The research method used is research and development (Research and Development) and the Borg & Gall development model. At the research stage and initial information gathering, problem analysis and needs analysis activities were carried out in the form of a questionnaire. Furthermore, the planning stage begins with the design of the tool and the development of the initial product format. The prototype is designed as an embodiment of defined ideas and ideas. In the initial trial phase, the media is tested on material experts and media experts and then evaluated. In the field trial phase, it was carried out at SMA Islam PB Soedirman 2 Bekasi and SMA TAMHAR for class XI IPA students. The media is tested in small-scale trials and large-scale trials, for small-scale trials conducted by PB Soedirman 2 Bekasi Islamic High School students with 15 students using online data collection and large-scale trials conducted on PB Soedirman 2 Bekasi Islamic SMA students with 17 students, and SMA TAMHAR with a total of 20 students, for data collection at the two schools used two different methods for SMA Islam PB Soedirman 2 Bekasi online and SMA TAMHAR face-to-face. Data collection was obtained using a Likert scale questionnaire, data for data collection at the two schools using two different methods for SMA Islam PB Soedirman 2 Bekasi online and SMA TAMHAR face-to-face. Data collection was obtained using a Likert scale questionnaire, data For data collection at the two schools using two different methods for SMA Islam PB Soedirman 2 Bekasi online and SMA TAMHAR face to face. Data collection was obtained using a Likert scale questionnaire, dataThe data obtained is quantitative data in the form of a percentage of the feasibility of the developed media and qualitative data in the form of comments and suggestions for improvement given by respondents. On the due diligence bymaterial experts obtained a percentage of 83.42% (good). Feasibility test by media experts obtained a percentage of 93.71% (very good). The percentage obtained through small-scale trials was 85.15% (good), while large-scale trials obtained a percentage of 85.11% (good). So it can be concluded that the digital-based friction coefficient practicum tool is suitable for use as a medium for learning physics.

**Keywords:** Practicum Tools, Friction Style, Digital

## INTRODUCTION

The rapid development of technology is very influential on the learning media in schools. The development of science and technology increasingly encourages renewal efforts in the use of technological results in the learning process. According to [1] Learning using teaching aids is a series of activities to convey material that aims to provide students with opportunities to be active in learning so as to allow students to gain knowledge and develop psychomotor skills and increase student creativity to solve problems faced in learning. In the teaching and learning process, educators are required to be innovative so that students get new experiences in the learning process to be fun. To see success in the learning process requires media or practicum tools that can help the learning process and outcomes in accordance with the level of thinking of students, therefore educators must use learning media.

Practicum tools can be used in understanding concepts and showing abstract phenomena in physics theory so that it becomes an adequate learning medium. One of the positive impacts of using props or practicum tools is: serve and facilitate a variety of human needs, but negative impacts can arise from technology that makes it easy to make things done instantly, making many generations less familiar with the basic concepts of science. So this is a challenge for educators to be able to prepare a generation that is ready for science and technology.

Some of the important electronic devices in the development of learning media include control devices such as microcontrollers, detectors or sensors, display devices or LCDs, and actuator devices. So with

various existing electronic devices, if the design of props or practicum tools using various electronic devices will produce data that is more effective, efficient and has accurate measurement and visualization results presented in digital form, it can be connected to computer devices for storage purposes and better data management.

Based on the description above, the researcher is interested in developing a physics practicum tool entitled "Development of Digital-Based Friction Coefficient Practicum Tool on Newton's Law ". In this study, researchers made a digital-based physics lab tool to measure the coefficient of friction, angle, distance, velocity, and acceleration in Newton's law material. Expected Digital-based physics practicum tools can make it easier for educators to explain concepts so that students are enthusiastic about participating in physics practicum activities at school.

## THEORITICAL REVIEW

a. Practicum Tools

The practicum tool is a tool that can be absorbed by the eyes and ears with the aim of helping educators to make the learning process more effective and efficient [2]. "Tool can be interpreted as a means that can be used to do something"[3]. Then according to KBBI "Tools: objects used to do something; tools; furniture (an)" [3]. In KBBI it is said that "Practicum: part of teaching, which aims to give students the opportunity to test and implement in real situations what is obtained in theory; practical lessons"[3]. Practicum in physics learning is a series of activities to prove and develop physics concepts that have been studied abstractly through books, the internet and classroom learning.[4].

So it can be concluded that the practicum tool is a tool that can be used to carry out an implementation in realizing theory in reality with the aim of helping educators in the learning process more effectively and efficiently.

According to Hodson [5] there are 5 objectives of practicum activities, namely: 1) To increase scientific knowledge, 2) To teach experimental skills,3) To develop a 'scientific attitude' such as being open-minded, being objective, and a willingness to suspend judgment, 4) Can develop skills, and can provide assessments, 5) To motivate students, with an interesting and fun simulation [5]. Meanwhile, according to Woolnough the objectives of implementing the practicum include: 1) Allows learners to develop and use their personal knowledge through hands-on experience, 2) Develop basic skills and social skills, 3) Motivate students so that they can increase interest in learning, 4) Become a vehicle for learning a scientific approach [5].

Then these objectives can be concluded that the purpose of practicum tools is to develop basic skills and social skills that can develop expertise from direct experience that can provide an assessment. The criteria for the feasibility of practicum tools include: (1) practicum tools must be in accordance with the concept of physics, (2) practicum tools according to the curriculum, (3) the performance of practicum tools must be interesting and in accordance with the subjective research, (4) practical tools are easy to understand, and (5) ) easy to use practicum tools [2].

b. Arduino

Arduino is an electronic prototyping platform that is open-source hardware based on flexible and easy to use hardware and software[6].

According to [2] Arduino is a platform consisting of software and hardware. Arduino hardware is the same as a microcontroller in general, only the Arduino pin naming is added to make it easy to remember. Arduino software is open source software so it can be downloaded for free. This software is used to create and enter program code into Arduino. Arduino programming is not as much as a conventional microcontroller stage because Arduino has been designed to be easier to learn, so beginners can start learning a microcontroller with Arduino.

Based on the description above, it can be concluded that Arduino is an electronic prototyping platform consisting of hardware and software.

## RESEARCH METHOD

The research method used is the research and development method (Research and Development which aims to improve the instructional design, development and evaluation process based on other specific problem-solving situations or generalized examination procedures. Research and development methods or in English, Research and Development is a research method used to produce certain products, and to test the effectiveness of these products [7]. To be able to produce certain products, research is used that is needs analysis and to test the effectiveness of these products so that they can function in the wider community, research is needed to test the effectiveness of the product.

The model used for product development is the Borg and Gall model. Brog and Gall define 10 steps used for Educational Research and Development (R&D). The research steps carried out in this study only reach the end product - not until the mass product manufacturing activity. Therefore, the researcher shortens / simplifies the steps taken. Thus, the steps used for module research and development include:

a. Preliminary research and information collection to analyze instructional media products to be developed,
b. Develop the initial product
c. Perform expert validation,
d. Conduct field trials, and
e. Make product revisions [8].

The first stage carried out was a preliminary research in the form of a needs analysis carried out on students. The data from the needs analysis were obtained through a questionnaire filled out by students. The questionnaire contains questions that are asked in order to find out the needs of students for the media to be developed. The questionnaire given is also equipped with a suggestion column for researchers.

Then the preparation of the initial product begins with making a product design, namely the design of the practicum tool, then development is carried out in accordance with the design. The results of the development that have been made are then validated by experts to be assessed, then the practicum tool is revised based on suggestions from the validator.

The next stage is the limited trial stage. The results of the revised practicum tool were then tested on a small scale on 15 grade XI students at SMA Islam PB Soedirman 2 Bekasi. Large-scale trials for 17 students of class XI at SMA Islam PB Soedirman and 20 students of class XI at SMA TAMHAR. Limited trials were carried out by filling out student questionnaires.

After a limited trial was carried out, the last stage was a revision of the digital-based practicum tool based on the suggestions of students. Then from the revised results obtained the final product.

## RESULTS AND DISCUSSION

In this research, a digital-based friction coefficient lab tool product has been developed on Newton's Law material. In the early stages of the research, the researcher conducted a preliminary study in the form of a needs analysis by giving questionnaires to students.

### Needs Analysis Results

The results of the needs analysis show that students need a digital-based friction coefficient practicum tool that makes it easier for them in practicum activities. In developing this practicum tool, students need to understand concepts and are interested because no one in schools has developed digital-based practicum tools.

### Developed Media Outcomes.

After obtaining data through needs analysis, the next step is to develop learning media.

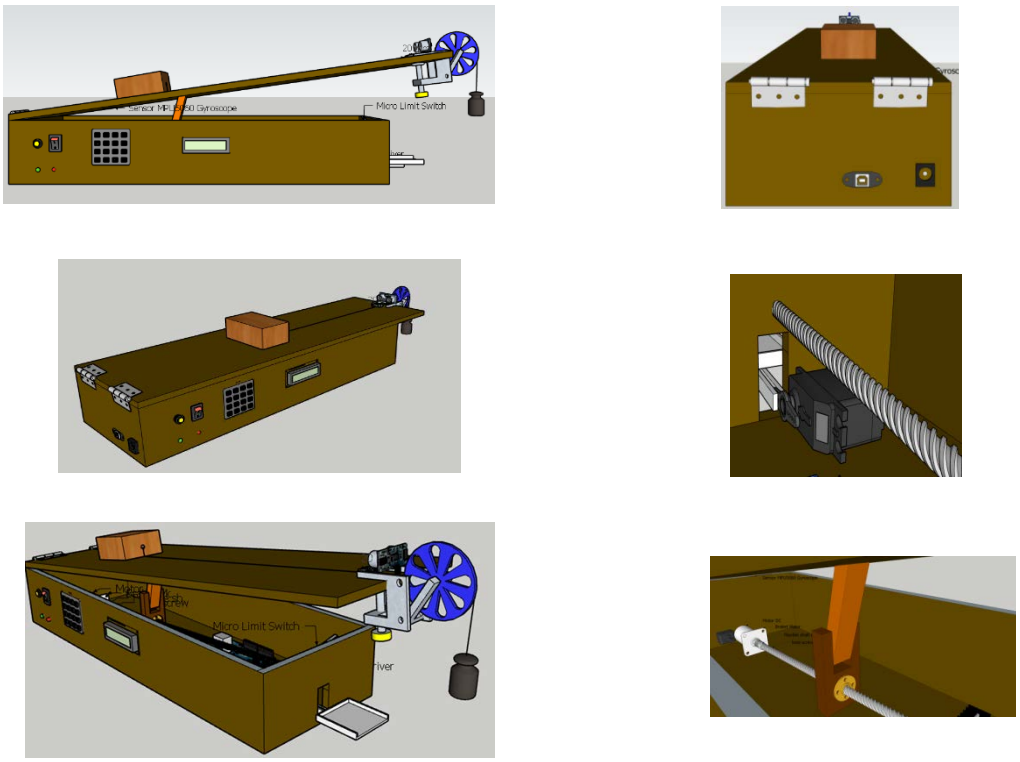



Figure 1. The results of the media that have been developed

**Feasibility Test Results**

Learning media can be said to be suitable for use in the learning process to be tested on students if it has gone through the due diligence process by experts. In this study, the feasibility of the media was assessed by three experts, namely two material experts and one media expert. The results of the assessment obtained through material experts and media experts are:

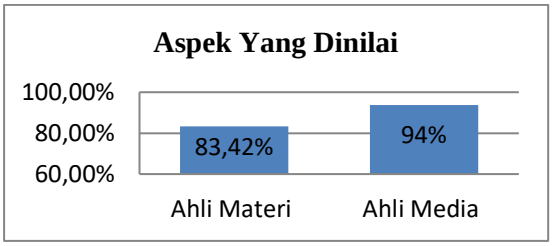



Figure 2. Results of research by media experts and material experts

The assessment by the experts showed that the percentage of eligibility given by the material expert was 83.42% with a good predicate, and the percentage of eligibility given by media experts is 94.00% with the predicate very good. Based on these results it can be concluded that the learning media developed by the researcher is suitable for use both in terms of material and media.

**Small and Large Scale Trial Results.**

After going through the due diligence by the experts, the learning media that had been developed by the researchers were tested on students. The following are the results of a small-scale trial:

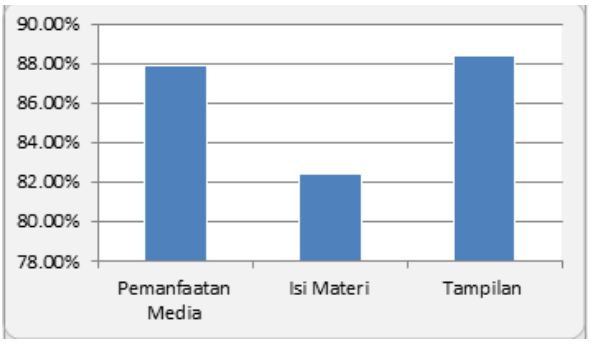



Figure 3. Small Scale Trial Results

These results show the results of the percentage of small-scale trials on the aspect of media utilization was 87.85% with a very good predicate, on the content aspect of the material obtained a percentage of 82.45% with a good predicate. In the aspect of display feasibility, the percentage is 88.38% with a very good predicate. If the three aspects are calculated on average, it will produce a percentage of 86.22% with a very good predicate. The following are the results of a large-scale trial:

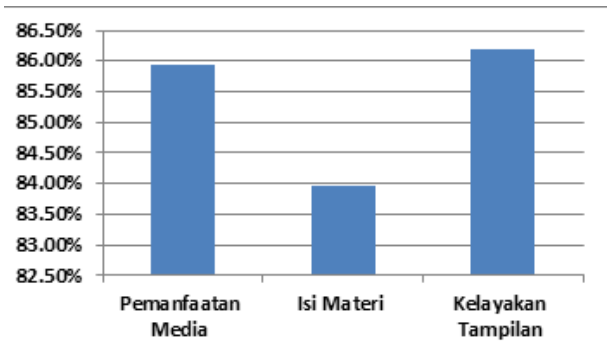



Figure 4. Large Scale Trial Results

These results show the results of the percentage of large-scale trials on the aspect of media utilization, namely 85.93% with a good predicate, on the content aspect of the material obtained a percentage of 83.95% with a good predicate, and the aspect of display eligibility obtained a percentage of 86.20% with a very good predicate.

The following is a comparison of the percentages obtained through small-scale trials and large-scale trials:

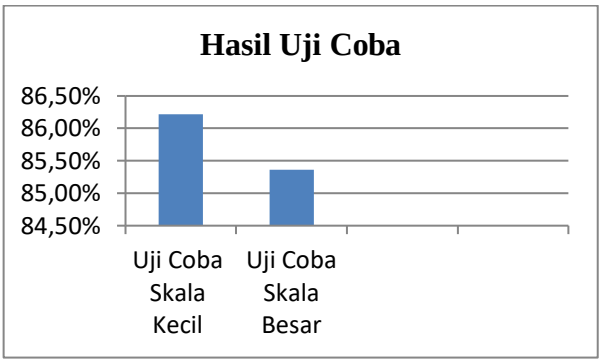



Figure 5. Comparison of Small Scale and Large Scale Trial Results.

The results of large-scale trials were 85.36% and small-scale trials were 86.33%. When compared to the results obtained when conducting small-scale trials and large-scale trials, the percentage value increases by 0.97%.

## CONCLUSIONS

Based on the research results, it can be concluded several things about the development of learning media developed by researchers, namely:

1. The end result of this development is a digital-based friction coefficient practicum tool and a practicum module which contains material, how to use it and student worksheets (LKPD). In addition, it is also equipped with pictures of the developed practicum tools.
2. The media developed has also passed the feasibility trial stage starting from the precision and accuracy trials, validation trials by experts and student responses. From the trial, it was produced that the coefficient of friction practicum tool has accurate accuracy because it produces data that is in accordance with the literature, and has good accuracy. Meanwhile, the results of validation by experts show the average value of material expert at83.42% (Good), media experts 93.71% (Very Good). Based on the material and media expert's assessment, the media developed is suitable for use.
3. Apart from being assessed by material experts and media experts, the media developed by the researchers were also tested on learners. On a small scale test was carried out on students with a total of 15 person. on a small-scale trial, obtained a percentage value of 85.15% with the predicate (Good)

Then for a large scale carried out to students with a total of 37 people. The results of large-scale trials were 85.11% with the predicate (Good). Based on these results it can be concluded that the coefficient of friction practicum tool is suitable for use as a reference for physics learning media at the high school level.

## REFERENCES

[1] H. S. Wahyuni and D. Rosana, “Physics Props Development based on Personal Desk Laboratory System to Improve Creative Thinking Ability and Students’ Scientific Attitude,” *J. Phys. Conf. Ser.*, vol. 1233, no. 1, 2019, doi: 10.1088/1742-6596/1233/1/012032.
[2] W. Widayanti and Y. Yuberti, “Pengembangan Alat Praktikum Sederhana Sebagai Media Praktikum Mahasiswa,” *JIPFRI (Jurnal Inov. Pendidik. Fis. dan Ris. Ilmiah)*, vol. 2, no. 1, pp. 21–27, May 2018, doi: 10.30599/jipfri.v2i1.161.
[3] P. Siswa, D. I. Sma, and K. Bengkulu, “Korelasi Pengetahuan Alat Praktikum Fisika Dengan Kemampuan Psikomotorik Siswa di SMA Negeri Q Kota Bengkulu,” vol. IX, no. 1, pp. 67–76, 2011.
[4] A. Waris and D. Nurjannah, “Pengembangan Alat Praktikum Sederhana Konsep Listrik Magnet untuk Siswa SMP Daerah Terpencil,” vol. 3, no. 2, pp. 1–7.
[5] M. L. Dewi, A. S. Budi, and E. Budi, “Pengembangan Modul Praktikum Fisika Berbasis Data Logger Untuk SMA SNF2015-II-169 SNF2015-II-170,” vol. IV, pp. 169–172, 2015.
[6] H. Santoso, “Panduan Praktis Arduino untuk Pemula,” 2015.
[7] Sugiyono. 2017. Metode Penelitian Kuantitatif dan Kualitatif dan R&D. Bandung: Alfabeta.
[8] Muji, “Pengembangan Perangkat Pembelajaran Keterampilan Membaca Model Pembelajaran Kontekstual,” *Pancaran*, vol. 4, pp. 1–14, 2014.
[9] Kause, MC (2019) 'Design of Arduino-Based Physics Teaching Aids (Case Study of Free Fall Motion)', Cyclotron, 2 (1). doi: 10.30651 / cl.v2i1.2511.

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

# Analysis of Learning Obstacles Related to Mathematical Thinking Skills

**Meyta Dwi Kurniasih[1*], S. B. Waluya[2] Rochmad[2], Sukestiyarno[2]**

[1]Universitas of Muhammadiyah Prof DR HAMKA, Jakarta, Indonesia
Tanah Merdeka Street, Kp.Rambutan, Pasar Rebo, East Jakarta, 13830, DKI Jakarta, Indonesia

[2]Semarang State University
Sekaran, Gunung Pati, Semarang City, Central Java, 50229, Indonesia

*Correspondence email: meyta.dkurniasih@uhamka.ac.id

## ABSTRACT

Critical thinking skills are a person's ability to think systematically and directed in providing feedback on information, analyzing assumptions, and making decisions about what is believed and done. Ability is superior in this 21st-century learning, it is important to have especially by prospective mathematics teacher students, but there are still many students who experience obstacles in honing these abilities. This study aims to analyze the epistemological constraints faced by students in improving mathematical critical thinking skills in lectures on transformation geometry. This study is descriptive qualitative research; data were collected from the test, interview, and observation. Given five problems related to thinking critically mathematically ability with five indicators, against 6 respondents who have different belief of mathematical, namely high, medium, and low. The results showed that of the five indicators of mathematical critical thinking ability, the lowest was about advice clarification and inference that is giving a further explanation about the application of concepts and ways to deduce problems. Therefore, it is suggested that lectures on transformation geometry are more related to daily conditions and better train students in making appropriate

**Keywords:** 21st-century skill, critical thinking, mathematics.

## INTRODUCTION

Skills in 21st-century learning, known as Four C's of 21st Century Skills are the thinking abilities that students must have in learning in order to support and improve the work environment [1]. The Importance of Thinking Ability This becomes a challenge for prospective students to master it so that in the learning process in class, it must be able to hone these abilities. One thinking ability is needed. Mathematics is the ability to think critically [2].

With the times and the speed of science, students must be equipped with quality critical thinking skills. Therefore, learning is directed not only in terms of understanding but also in the analysis of concepts needed to solve problems more effectively [3]. The ability to think critically mathematically is the basis of the process of thinking to analyze arguments and bring ideas to meaning to develop logical thinking patterns [4]. Finally, mathematical critical thinking skills can be honed if prospective teacher students are accustomed to problems that contain logical thinking processes.

Critical thinking processes are reasoning activities that are based on studies, all in the analysis of causes and how to proceed. Prospective teacher students who are able to think critically if in their learning can express ideas, arguments based on previous concepts, so students are not only good listeners, but are also able to understand and analyze the information obtained. One of them is learning geometry transformation.

This branch plays an important role in life especially as an application in solving problems related to size and shape [5]. Like measuring tower height, area, volume, and so on. Because of its urgency, geometry is a subject that must be taught to prospective mathematics teacher students. Therefore, the learning process of geometry must be done innovatively [6].

For the development of active and innovative learning, there are at least three important elements namely time, teaching materials, and teaching methods. If all three are properly integrated, it will improve students' thinking abilities at a higher level [7], so that in learning geometry, learning resources are needed in the form of materials/textbooks which can not only improve students' cognitive abilities but

also their effective abilities. Furthermore, it must be realized that in learning geometry, lecturers have a very important role to create effective and pleasant environmental conditions for prospective teacher students [8]. An effective and enjoyable environment is expected to maximize coaching and arouse the interest of prospective teachers in learning. Therefore we need a way of including (1) encouraging prospective teachers to find their own concepts or formulas, (2) actively involving prospective teacher students in finding concepts or formulas, (3) using a program/application suitable for learning

In addition to the learning process being a factor in mathematical critical thinking ability, there are also affecting factors that influence it, one of which is a belief about mathematics. Mathematical belief affects how students "welcome" mathematics lessons, [9] which is the result of experience. Mathematics Education Study Program students who later will be educated to become mathematics teachers, are known to still experience difficulties in dealing with mathematics. This can be seen, when studying mathematics, they are often not confident in explaining the mathematical material being studied. They look unsure in learning mathematics. Whereas with good mathematical beliefs, prospective teacher students are expected to be able to realize the potential situation to be able to think forward mathematically [10].

If students have good beliefs, then they will try even more in learning mathematics, because beliefs have a direct relationship with one's business so beliefs become the foundation of learning [11]. However, this does not appear to students when dealing with math problems, more quickly discouraged and unsure of their own.

From the description above, this study analyzed the epistemological learning obstacle of prospective teacher students related to the improvement of mathematical critical thinking skills, when viewed from beliefs in mathematics. Epistemological learning obstacle is a person's knowledge that is only limited to certain contexts, so when he is faced with different situations can result in the knowledge he has cannot be used or have difficulty in using it. There are 3 indicators of learning epistemological constraints are Conceptual, Procedural, and Technical Operational.

## RESEARCH METHOD

This research was conducted to analyze the challenges of pre-service teacher learning, especially to improve critical thinking skills in mathematics. This research method is descriptive qualitative research that aims to describe the barriers about epistemology students who learn mathematical-related thinking skills with 4 dimentions such as 1) advanced clarification, 2) basic support, 3) inference, and 4) strategies and tactics. The research subjects were six pre-service mathematics teachers who attended the transform geometry lecture consisting of 2 students with high mathematical belief (S1, S2), two students with moderate mathematical belief (S3, S4), and two students with low mathematical belief (S5, S6)). The questionnaire about mathematical belief was given to prospective teacher students to collect responses about the beliefs of mathematics while attending learning in lectures. Indicators of belief in mathematics were clarified into 5 (five) indicators, namely certainty of knowledge, the role of lecturers, systematic processes, innate ability and quick learning with five answer choices in the form of a rating scale. Which before has been done instrument validity and reliability.

## RESULTS AND DISCUSSION

### *3.1 Mathematical Critical Thinking Skills of Students with Low Mathematical Belief*

From 27 student teacher candidates randomly taken 2 students who have low mathematical beliefs namely S1 and S2.

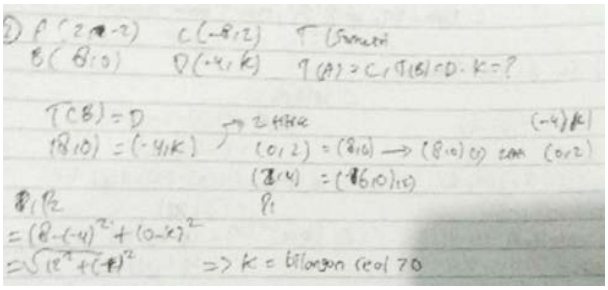


**Figure 1.** Result of S1

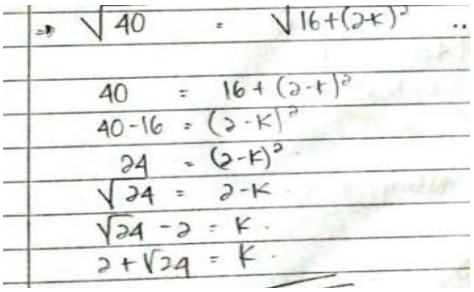


**Figure 2.** Result of S2

**Table 1.** Result about Critical thinking ability respondent S1 and S2

| Type of obstacle | Identification of obstacles |
|---|---|
| Conceptual | S1 and S2 do not identify the results of deductions made but can determine some completion steps that are not yet perfect for the mention. On the ability to think critically S1 and S2 are less able to clarify the purpose of identifying or formulating questions accordingly |
| Procedural | S1 completion is not in accordance with Step should be, S2 is correct in the procedure |
| Technical Operational | S1 experienced an error in calculating the value of the calculated operation, whereas the S2 calculation was correct, but the information used was not written correctly |

From the results of S1 and S2 students who are classified as having low mathematical beliefs, there are obstacles, especially in terms of procedural and operational techniques, although in identifying problems they have done but still not perfect, so in the process of completion (operational steps), there are still many mistakes. In this case, students who have low mathematical belief need practice and deepening of the material. Deepening of the material is needed so that students can make connections between the concepts that have been learned and those that will be studied [12].

### *3.2 Mathematical Critical Thinking Skills of Students with Medium Mathematical Belief*

From 27 student teacher candidates randomly taken 2 students who have medium mathematical beliefs namely S3 and S4.

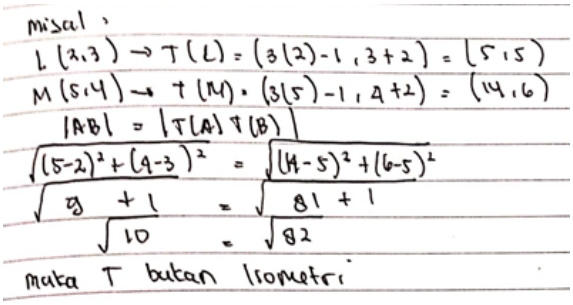


**Figure 3**. Result of S3 and S4

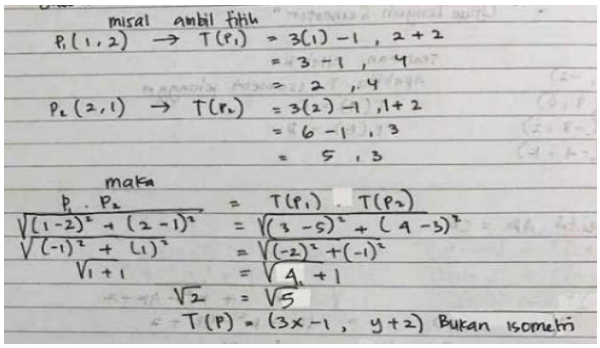


**Figure 4**. Result of S3 and S4

**Table 2.** Result about Critical thinking ability respondent S3 and S4

| Type of obstacle | Identification of obstacles |
|---|---|
| Conceptual | S3 and S4 do not identify the questions given and provide reasons for their completion. S4 makes a mistake in writing the point, namely point T (P1) |
| Procedural | The solution to S3 and S4 in the end is not given an explanation that the distances AB and T(A)T(B) are not the same (not marked are not equal) |
| Technical Operational | technically, S3 and S4 have done the calculations correctly |

From the test results, the obstacle for S3 and S4 in identifying the questions given was the incomplete writing of the isometric concept which resulted in the correct answer. The results of the interview with S3 why he only answered like that, he said that he knew that important concepts were not the same. S4 replied that what was important was not the same. However, if asked further about the concept of isometry, they still could not give the right answer.

### *3.3 Mathematical Critical Thinking Skills of Students with High Mathematical Belief*

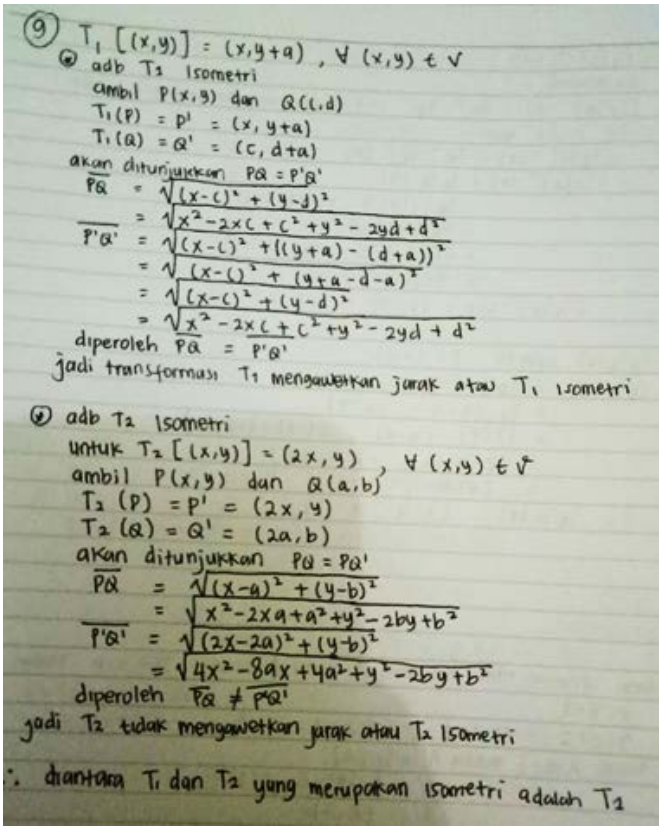



**Figure 5.** Result of S5

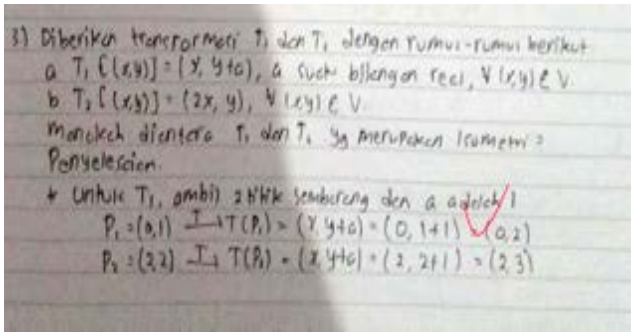



**Figure 6.** Result of S6

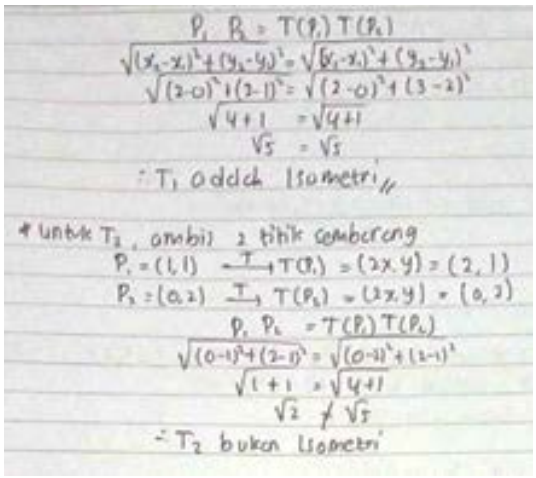



**Figure 7.** Result of S6

**Table 3.** Result about Critical thinking ability respondent S5 and S6

| Type of obstacle | Identification of obstacles |
|---|---|
| Conceptual | S5 is the obstacle in writing the terms or identification of the problems given, for S6 has provided the right definition. |
| Procedural | S5 and S6 can solve the problem, but in the middle of the conclusion there is an error, namely there is no sign that is not the same as for the given equation. |
| Technical Operational | There are no obstacles |

From table 3 above, it is known that students' mathematical critical thinking skills with high mathematical belief from the conceptual side, S5 and S6 experience obstacles to more complicated concepts. However, for procedural obstacles at the end, they often forget the proper conclusions.

## CONCLUSIONS

Research subjects who have low mathematical belief experience learning barriers especially related to procedural problems and operational techniques. They do not understand errors in calculating and more precise problem-solving steps. Research subjects who have mathematical belief are experiencing procedural obstacles such as errors in writing conclusions. And students with high mathematical belief experience conceptual problems in integrating their abilities.

## REFERENCES

[1] B. Stauffer, “What Are 21st Century Skills?,” 2018. [Online]. Available: https://www.aeseducation.com/blog/what-are-21st-century-skills. [Accessed: 03-Jun-2020].
[2] T. pamungkas Alamsyah and Turmudi, “Kemampuan Berpikir Kritis Dan Kreatif Serta Self-Esteem Matematis Siswa Melalui Model Advance Organizer,” *Pendidik. Mat. Kalamatika*, vol. I, no. 2, pp. 119–128, 2016.
[3] M. D. Kurniasih, “Pengaruh Pembelajaran React Terhadap Kemampuan Berpikir Kritis Matematis Ditinjau Dari Habit Of Mind Mahasiswa,” 2017.
[4] T. Jumaisyaroh, E. E. Napitupulu, and H. Hasratuddin, “Peningkatan Kemampuan Berpikir Kritis Matematis Dan Kemandirian Belajar Siswa Smp Melalui Pembelajaran Berbasis Masalah,” *Kreano, J. Mat. Kreat.*, vol. 5, no. 2, p. 157, 2016, doi: 10.15294/kreano.v5i2.3325.
[5] N. Siregar and N. Ratnaningsih, “Sikap Siswa Terhadap Pembelajaran Geometri Melalui Model Pace Berbantuan Geogebra,” *Kalamatika J. Pendidik. Mat.*, vol. 4, 2019.
[6] S. Maarif, W. Wahyudin, A. Raditya, and K. S. Perbowo, “Introducing geometry concept based on history of Islamic geometry,” *J. Phys. Conf. Ser.*, vol. 948, no. 1, 2018, doi: 10.1088/1742-6596/948/1/012040.
[7] T. R. Fabiyi, “Geometry Concepts in Mathematics Perceived Difficult To Learn By Senior Secondary School Students in Ekiti State , Nigeria,” *IOSR J. Res. Method Educ.*, vol. 7, pp. 83–90, 2017, doi: 10.9790/7388-0701018390.
[8] M. Salam, L. Misu, U. Rahim, N. Hindaryatiningsih, and A. R. A. Ghani, “Strategies of

metacognition based on behavioural learning to improve metacognition awareness and mathematics ability of students," *Int. J. Instr.*, vol. 13, no. 2, pp. 61–72, 2020, doi: 10.29333/iji.2020.1325a.

[9] W. Rahayu and M. D. Kurniasih, "The influence of react strategy towards mathematical belief.," in *International Seminar on Innovation in Mathematics and Mathematics Education 1st.*, 2014.

[10] S. Tirto, T. Herman, and Turmudi, "Improving Mathematical Beliefs of Pre-service Teacher Trough Valsiner Zone Learning," *J. Phys. Conf. Ser.*, vol. 1179, p. 012010, 2019, doi: 10.1088/1742-6596/1179/1/012010.

[11] S. Schuck and R. Brandenburg, "Self-Study in Mathematics Teacher Education," no. 1987, pp. 1–29, 2019, doi: 10.1007/978-981-13-1710-1_29-1.

[12] G. Rrousseau, "Epistemological Obstacles, Problems, And Didactical Engineering," in *Theory of Didactical Situations in Mathematics*, Kluwer Academic Publisher, 1997, pp. 1970–1990.

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

# Analysis of the Needs of Higher Order Thinking Skills (HOTS) Using A Four Tier Type Test Diagnostic Instrument in Learning Physics

**Nurliana Apriyanti[1*] and Feli Cianda Adrin Burhendi[1]**

[1]Physics Education Study Program, University of Muhammadiyah Prof. DR. Hamka, Campus B Tanah Merdekastreet, Kp. Rambutan, Pasar Rebo, East Jakarta 13830, DKI Jakarta, Indonesia

*Correspondence email: nurlianaapriyanti15@gmail.com

## ABSTRACT

The preliminary study in this study describes the need for test evaluation in the learning process for teachers and students in public high schools in the Bekasi district. This study consisted of field observations. The objectives of this study were (1) to determine the form of tests conducted by the teacher, (2) to determine the cognitive level of the tests used, (3) to examine the constraints and barriers that occurred to students in the learning process, (4) to explore the teacher's needs for the test. Four tiers as a learning evaluation. The subjects of this study were students in high schools (SMA) and physics teachers at school. The sample was randomly selected with 60 students and 5 teachers in the three schools. The results of the analysis show that students and educators need an evaluation tool for the assessment of student learning outcomes in the form of a four-tiered or four-tiered multiple-choice diagnostic test. This test can be used to reveal misconceptions or understanding of students about material that has not been understood, besides that it can measure students' higher-order thinking skills.

**Keywords:** evaluation, test, four-tier, higher-order thinking skills

## INTRODUCTION

A learning process, of course, has an evaluation. One of the problems that occur in the world of education in Indonesia is the low level of evaluation tools in learning. This learning evaluation is a measurement and assessment of the learning process where educators assess the activities and interactions of students using test kits. The purpose of learning evaluation is of course to find out whether the learning process of students in following the learning implementation plan is implemented or has deficiencies in the learning process, to find the best solution to achieve educational goals. The importance of learning evaluation for students is to measure the achievement of success in following the learning process that has been given by the educator.

In physics learning, in particular, the purpose of learning is to deliver students to understand physics concepts and connect with everyday life.In the 2013 curriculum, efforts to improve the curriculum, curriculum revisions were again carried out in 2017 with improvements in strengthening character education (PKK), literacy movements, 21st-century skills known as 4C (creative, critical thinking, communicative and collaborative), and integrating HOTS (Higher Order Thinking Skills) or higher-order thinking skills in learning [1]. Students' high-level thinking skills are based on the results of the Program for International Student Assessment (PISA) which shows that the achievement of reading literacy, mathematical literacy, and scientific literacy of Indonesian students is very low [2]. In connection with the four main points of the education policy "independent learning" which was initiated by the Minister of Education and Culture, one of which is about the implementation of the National Examination in 2021. Minister of Education and Culture Nadiem Anwar Makarim explained that "The implementation of the UN in 2021 will be changed to a Minimum Competency Assessment and Character Survey which consists of the ability to reason using language (literacy), the ability to reason using mathematics (numeracy) and strengthening character education. " [3]. Also, Nadiem said in his speech, "To be able to answer multiple choices, the child must be able to understand paragraphs, understand arguments and also read the diagram, to understand what is meant by the visual display of the salt. This is from PISA, ladies, and gentlemen. [4] Following the 2013 curriculum and educational policies regarding "independent learning", a good assessment is needed to assess learning activities. To measure the ability of students to the material presented in the learning process, of course, an assessment process must be carried out. Tests are structured performance situations that can be analyzed to produce a numerical value, which can be used to deduce individual differences in the constructs of performance measured through testing. [5] Tests conducted in schools today still tend to use multiple choice in general. Multiple choice has weaknesses to be an assessment of learning outcomes, including

ineffective in measuring several types of problem-solving, the ability to organize and express ideas. In this regard, there are already several schools that use multiple-choice tests in other forms. An assessment can find out the learning difficulties experienced by students in the learning process. Based on the results of the assessment, it can be seen that the material/competencies have not been understood or achieved by students. In the 2013 curriculum, it is related to the difficulty of assessing students both attitudes, knowledge, and skills. Assessment of the knowledge aspect by conducting tests of student learning outcomes [6]. In its function, the test is divided into four, namely formative assessment, summative assessment, placement assessment, and diagnostic assessment [7]. Diagnostic tests are used to identify problems or learning difficulties of students so that in compiling a diagnostic test, it must be designed with the format and response that is owned by the diagnostic test [8]. The most commonly used tests are formative and summative. The four-tier test is a development of the three-tier multiple-choice diagnostic test. Four Tier consists of four levels including the first level, contains multiple-choice questions with three distracting answers, and one answer that students have to choose. The second level contains the level of confidence in choosing answers. The third level contains students' reasons for choosing answers consisting of three choices of reasons provided and one open reason. The fourth level contains the level of students' confidence in choosing reasons [9]. According to Nugroho, the high-order thinking ability in [10] is defined as the ability to apply knowledge by including analyzing, evaluating, and creating activities in solving problems. The high-level thinking process by solving a problem that is then analyzed, analyzed, and given a solution will help students think. Four-tier questions can also be used to test students' understanding and identify misconceptions. According to Cullinane in [11]. The second tier of two-tier multiple-choice questions can be used for students 'higher-order thinking skills and seeing students' ability to provide reasons. Inclusion second stage to reduce the occurrence of fortune is often a weakness of the form of multiple-choice questions in general. Similar to the form of two-tier questions on four-tier questions, there are reasons that students must answer to understand the conceptual understanding of the material that has been given. This study aims to: (1) determine the form of the test conducted by the teacher, (2) determine the cognitive level used, (3) examine the constraints and barriers that occur to students in the learning process, (3) explore the teacher's needs for the four test tier as a learning evaluation.

## RESEARCH METHOD

This study used an observation method in the field which was carried out on January 8-24 2020 in three State Senior High Schools (SMA) in Bekasi Regency. The sample used was random sampling, with research subjects totaling 60 students and 5 teachers in three high schools.

Data collection techniques by distributing needs analysis questionnaires to teachers and students. The questionnaire was used to obtain data in the field regarding the experiences and needs of students. The research data were analyzed descriptively and qualitatively. The process of processing and analyzing data is carried out in four stages.

The first stage is data from the results of the questionnaire distribution. The second stage of data tabulation is adjusted according to class, nature, and type for easy reading and analysis. The third stage of data analysis is carried out qualitatively, namely analyzing by explaining and relating the data that has been obtained with the research. Stage four is defining the results of the analysis following the existing statements and problems and making conclusions.

## RESULTS AND DISCUSSION

In this study, conducting activities by analyzing the results of the needs questionnaire that had been distributed to students in three MIPA schools.

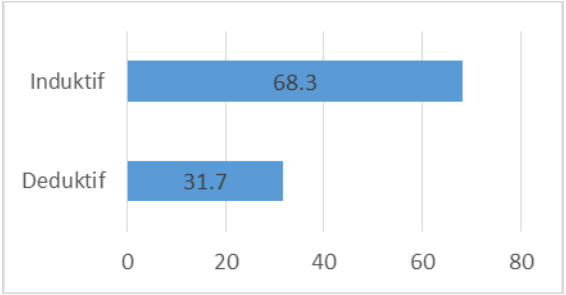


Figure 1. Learning Strategy

The data obtained from students showed that teacher learning strategies were more likely to teach inductively.

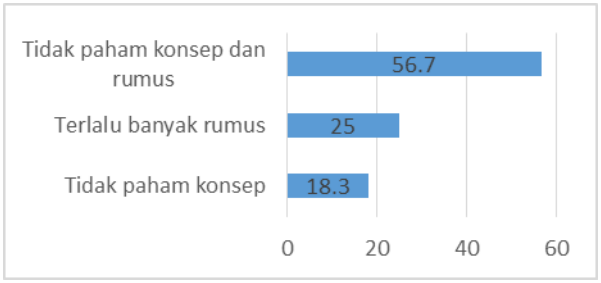



Figure 2. Physics Lessons Difficult

Students reveal that physics is difficult because they do not understand the initial concepts of material and formulas that are poorly understood.

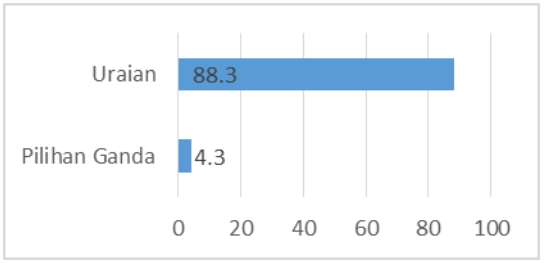



Figure 3. Test form

In terms of learning evaluation with tests as a tool in the assessment. Students revealed that the form of tests used by many educators still used descriptions.

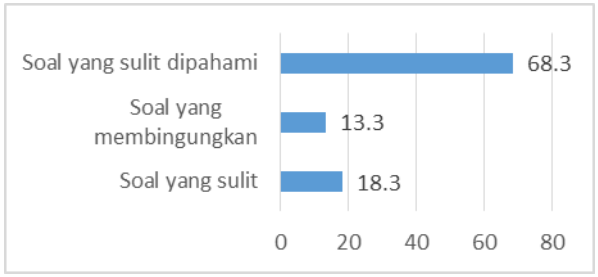



Figure 4. Problem HOTS

According to students, HOTS questions were difficult for them to understand, so that in the process, students found it difficult to solve questions.

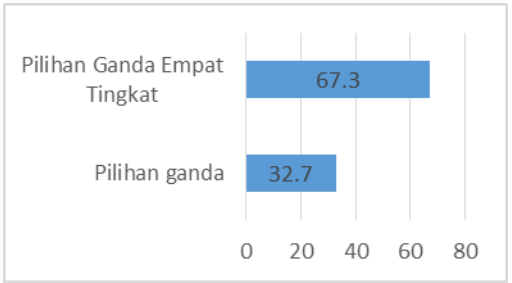



Figure 5. HOTS Test Form

Students reveal that a four-tier multiple-choice test or four-tier multiple choice can be used to test higher-order thinking skills or Higher-Order Thinking Skills. Analyzing the results of a questionnaire on the needs of physics subject teachers that have been distributed in three public high schools in the Bekasi Regency. This questionnaire is analyzed to obtain the information needed by the teacher in evaluating learning.

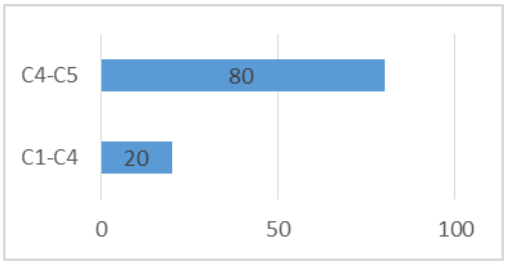



Figure 6. Cognitive Domain

The cognitive domain used by educators in making tests or questions averaged at C4. In this case, the teacher has used the HOTS test in the learning process.

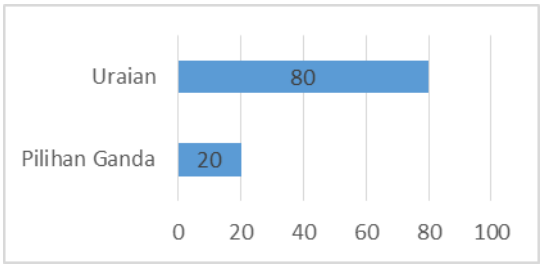



Figure 7. Test Form

The view of educators regarding the form of the average test still tends to use the test in the form of a description as a tool for assessing student learning outcomes.

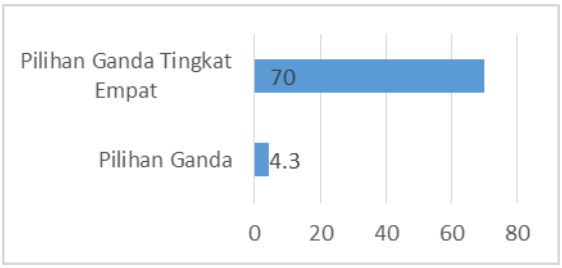



Figure 8. HOTS Test Form

Educators 'perspective on the test in the form of multiple-choice four or four-tier is considered sufficient to be used as a test in measuring students' higher-order thinking skills.

From the questionnaire that has been distributed, it can be formulated that: (1) educators and students need a four-tier multiple-choice test or four-tier multiple choice in addition to uncovering the misconceptions that occur to find out the higher-order thinking skills of students in the learning process. (2) the test questions are designed to be simple and easy to understand by students without reducing the steps for preparing the HOTS test or diagnostic tests. (3) assisting students and educators in identifying weaknesses in the competencies or material provided.

## CONCLUSIONS

Based on the results of the study on needs analysis research, it can be concluded that: a. The evaluation of the four-tier test is assessed by teachers and students as still minimal or of little use in the learning

process, b. Teachers and students need evaluation tools that can reveal misconceptions to be able to understand the concepts in the provision of teaching materials so that they can help students in higher-order thinking, c. The teacher can design a good evaluation tool to see the ability of students to understand the concept of the material given in the physics learning process.

## REFERENCES

[1] A. R. Firdaus, "Studi Deskriptif Strategi Guru Dalam Mengajarkan Materi IPA Pada Kurikulum 2013 Di Sekolah dasar," Jurnal Penelitian Pendidikan Guru Sekolah Dasar, p. 3135, 2019.

[2] S. Ndiung and M. Jediut, "Pengembangan Instrumen Tes Hasil Belajar Matematika Peserta Didik Sekolah dasar Berorientasi Pada Berpikir Tingkat Tinggi," Pendidikan dasar dan Pembelajaran, vol. 101, no. 1, p. 94, 2020.

[3] K. P. d. Kebudayaan, "kemendikbud.go.id," Biro Komunikasi dan Layanan Masyarakat Kementerian Pendidikan dan Kebudayaan, 11 Desember 2019. [Online]. Available: kemendikbud.go.id/main/blog/2019/12/mendikbud-tetapkan-empat-pokok-kebijakan-pendidikan-merdeka-belaja. [Accessed 28 Juni 2020].

[4] D. Hutabarat, "https://m.merdeka.com," merdeka, 12 Desember 2019. [Online]. Available: http://m.merdeka.com/peristiwa/ini-contoh-soal-assesmen-pengganti-un-menurut-nadiem-makarim.html. [Accessed 28 Juni 2020].

[5] D. F. Setiawan, "Prosedur Evaluasi Dalam Pembelajaran," in Prosedur Evaluasi Dalam Pembelajaran, Slemana, Deepublish, 2018, p. 183.

[6] Sarkadi, "Tahapan Penilaian Pembelajaran Berdasarkan Kurikulum 2013," in Tahapan Penilaian Pembelajaran Berdasarkan Kurikulum 2013, Surabaya, Jakad Media Publishing, 2020, p. 3.

[7] I. Emaliana, P. A. Tyas, S. K. Khotimah and G. E. N. Widyaningsih, "Evaluasi Pembelajaran Bahasa Asing Pada Pendidikan Tinggi," in Evaluasi Pembelajaran Bahasa Asing Pada Pendidikan Tinggi, Malang, UB Press, 2019, p. 18.

[8] I. Sriyanti, "Evaluasi Pembelajaran Matematika," in Evaluasi Pembelajaran Matematika, Ponorogo, Uwais Inspirasi Indonesia, 2019, p. 26.

[9] A. P. Rukmana, T. Mayasari and A. C. Yusro, "Pengembangan Four Tier Diagnostic Test Untuk Mendeteksi Miskonsepsi Pada Fisika SMA," Seminar Nasional Pendidikan Fisika V, p. 2, 2019.

[10] I. Fatmawati, J. Handhika and E. Kurnadi, "Pengaruh Penerapan Modul Fisika Berbasis Setrada (Seni Tari Dan Drama) Untuk Meningkatkan Kemampuan Berpikir Tingkat Tinggi Siswa SMK," Seminar Nasional Pendidikan Fisika V, vol. 1, p. 2, 2019.

[11] F. N. Sholihat, A. Samsudin and M. G. Nugraha, "Identifikasi Miskonsepsi dan Penyebab Miskonsepsi Siswa Menggunakan Four Tier Diagnostik Test Pada Sub-Materi Fluida Dinamik: Azaz Kontinuitas," Penelitian dan Pengembangan Pendidikan, vol. 3, no. 2, pp. 175-180, 2017.

[12] N. Liana, W. Suana, F. Sesunan and Abdurrahman, "Pengembangan Soal Tes Berpikir Tingkat Tinggi Materi Fluida Untuk SMA," Komodo Science Education, vol. 01, no. 01, p. 68, 2018.

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

# Application of Learning Model Search, Solve, Create, Share and (SSCS) with Brain Quiz Game Learning Towards Creative Thinking Skills Student of Physics

**Nyai Suminten[1]**

[1]Physics Education Study Program, Prof. Muhammadiyah University. DR. Hamka
Tanah Merdeka Street, Kp.Rambutan, Pasar Rebo, East Jakarta, 13830, Indonesia

*Correspondence email: nyaisuminten87@gmail.com

## ABSTRACT

The purpose of this research is to obtain a description of the application from learning model the Search, Solve, Create, and Share (SSCS) with game Brain Quiz learning on the creative thinking skills of high school students of physics in the impulse momentum material. The research method used was a quasi-experimental design of the "pretest-posttest control group design" which was carried out in class X at one of the high schools in East Jakarta for 2019/2020 Academic Year. Data collection is done by using the pretest and posttest for students' creative thinking skills. Based on the results of data analysis, the average N-gain of creative thinking skills of students is 0.84 and the standard deviation is 0.07, with 92% in the high category. So it can be concluded that the application of learning model Search, Solve, Create, and Share (SSCS) with game Brain Quiz learning can significantly improve students' creative thinking skills.

**Keywords:** SSCS learning model, brand quiz game learning, creative thinking skills.

## INTRODUCTION

Physics is a part of science whose scope is related to natural phenomena experienced by humans. In general, physics is a forerunner to technological advances that develop in the era of globalization like today. It is undeniable that the current technological development is very rapid, technological development is also penetrated in the field of education in order to support and improve the quality of education that leads to modern education.

But in reality, there is still very little use of digital and cellular technology in the field of education, especially in the physics learning process in the classroom. Physics learning is still considered to be stiff and monotonous, learning is still considered to be conventional. This is certainly a problem in the learning process that affects the internal and external motivation of students in learning, so that it can linearly lead to underdevelopment of students' creative thinking skills. Therefore, there needs to be innovation in the physics learning process that supports the growth of students' creative thinking skills, one of which is the use of technology-based learning media. The use of technology-based learning media is in line with the Regulation of the Minister of Education and Culture of the Republic of Indonesia No.68 of 2014, which states that educators are required to be able to realize the learning situation that supports the potential of students, it is necessary to have support through the use of information and communication technology that can explore resources learn effectively and efficiently by maximizing the role of technology and communication and computer skills [1]. Responding to this, it is necessary to have innovation in learning media especially by utilizing technological advancements to support ideal learning.

In the process of learning physics using technology, one of them can use physics learning media based on Android with a brain quiz game. This learning media combines the concept of the game with the concept of learning that is designed according to the needs of students and responds to various student complaints about the difficulty of understanding abstract physics material. The incorporation of these concepts becomes very important in the process of learning physics because it is an attraction and learning motivation that can affect the development of students' creative thinking skills in solving problems in the form of games, especially in the material of momentum and impulses. Anwar et al think creatively is a new way of seeing and doing something that includes 4 aspects including, fluency (fluency), flexybility (originality), originality (authenticity), and elaboration (detail) [2]. One learning model that can develop students' creative thinking skills is the Search, Solve, Create and Share (SSCS)

learning model. The Search, Solve, Create and Share (SSCS) learning model refers to the four steps of problem solving, namely the search (investigate), solve (plan solving), create (construct solving), and share (communicate) phases [3]. The Solve stage can be linked to problem solving by completing games at each level in the use of physics media learning quiz brands, while create serves to develop students' creative thinking skills according to indicators of creative thinking skills.

## THEORY OF STUDY

### *Creative Thinking Skills*

The creative thinking skills to think creatively is an skill that should be possessed by every student. Creative thinking, is a mental process by focusing on the search for many ideas, the emergence of various abilities and many correct answers to a problem. According to Lawson [5] creative thinking is interpreted as a creative process, namely feeling the difficulties, problems, information gaps, missing elements, and disharmony, defining the problem clearly, making guesses or formulating hypotheses about deficiencies, testing these allegations and the possibility of improvement, retesting or even redefining the problem, and finally communicating the results [4]. To measure creative thinking skills, it can be used to test creative thinking skills that contain six indicators, namely: asking questions, guessing causes, guessing the effects of an event, improving the outputs, expressing the usefulness of objects and predicting. The aspects of creative thinking skills according to Hendra are as follows:

1. Fluency
   - The skills to generate many ideas / answers
   - The skills to have broad ideas

2. Details (elaboration)
   - The skills to detail certain details

3. Flexibility
   - The skills to produce ideas, answers or questions from different points of view
   - The skills to give a different direction of thinking

4. Originality (originality)
   - Many variations on the skills to give unusual answers, other than others that are rarely given
   - Many variations of ability give different directions of thinking [5].

### *Search, Solve, Create and Share (SSCS) Learning Models.*

The stages of the SSCS learning model consist of search (students ask inquiry questions about topics they like to investigate), the Solve stage (students create designs for designs that will be used in inquiry to find answers to their inquiry questions, the create phase (students determine ways to be used to communicate their findings, the share stage (students share or provide results and evaluation of the investigation conducted by Pizzini [6].

### *Brain Quiz Game Learning*

Brain quiz is a physics learning media in the form of a game in which there is physics material, in this study physics material is related to impulse momentum. This brain quiz can be accessed via an android device. Benny A. Pribadi explained that in conducting the learning process using the game method, students need to follow certain rules to achieve goals that are competitive or competent and challenging [7].

## RESEARCH METHOD

The method used in this research is the experimental method. "According to Campbell and Stanley. Experimental research is a form of research in which variables are manipulated so that it can be ascertained the influence and effect of these variables on other variables investigated or observable. So based on the opinion of experimental research experts is a research conducted by manipulating so that the resulting effect is minimal. Pre-Experimental Designs with One-Group Pretest-Posttest Designs. The design of this study consisted of only one group (there was no control group), while the research process

was carried out in three stages, namely: (1) conducting a pretest to measure the initial conditions of the respondent before being given treatment, (2) giving X treatment, (3 ) do a post-test to determine the state of the dependent variable after being given treatment. The design of this study can be seen in the table below:

Table 1. Research Design

| **O1** | **X** | **O2** |
|---|---|---|
| ***Pretest*** | **treatment** | ***Posttest*** |

Information:
X: The treatment given using the SSCS Learning Model with media assisted with brain quiz games.
O1: Pretest value (before treatment)
O2: Prosttest value (after treatment)
Source: Sugiono [8].

## RESULTS AND DISCUSSION

The indicators of creative thinking skills developed in this study consisted of five indicators, namely: (1) asking questions, (2) guessing causes, (3) guessing effects, (4) improving outputs, and (5) predicting. The indicator details are as follows:

1. Ask. Students are asked to develop as many questions as possible about things that occur in the picture given impulse momentum material about collisions or vehicle crashes;
2. Guess the causes. Students are asked to guess the sources of the cause of an event, especially in the material impulse momentum about collisions or vehicle crashes;
3. Guess the consequences of an event. Students are asked to predict the consequences that will occur caused by an event, especially in the material momentum impulse about collisions or vehicle crashes;
4. Improve the output. Students are asked to reveal the best and extraordinary ways to improve the information provided to be more precise and easily understood information;
5. Forecasting. Students are asked to write down other things that will also occur as a result of the occurrence of material events of impulse momentum about collisions or vehicle crashes;

The five indicators are outlined in a learning media in the form of a brain quiz game that can stimulate and challenge students in completing each level of the game related to physics impulse momentum learning material. In addition, the application of the SSCS learning model has an important role in practicing this creative thinking skills.

Improving students' creative thinking skills with the application of the Search, Solve, Create and Share (SSCS) learning model with the media brain quiz on the impulse momentum material is explored based on the pretest answers before learning and posttest after learning. The results of the assessment of creative thinking skills in the form of scores are then calculated on average. The average value of pretest, posttest and N-gain creative thinking skills can be seen in Figure 1 below:

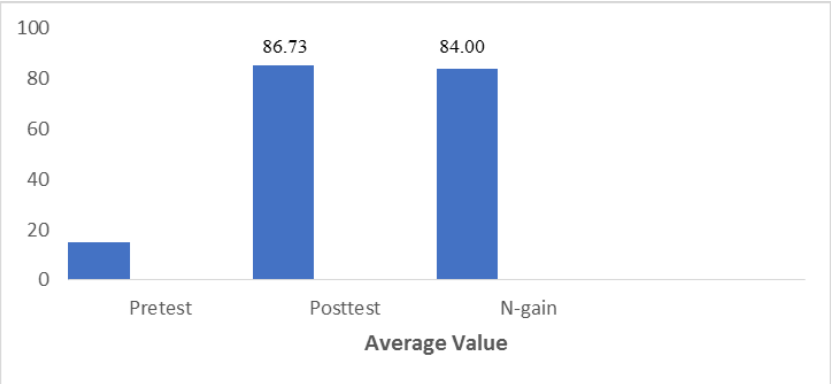


Figure 1. Average pretest, posttest and N-gain creative thinking skills

The picture above shows that prior to the holding of the SSCS model using the media brain quiz, the average score of students' creative thinking pretest was 15.19, while for the posttest value was 86.73 and the average value of N-gain was 84.00 with 92% in the category high, with a standard deviation of 0.07. This shows that the application of the Search, Solve, Create and Share (SSCS) learning model with brain quiz media can improve students' creative thinking skills.

While the acquisition of N-gain on each indicator of students' creative thinking skills is shown in Figure 2 below.

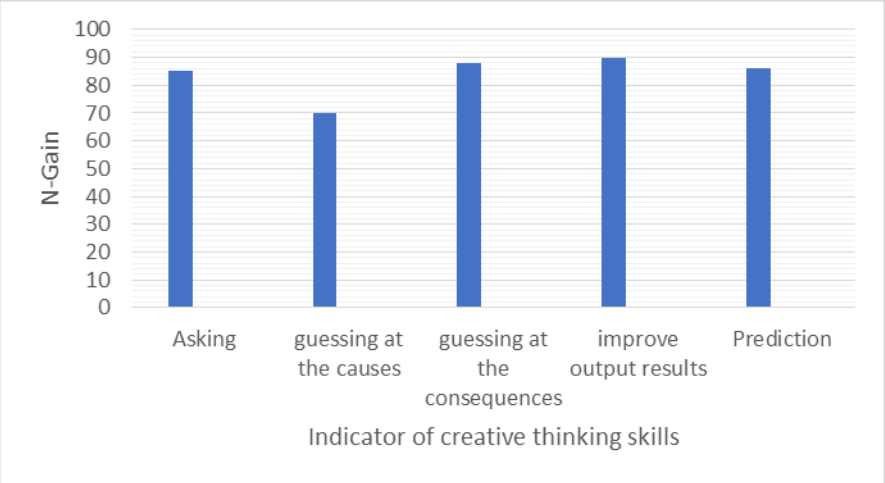



Figure 2. Acquisition of N-gain creative thinking skills for each indicator

Based on Figure 2, it can be seen that the highest N-gain acquisition occurs in the indicator of improving the output which is 90.0 with the high category and the lowest occurs in the guessing indicator of causes of 70.0 with the medium category.

Exposure to impulse momentum material by applying the SSCS learning model using physics learning media in the form of brain quiz is described sequentially equipped with simulations and game animations of several levels, sample questions, exercises, and evaluations at each meeting proven to be able to improve students' ability to ask, guess the causes, guessing the effects and improving the output of impulse momentum material.

Creative thinking skills are among the higher order thinking skills. According to [10] Creative thinking skills mean thinking effort by using various mental operations namely fluency, flexibility, authenticity and decomposition of ideas to produce something original, new and valuable [9]. Creative thinking skills need to be developed in students because through creative thinking skills students are able to solve one problem with different solutions.

Based on the results obtained it can be concluded that the increase in the creative thinking skills of the impulse momentum of students who take part in learning using the SSCS learning model with brai quiz media significantly increases compared to before the learning process.

## CONCLUSIONS

Based on the results of the study it can be concluded that the students' creative thinking skills on the subject of significant impulse momentum have increased with the application of the SSCS learning model using the media of physics learning brain game quiz.

## REFERENCES

[1] Kemendikbud, Permendikbud RI Nomor 68 Tahun 2014 Tentang Peran Guru Teknologi Informasi dan Komunikasi dan Guru Keterampilan Komputer dan Pengelolaan Informasi dalam Implementasi Kurikulum 2013. 2014, pp. 1–6.

[2] Anwar, N. M. et al., A Comparison of Creative Thinking Abilities of High and Low Achievers Secondary School Students. International Interdiciplinary Journal of Education, Vol. 1, No. 1, pp. 1-6, 2012.
[3] Mustofa, Zainul et.al. Pengaruh Model Pembelajaran SSCS (Search, Solve, Create, and Share) dengan Strategi Mind Mapping terhadap Penguasaan Konsep Fisika Pokok Bahasan Teori Kinetik Gas Siswa, Seminar Nasional Fisika Dan Pembelajarannya, pp. 35-41, 2015
[4] Penguasaan Konsep Fisika Pokok Bahasan Teori Kinetik Gas Siswa.Online. Jurnal Pembelajaran Fisika, Vol. 7 No. 4, Desember 2018, pp. 334-340
[5] Lawson, A.E. Science Education Information Report, 1980 AETS Yearbook The Psychology of Teaching for Thinking and Creativity. Ohio: Clearinghouse. 1979
[6] Hendra Erik Rudyanto, Model Discovery Learning dengan Pendekatan Saintifik Bermuatan karakter untuk Meningkatkan Kemampuan Berpikir Kreatif. Online. Tersedia di http://acadiau. ca. pdf [diakses 20-01- 2020].
[7] Pizzini, Edward L. et.al. Rethinking Thinking In the Science Classroom. The Science Teacher: 22-25. 1988. Online. Tersedia di http://acadiau. ca. pdf [diakses 20-01- 2020].
[8] Pribadi, Desain dan Pengembangan Program Pelatihan Berbasis Kompetensi Implementasi Model ADDIE. Jakarta: Prenada Media Group, 2014.
[9] Sugiyono, Metode Penelitian Pendidikan Pendekatan Kuantitatif, Kualitatif, dan R&D. Bandung: Alfabeta, 2015.
[10] Juremi, S. dan Ayob, A. Menentukan Kesahan Alat Ukur-Alat Ukur Kemahiran Berfikir Kritis, Kemahiran Berfikir Kreatif, Kemahiran Proses Sains, dan Pencapaian Biologi 2000. [Online]. Tersedia: http://www.geocities.com/drwanrani/Sabaria_Juremi.html.

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

# Mathematical Gesture of the Blind Students in the Calculate Operation of the Buner Learning Theory

**Tifany Dita Saskia[1*], Wahidin[1]**

[1]Faculty of teacher Training and education, University of Muhammadiyah Prof. Dr. Hamka (UHAMKA), tanah merdeka street, Kec. Pasar Rebo, East Jakarta, 13830, DKI Jakarta, Indonesia

*Corespondence author: tifanyditasaskia@gmail.com

## ABSTRACT

Gesture is very closely related in everyday life, especially in the field of education. This study was applied to a blind person who is in blind type by applying Bruner's theory of learning in a counting operation. Based on this study, the gesture that emerged during the application of Buner learning theory was 85 times. It consists of 43 iconic gestures, 22 metaphoric gestures, and 20 times of an all-time gestures. With the percentage of iconic gesture emergence of 50.5%; Metaphorical gesture of 25.9%; and an in-23.6% gesture. At the imposition of the Buner's theory of learning can be the dominant kinaesthetic intellect among them storytelling, storytelling, singing, and Murotal.

**Keywords:** gesture, blind students, Bruner's theory of learning.

## INTRODUCTION

Vision impairment is another term used for people who are visually impaired. Vision impairment or often known as visual impairment is abnormal vision conditions or disorders [1]. Blind children are one of the categories of children with special needs that have sensory impairment in vision function [2].

The state of vision disorder is a condition when one cannot see a hand movement at a distance of less than one metre, the vision sharpness of 20/200 feet is the sharpness capable of seeing an object at a distance of 20 feet, and the field of management is not wider than 20° [1]. Imperfect vision conditions are based on several things such as heredity, due to accidents and others. This condition limits the daily activities for people with visual impairment.

For children in the compulsory period of study, they have a high sense of curiosity, so variety of deeds and words must be delivered in a way that is good and true. This should be done so that children with visual impairment are able to interact normally with everyone they meet. [3] explains that blind children lose time of study in their lives, those with vision limitations are not easy to have an interactions with their environment, having difficulties in finding their toys and friends, and had difficulty imitating his parents in everyday life. A blind who see themselves negatively will have a bad influence on their self-esteem [4].

The surrounding people can influence the student's mindset and mental during the life of society later. Support can be provided by inviting students with special needs with positive-minded, convincing that he has the ability, showing the special talents they have, also by doing a flexible approach [1].

Everyone has their own characteristics in solving mathematical problems both orally and in writing. In students with disabilities such as children with special needs, they are usually harder to express their grievances directly. Therefore, everyone around him should be mindful of every movement and behavior he does. In addition to delivering their inconveniences to one thing orally, they unknowingly convey them through his body language. Body language is a means of "listening" to one's emotions and feelings [5]. Emotions are reactions to a person or to certain events. So it can be said that gesture is the most honest thing inherent to every human being [5]. In fact, when students talk about the concept of what they learn, they often reveal it in body movements first before they reveal it orally and sistematically [6].

Body language naturally has several types of messages, and by understanding the messages contained therein, we can reveal certain intentions that could not be conveyed by words [5]. Paul Ekman also said that one's emotional leakage could be revealed through a Non-verbal message (body language) [5].

Supporting the use of cues increases the learning opportunity of the word that the child can access, empowering toddlers to seek information about the world around them [7].
Explained that McNeil presented four main categories of gesture, namely: [6]

- Gesture Pointing (deictic) is a movement that serves to show the object or location, often with the index finger or with another finger or the entire hand. For example, pointing to the cube as an expression refers to that cube);
- Iconic gestures are movements that are echoing the semantic content directly through the shape or trajectory of the hand. For example, a hand movement depicting a triangle in the air as a triangular expression;
- Gesture Metaphis is a picture of semantic content through metaphors;
- And Gesture beat is a simple gesture, rhythmic movement that does not reveal semantic content.

However, in this study, researchers focused on research on three types of gesture, namely iconic gestures, metaphoric gestures and an exposed gesture. Gesture is very helpful for others to understand the implied intent of body movements that are done spontaneously by the interlocutor. Gestures are often used as evidence that the body is involved in thinking and talking about ideas expressed through body movements [6]. Iconicity is usually exploited in the resulting movements by hearing non-signers and in many cases these movements can be aligned in shape with the iconic features depicted in the sign [8].

More in the field of education where a teacher must understand the gestures and characteristics of each student. This applies to every time the learning process is done especially on math learning. Mathematics subjects need to be given to all students ranging from elementary school to equip students with logical, analytical, systematic, critical, and creative thinking skills, as well as ability to cooperate [9]. Mathematics with life is something that cannot be separated. Math learning needs to be specially designed, so that mathematics is not the dreaded subject, but instead mathematics becomes a lesson of interest by students who can eventually increase students ' confidence in mathematics [10]. Visually impaired people have a sense of tasting, smell, taste, listeners as a tool that serves to collect various information around. So, the visual disability should be able to use other senses that still function so that the delivered information is easier to understand.

The expression and appreciation of students in solving mathematical problems will help teachers to understand whether the type of problem given is difficult by students, including to identify appropriate and accurate evaluation methods for measuring Mathematical knowledge, as well as to design a more effective learning environment [6]. Without gestures, according to this hypothesis, the brain circuitry needed for language can’t be in the way they seem to have [11].

Educations have an important roles for person with disabilitie’s knowledge. In addition, education has a dynamic influence in preparing human life in the future. Education [3]. The classic problem that often occurs in the mathematical learning process is the difficulty of the child in understanding mathematical problems. The unfamiliarity of basic mathematical concepts has become one of the main factors of the students who have difficulty in understanding math lessons. Based on the problems above related to the limitations of students who are visually impaired and learning process, Bruner theory is considered as the right solution to provide understanding of the learning of counting operations Mathematics in visual impairment. The Bruner theory of learning is considered appropriate because in Bruner's theories there are not boring stages of learning, so students stay excited in mathematics learning activities. Bruner's theory of learning can inspire motivation and make students more active in learning [12]. In the application of Bruner's theory teachers only play a role as the creator of learning situations and design learning scenarios so that students are active and independent in reaching the concept of subject matter [13] according to [14], based on the explanation Spelled out by As for the stages in Bruner's theory as follows: 1) the enactive phase; At this stage of knowledge.

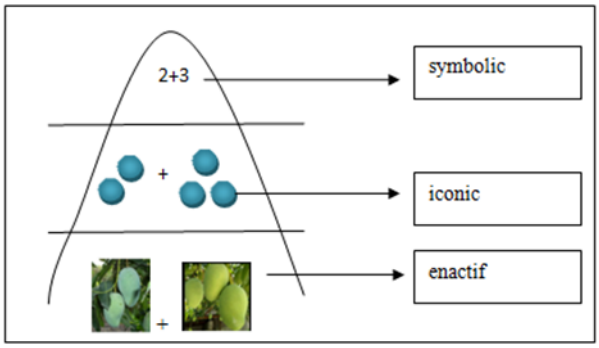



Figure 1. Chart of Bruner's theory of learning

## RESEARCH METHOD

This research was conducted in SKh Yenaiz with the subject of a visually impaired HK. Researchers act as the main instruments in this research, as they range from the design of the circuit, the data processing, to the research results done by the researchers themselves. This research is a qualitative study with a case study research method.

The Data that can be from the research process is the conversation text of the interview. Researchers use several tools that can strengthen the research results, such as tape recorder, camera phone and observation results. In the data analysis technique, researchers use the ATLAS. TI qualitative data application as an application to simplify the data analysis process.

## RESULTS AND DISCUSSION

Because the subjects studied were patients with visual impairment belonging to the category of total blind, then this research is done by the method of interview, observation and documentation conducted to complete the information about the gesture Mathematical students who occur when given mathematical stimuli based on Bruner's theory of learning. In this study, students more often use gestures in the learning theory of Bruner active stage. This may be due to the limitations of the blind child only in the sensing field, but the sense of hearing and the perception can be utilized to understand the concept of the integer count.

Tabel 1. Mathematical Gesture Observation Table of the blind students in calculating operations based on Bruner's theory of study

| Bruner's Theory / Gesture | Enaktif | Iconics | Symbolics | Score | % (100%) |
|---|---|---|---|---|---|
| **Iconics** | 22 | 13 | 8 | 43 | 51,1% |
| **Metaforics** | 12 | 3 | 6 | 21 | 25% |
| **Deictics** | 3 | 14 | 3 | 20 | 23,8% |

### Mathematical Gesture of blind students based on Bruner phase Enaktif learning theory

In the application of the theory of active-stage Bruner learning, researchers use a pen as a concrete object that students often encountered. In its implementation, researchers are helping students to show a group of pens that will be used as concrete objects in the counting operation. Based on the ability of the new students to know the counting stage from the number one to fifty five, the researcher gives the calculated operation applied is the totalizing calculate operation and reduction as the basic calculated operations that need Known by the students. Because at the beginning of the calculation students make an mistaken calculate, then the researcher helps the student to hold the stationery that will be calculated. Based on [10] the student who first made a mathematical mistake, after getting the help of his friend who used the gesture was able to solve the problem and correct the correct answer. When making

mistakes in calculations, students direct the ear to the sound source that BA students do is one manifestation of the sensory use [15]. In the application of Bruner learning theory in calculating operations against visually impaired students, there are some gestures or spontaneous movements that are quickly performed by students including:

**Iconic Gesture**

In iconic spikes, attitudes and speeches usually present the same or part of the same thing [16]. Students pick up stationery that has been in the move from the left hand to the right hand while saying the number "five". In this case, the student gives a cue that the stationery he is given is a number five. Students do the same for the other stages of calculation he does. In this stage, students perform the iconic gestures 22 times.

Figure 2. Students pick up stationery that has been in the move from the left hand to the right hand while saying the number "five".

Students pick up stationery that has been in the move from the left hand to the right hand while saying the number "five".

**Metaphoric Gesture**

The metaphoric Gesture that happens was when students are asked to calculate the number of stationery on the table. Researchers put seven stationery on the table, then students were asked to calculate the number of stationery on the table. The Gesture performed is when the student raises one by one the stationery that is on the table according to the calculations they does. The Gesture that happens is seven times. Another Gesture occurred at the time the researcher asked 2 + 3 questions, the student was assisted to hold 2 pieces of the left hand pencil and three pencils in the right hands. Then the students unite all the stationery that is in the right hand and his left hand and begin to do the calculations. The Gesture that occurs during the study is when the student moves the stationery from the left hand to the right or vice versa according to the phases of calculation. In this question, students do a metaphorical gesture that is as much as five times. Based on the observation that has been done recorded that the students perform metaphoric gesture of 12 movements.

Figure 3. The Gesture performed is when the student raises one by one the stationery that is on the table according to the calculations it does.

**Diectics Gesture**

Gesture in. In this gesture students do how many movements such as pointing. This pointing movement is done with the fingers of the hand. However, at this stage, students are more often used to perform a gesture using their index.

Figure 4. The Gesture performed is when the student raises one by one the stationery that is on the table according to the calculations it does.

Based on the observation that has been done, it is shown that the same gesture that occurred 3 times.

**Blind Student Mathematical Gestures Based on Iconic Bruner Stage Learning Theory**

On the implementation of the iconic Bruner learning theory, researchers use abacus as props that students will use during the study. In its implementation, researchers are helping students to demonstrate the line of pens that will be used as concrete objects in the counting operation. Based on the ability of the new students to know the counting stage from the number one to fifty, the researcher gives the calculated operation applied is the totalizing counting operation and reduction as the basic calculated operations that need to be known by the students.

In the application of Bruner learning theory in calculating operations against visually impaired students, there are some gestures or spontaneous movements that are quickly performed by students including: Iconics Gesture

In the application of an iconic stage Bruner learning theory, iconic gestures often appear when students are recalculating their operations according to their own points.

**(a)** **(b)** **(c)**

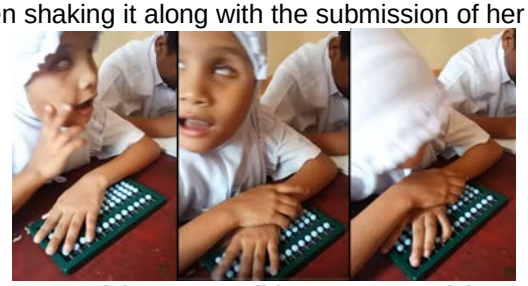
Figure 5. Iconic gestures: Students pronounce calculations that correspond to the amount of reduction on the calculation. Students: One, two, three.

Based on the observation that has been done, it appears that the iconic gesture that the student performed is 13 times.

**Metaphoric Gesture**

The gesture that occurs when research in the enaktif phase, occurs several times metaphoric gestures, such as when the researcher asks students to calculate the number using Abacus, but the students do not want to do so. When the researcher asked her why, she replied "I was ashamed " and then moved

the right hand that she would swing from above to touching her cheeks and then towards the left hand that was on the table and then shaking it along with the submission of her head.



**(a) (b) (c)**

Figure 6. Methaphoric Gesture

**(a) (b)**

Figure 7. Metaphoric gesture: The movement swinging hands until the two palms are united, then in the release again.

Based on the observation that has been done, it appears that the metaphoric gesture occurred 3 times.

**Gesture Deictics**

In the application of the Beuner learning theory at the iconic stage, diektik gesture was a gesture that often appears. Because at the application of the use of Abacus students use their fingers to point at Abacus as a sign or limitation of their calculation. Sometimes students also use their thumbs to calculate the abacus.

This Gesture is seen when students are asked to count his or her abascus at the beginning of the application of Bruner's theories in iconic stages. In this case, the student performs diektik gestures 13 times, when the student pointing their abascus one by one before he/she shifts up his abascus, plus 1 time when students explain that the student cannot calculate the next item. At this stage the student performs 14 times the in-time gesture.

Figure 8. On-the-gesture: gestures point to the details of abacus such as the calculations.

Based on the observation that has been done was recorded that the students did andiektik gesture in 14 times movement.

**Mathematical Gesture of Blind Students Base on Burner's Learning Theory Symbolic Stages**

Based on the limitations possessed by the subjects studied, on the application of the theory of learning this symbolic stage Bruner researchers conducted the observation by stimulating the students to do

stories related to mathematics. In this case researchers do the research by asking students to sing the song "Balonku".

At this stage, students feel more comfortable with the communication built between the researchers and the students concerned. This is evident when in the midst of an enthusiastic student study to tell a creepy story that he knows. Researchers also listened to the story.

Researchers concluded that the application of Bruner learning theory to blind students, teachers can stimulate the dominant knowledge of the students in question. Based on the research that has been done, here is the result of the gesture occurring from the process.

**Iconics Gesture**

The iconic gesture that took place on the application of Bruner's theory of learning at the symbolic stage was seen in some very fast-paced gestures, including when the student sang a song called "Balonku". The student lifts the five right fingers while singing the appropriate lyrics.

**(a) (b) (c)**

Figure 9. Hand gestures stretch the five fingers while saying the lyrics "Balonku there five".

Another Gesture is seen when given a question about the number of people who are at home. Students appoint one of his fingers to show that only one person was in his home. Based on the observation that has been done, it appears that the same gesture that occurred 8 times.

**Metaphoric Gesture**

A metaphoric Gesture at the symbolic stage occurs when a student moves his or her abascus towards the table while stringing a tone from a few taps resulting from his abhortic that touches the table.

**(a) (b)**

Figure 10. Movement swinging abacus towards the table. The next gesture occurred when the student made a shaking motion shake his abascus in the air when the song was finished.

Figure 11. Abacus ' Swinging movement when finished singing the song "Balonku".

Next this gesture occurs when students explain who the name of the person who lives in his house while swinging his hand on the table. Based on the observation that has been done, it is seen that the metaphorical gesture occurred 6 times.

**Gesture Diektik**

In the application of a symbolic phase of Bruner learning theory, there are three times of an applied gesture. That is when students count the number of people in his house when the researcher asks "How many people are at home?"

At the conclusion of this study, precisely on the application of the symbolic stage of Bruner learning theory, students look more comfortable to interact with researchers. It is evidenced by the emergence of some compound intelligence, critical questions and critical attitudes of students. This is evidenced by the results of analysis that shows some facts from the interview results.

| Name | Grounded | Density |
|---|---|---|
| enaktif | 10 | |
| gesture diektik | 20 | |
| gesture ikonik | 43 | |
| gesture metaforik | 21 | |
| kecerdasan lain yang dominan | 10 | |
| kritis | 47 | |
| operasi hitung | 36 | |
| pertanyaan kritis siswa | 15 | |
| proses berhitung | 9 | |
| TB Bruer simbolik | 18 | |
| TB Bruner ikonik | 6 | |

Figure 12. Data analysis results using ATLAS. TI application some of the dominant intelligences of visual impairment students are singing, murotal, and storytelling.

**CONCLUSIONS**

Based on this study, the gesture that emerged during the application of Bune learning theory was 84 times. It consists of 43 iconic gestures, 21 metaphoric gestures, and 20 times of an exposed gesture. With the percentage of iconic gesture emergence of 51.9%; Metaphorical gesture of 25%; and an in-23.6% gesture.

Based on the results of the study above, researchers concluded that the application of Bruner learning theory in blind students is quite capable of making students more relaxed in learning. The stage of Bruner learning theory is capable of creating compound intelligence, critical questions and critical attitudes of students delivered directly by students. This may be due to the lack of blind children only to

the sense of vision, but the sense of hearing and neglect can be utilized to understand the concept of the integer count [17].

## REFERENCES

[1] Manastas, L. *Strategi Mengajar Siswa Tunanetra*. Yogyakarta: Imperium. 2014.

[2] Me, P. K. *Low vision*. 2017.

[3] Kurniawan, I. Implementasi Pendidikan Bagi Siswa Tunanetra Di Sekolah Dasar Inklusi. *Edukasi Islami Jurnal Pendidikan Islam*, Vol. 04, pp. 1044–1060. 2015. Retrieved from http://staiabogor.ac.id/wp-content/uploads/2016/05/5-V-04-N-08-JULI-2016.pdf

[4] Audit, P. S. Peran Dukungan Sosial terhadap Pembentukan Self Esteem yang Tinggi pada Remaja Tunanetra di Sekolah Khusus. *Kesehatan Lingkungan*, Vol. 5 , pp. 139–155. 2008

[5] Antonius, D. *Gesture the secret of body lenguage and facial expression*. Jakarta: PsikologID. 2019.

[6] Fadiana, M. Peran Gesture dalam Pembelajaran Matematika. *Prosiding Seminar Nasional Masif II*, pp. 44–49. 2016.

[7] Romano, M. K., & Windsor, K. S. Increasing deictic gesture use to support the language development of toddlers from high poverty backgrounds. *Early Childhood Research Quarterly*, Vol. 50, pp. 129–139. 2020. https://doi.org/10.1016/j.ecresq.2018.12.004

[8] Ortega, G., Schiefner, A., & Özyürek, A. Hearing non-signers use their gestures to predict iconic form-meaning mappings at first exposure to signs. *Cognition*, Vol. 191, Series 103996, Juni 2019 https://doi.org/10.1016/j.cognition.2019.06.008

[9] Yusri, Y., & Arifin, S. Desain Pembelajaran Kooperatif Berbasis Teori Bruner Untuk Meningkatkan Kualitas Pembelajaran Matematika. HISTOGRAM: Jurnal Pendidikan Matematika, vol. 2, no. 2, p. 147. 2018 https://doi.org/10.31100/histogram.v2i2.233

[10] Hardianto, Subanji, & Rahardjo, S. Analisis Penggunaan Gesture Untuk Siswa Dalam Proses Diskusi. *Pedagogy*, Vol. 1 (2000), pp. 36–47, 2016.

[11] McNeill, D. Gesture and Thought. Gesture and Thought, (January 2005). 2013. https://doi.org/10.7208/chicago/9780226514642.001.0001

[12] Putra, A. N. P., Tampubolon, B., & Rosnita. Pengaruh Penerapan Teori Bruner terhadap Hasil Belajar Matematika Kelas III Sekolah Dasar. Pendidikan, 2016, pp. 1–9.

[13] Bruno, L. Penerapan Teori Bruner dan Peta Konsep dalam Meningkatkan Penalaran dan Pemahaman Konsep Matematika. *Journal of Chemical Information and Modeling,* Vol. 53, No. 9, pp. 1689–1699, 2019, https://doi.org/10.1017/CBO9781107415324.004.

[14] Lestari, D. Penerapan Teori Bruner Untuk Meningkatkan Hasil Belajar Siswa Pada Pembelajaran Simetri Lipat di Kelas IV SDN 02 Makmur Jaya Kabupaten Mamuju Utara. *Jurnal Kreatif Tadulako,* Vol. 3, No. 2, pp. 129–141. 2013. Retrieved from https://media.neliti.com/media/publications/121377-ID-penerapan-teori-bruner-untuk-meningkatka.pdf

[15] Rachmaningtyas, N. A. & S. Profil Cara Belajar Matematika Anak Berkebutuhan Khusus (ABK) Tunanetra dalam Pembelajaran Matematika Kelas X di SMA Negeri 1 Bambanglipuro Kabupaten Bantul. *Prosiding Sendika*. 2018.

[16] Bowcher, W. L., & Zhang, Z. Pointing at words: Gestures, language and pedagogy in elementary literacy classrooms in China. *Linguistics and Education*, Vol. 55, series 100779. 2020. https://doi.org/10.1016/j.linged.2019.100779

[17] Heflina. Meningkatkan Kemampuan Operasi Hitung Bilangan Bulat Melalui Media Manik-Manik Bagi Anak Tunanetra Kelas D-4 Slb Tunanetra Payakumbuh. *E-Jupekhu*. Vol. 4, pp. 28–39. 2015.

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

# The Influence of Reciprocal Teaching Learning Models to Mathematics Learning Outcomes of Grade Vii Students' Junior High School 89 Jakarta

**Devi Julianti[1]**

[1]Departement of Mathematics Education, Faculty of Teacher Training and Education, Muhammadiyah Prof. Dr. Hamka University
Tanah Merdeka Street, Kp.Rambutan, Pasar Rebo, East Jakarta, 13830, Indonesia

Correspondence email: devi.julianti40@gmail.com

## ABSTRACT

"The Influence of Reciprocal Teaching Learning Models to Mathematics Learning Outcomes of Grade VII Students' Junior High School 89 Jakarta". Essay. Jakarta: Departement of Mathematics Education in the Faculty of Teacher Training and Education, Muhammadiyah Prof. Dr. HAMKA University, 2020. This study aims to determine the effect of mathematics learning outcomes by using the Reciprocal Teaching learning model on class VII SMPN 89 Jakarta in the first semester of the 2019/2020 academic year. This research method uses quasi experiment. The study population was 71 students. The sampling technique used is saturated sampling. In the validity test using Biseral Point Colleration as many as 10 essay questions with 6 valid questions and 4 about drop questions. While the reliability test using the KR-20 formula obtained r count = 0,491 > r table = 0,339, then the data has a reliable instrument. Furthermore, the data were analyzed by the requirements test, namely the normality test using the Liliefors Estimated Error Test obtained by Lo 0,138 < Lt 0,151, it can be concluded that the data is normally distributed. While the homogeneity test using the Fisher test obtained Fcount 1.08 < Ftable 1.77, it can be concluded that the homogeneity test has a homogeneous distribution of group variance data. In the hypothesis test used t-test obtained tcount 4,446 with ttable 1,995 at α = 0,05, then H0 is rejected which states that there is a significant influence on learning by using the Reciprocal Teaching learning model on learning outcomes mathematics seventh grade students at Junior High School 89 Jakarta.

**Keywords:** Reciprocal teaching learning models, learning outcomes, mathematics.

## INTRODUCTION

The aim of mathematics in junior high school (SMP) is an understanding of the mathematics disciplines and the work skill (project) to produce a product that will result in the mastery of one's competence as a result of learning. Therefore, mathematical learning should be oriented at activities that support the understanding of concepts, principles, procedures, in relation to the context of their daily lives outside of school, so that math learning becomes meaningful and enjoyable.

The creation of a meaningful learning experience for students is certainly not the easiest thing if many teachers are accustomed to designing learning that is just sitting, hearing, and silent. While there will be many difficulties in realizing. But there are many ways you can make learning more quality. Teachers can look for references in designing interesting and enjoyable learning by using learning models that correspond to students ' characteristics.

Based on the results of observations conducted at SMPN 89 Jakarta that students do not yet have the ability to be an indicator of understanding. One of the factors that caused it to happen is that the learning process is still one-way communication (teacher centered), teachers are not optimal using learning media. Ongoing learning has not manifested the whole student modality of learning. The method used by teachers in delivering mathematics lessons is only lectures, practice questions, questions and answers and assignments, the absence of problem-solving activities in the form of group or individual assignments, students are just sitting quietly listening to what the teacher explained, noting the material and working on the practice in their respective training books. Students also lack active participation, raising questions and Opinions.

Addressing the problems described above, it is necessary to do so in order to improve the learning outcomes of mathematics in order to achieve maximum results or at least reach minimum submission criteria (KKM). The reciprocal Teaching approach offers solutions. In the pendekatan reciprocal teaching

approach. There are four Basic Strategies involved in the learning process, i.e. the application of questions, clarifications, and predictions.
According to [1] the study of reciprocal Teaching is one of the learning models that have the benefit of learning goals achieved through self- learning activities and students are able to explain their findings to other parties. The characteristic of reciprocal teaching Learning by [2] is: 1) dialogue between students and teachers, each of which gets a turn to lead the discussion; 2) reciprocal means an interaction in which a person acts to respond to another; 3) a structured dialogue using four strategies: Merangum (summarizing allegations thereof), making questions (questioning), clarifying (clarifying unpressing),and predicting (predict predicting).

In accordance with the background and the formulation of problems as outlined, the purpose of this research is to: prove and know the influence of the learning Model of Recipocal teaching to the mathematics learning outcomes of grade VII students in SMPN 89 Jakarta.

## RESEARCH METHOD

The study was conducted in class VII SMPN 89 Jakarta, odd semester, and the school year 2019/2020. The population in this study was all students of grade VII smpn 89 Jakarta school year 2019/2020. The total of 71 Students is a class VII G amounting to 36 students, class VII H which amounted to 35 students. The sampling techniques used in this study were the saturated sampling techniques. [3] argues that I hadanother saturated sample being a census, in which all members of the population were made samples. Saturated samples are often interpreted as the maximum samples, plus nothing will change the representation. As stated by [4]. A quasi experimental Design experiment has a control group. In this study used two classes. Namely the control class And the experimental class. The Total number of students in both classes was 71. The student control class amounted to 36 students and 35 in the experimental class. The data collection technique used is a form of essay. Each keyword problem is given a maximum value of 4/5, while the wrong or unanswered question keyword is assigned a value of 0. Before the instrument is given to the sample, the validity test and reliability test were first carried out. After testing – these tests, then conducted a test of normality and homogenity which later became a requirement for hypothesis testing. To test the hypothesis used degrees of freedom at the level of significance $\alpha = 0.05$ with Tcount higher than the price of Ttable. In the sense of thank Ho if Tcount < Ttable and instead reject Ho if Tcount > ttable.

## RESULTS AND DISCUSSION

The Data obtained in this study was analyzed with descriptive statistics and inferential statistics i.e. test-T. The Data in this study is the result of students ' mathematical learning outcomes as a result of applying Reciprocal teaching learning models on experimental classes and expository learning models in the control class.

Table 4: Recapitulation of math learning results calculation

| Descriptive statistics | Experimental classes | Control class |
|---|---|---|
| Mean (M) | 59.58 | 46.17 |
| Median (Md) | 61 | 46 |
| Mode (Mo) | 4 | 57 |
| Variance | 150.85 | 162.96 |
| Standard deviation | 12.28 | 12.76 |
| Max | 86 | 71 |
| Min | 29 | 25 |

From the research data obtained the median price of learning results Mathematics students grade VII H as experimental classes at SMPN 89 Jakarta is 59,58 Median 61 mode 54 with Standart deviation 12.16 while for the average price learning results control class is 46.17 median 46 mode 32 with standard deviation 12.76. To find out if there is an impact on the average price of math learning results before and after treatment, it is necessary to do further analysis.

The hypothesis testing is done by testing the similarities and averages according to the hypotheses done then the tests conducted were test similarities of two averages two parties. To test Ho stating that there is no influence on the model of Reciprocal teaching learning to study results of the mathematics of grade VII students at SMPN 89 Jakarta , then the test-T.

From the calculation resultt count = 4,446 whereas Ttable = 1.995 at the equivalent of α = 0.05 significance. Mean Tcount > ttable = 4,446 > 1.995 states that H1 was accepted and H0 rejected, thus there was the influence of the model of reciprocal teaching Learning to the learning outcomes of grade VII Mathematics students' at SMPN 89 Jakarta.

Some of the things that can be used for the reason that the model of reciprocal teaching learning is better than the expository model, which is the learning model of reciprocal teaching always involve students. During the learning process, students are more active and motivated to follow the material being taught, because in the process teachers emphasize the students to work together and exchange opinions in completing the task given by the teacher. This is in accordance with student feedback responses during learning. So that students are trained to hone their knowledge and can build their own knowledge using the entire student's own modality.

Overall, the model of Reciprocal Teaching Learning gives students the opportunity to learn by involving the entire student's modality so that students become self-taught and dare to express opinions, discuss, apply concepts. Therefore, researchers are able to learn that a reciprocal teaching learning model can influence student learning outcomes, especially Mathematics Learning. This is evidenced by the average value matematika of Students ' mathematical learning outcomes using a higher reciprocal Teaching Learning model

## REFERENCES

[1] Suyitno, Amin et al.. *The Fundamentals and Learning of Mathematics I (Diktat).* Semarang: Department of Mathematics FMIPA, IKIP Semarang. 2001
[2] Palincsar, A. S., & Brown, A. L. *Palincsar reciprocal Teaching.* Vol. 2, pp. 117 – 175. 1984.
[3] Sugiyono*. Statistics for research*. Bandung: Alfabeta. 2017.
[4] Sugiyono*. Combination Research Method (Mixed methods).* Bandung: Alfabeta. 2014.

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

# The Effect of Reciprocal Learning Model Using Edmodo on Student Learning Outcomes

**Haseena Chika Pawinsky[1*] and Tri Isti Hartini[1]**

[1]Physics Education Study Program, Muhammadiyah University. Prof. Dr. Hamka
Tanah Merdeka Street, Kp.Rambutan, Pasar Rebo, East Jakarta, 13830, Indonesia
Correspondence email: haseenachikap24@gmail.com

## ABSTRACT

This study aims to determine the effect of student learning outcomes using reciprocal learning learning models using edmodo on student learning outcomes. The research method used is quantitative research methods with the research design One Group Pretest-Posttest Design. The sample used was purposive sampling. In the validity test using Point Biserial Correlation, there were 25 selected essay questions with 20 valid questions and 5 drop questions. While the reliability test using the KR-20 formula obtained rcount 0.9378> 0.433 rtable, then the data has a reliable instrument. Furthermore, the data were analyzed the requirements test, namely the normality test using the Liliefors test. Estimated errors were obtained $L_o = 0{,}0951 < L_t = 0{,}190$, it can be concluded that the data is normally distributed. While the homogeneity test using the Barlett test was obtained $\chi^2_{count} = 2.47 < \chi^2_{table} = 20.28$, it can be concluded that the homogeneity test has group variance data with a homogeneous distribution. In the hypothesis test, t-test was used, it was obtained $t_{count} = 10.95 > 1.68 = t_{table}$, it can be concluded that the null hypothesis $H_0$ was rejected, which stated that there was a significant effect on learning using the Reciprocal Learning learning model using Edmodo on student learning outcomes..

**Keywords:** Reciprocal Learning, Edmodo, Learning Outcomes

## INTRODUCTION

Indonesia is a country that prioritizes education for the advancement of its people. Education is a process of obtaining knowledge through relevant sources in order to educate humans. Human or someone who gets education will have high knowledge, abilities and resources. In schools, especially in physics lessons, educators have not involved students to take an active role in a series of learning activities and still use conventional methods and do not use learning media, which causes students to be passive, lazy to read, not listening to what educators say, and do not understand what the educator says. This, makes learning activities boring, educators not interested and what was conveyed by educators did not sink in the heads of students. So that students consider physics lessons to be very difficult to understand. Because physics has many different formulas in each material taught, this causes physics to be disliked and less attractive to students and affects the learning outcomes of students. According to [7] learning outcomes are abilities that children get after going through learning activities. Learning itself is a process of someone trying to obtain a relatively permanent form of behavior change. In learning activities or intural activities, teachers usually set learning goals. Students who succeed in learning are students who have succeeded in achieving learning goals or instructional goals.

The achievement of learning objectives cannot be separated from the teacher developing a learning model that involves students effectively in the learning process. The development of the learning model aims to build learning conditions that make students able to learn actively and pleasantly so that students get optimal learning outcomes. There are many learning models that can be used by teachers in teaching, one of which is the reciprocal learning model. According to [6] Reciprocal is reverse learning is a constructivist approach based on the principles of making or asking questions. Reciprocal Learning learning model itself has the aim of teaching reading comprehension independently in the classroom and students are required to summarize, ask questions, clarify and predict. In the 21st century, the uses of technology created by scientists are very diverse.

Students are very easy to find any kind of information, anytime and anywhere through the technology they have such as; Smartphones, tablets and laptops that are accessed by internet networks. Many students misunderstand technological advances that are currently developing rapidly. Many learners use their Smartphones to play games, accessing social media, and even being used as a prestigious event that is less useful in education. With the ease of accessing this information, students must be wise

in the use of advanced and developing technology. In accessing information, students usually access information through their social media, google, websites and learning or e-learning applications. E-Learning is a software used in learning. E-learning as one of the monotonous and boring learning solutions becomes interesting learning and follows technology. One of the e-learning lessons is edmodo. According to SEAMLOC inside then students must be wise in the use of technology that is currently advanced and developing. In accessing information, students usually access information through their social media, google, websites and learning or e-learning applications.

E-Learning is a software used in learning. E-learning as one of the monotonous and boring learning solutions becomes interesting learning and follows technology. One of the e-learning lessons is edmodo. According to SEAMLOC inside then students must be wise in the use of technology that is currently advanced and developing. In accessing information, students usually access information through their social media, google, websites and learning or e-learning applications. E-Learning is a software used in learning. E-learning as one of the monotonous and boring learning solutions becomes interesting learning and follows technology. One of the e-learning lessons is edmodo. According to SEAMLOC inside E-Learning is a software used in learning. E-learning as one of the monotonous and boring learning solutions becomes interesting learning and follows technology. One of the e-learning lessons is edmodo. According to SEAMLOC inside E-Learning is a software used in learning. E-learning as one of the monotonous and boring learning solutions becomes interesting learning and follows technology. One of the e-learning lessons is edmodo. According to SEAMLOC inside [3] edmodo is a social media platform that is often described as a faceook for schools and can do more as needed. Edmodo is developed based on the principles of group-based class management and social media. Edmodo is very comprehensive as a course management system like Moodle, the difference is that access is faster and easier to use by using several features that have the same function as the course management system.

## Theoretical basis

### A. Learning Media

The word media comes from Latin which is the plural form of "medium" which literally means intermediary or introduction [4]. Then in the Big Indonesian Dictionary (KBBI) the media is defined as an intermediary, a liaison, which lies between two parties (people, groups), as well as a means (means) of communication such as newspapers, magazines, radio, television, films, posters, and banners. . According to [9] said, if it is understood in broad terms, then the media are people, materials, or events that build a condition or make students able to acquire knowledge, skills, or attitudes. In this sense, teachers, textbooks, and the school environment are media. More specifically, the notion of media in the teaching and learning process tends to be defined as graphic, photographic, or electronic tools to capture, process, and reconstruct visual or verbal information. [2] implicitly saying that learning media includes tools that are physically used to convey the content of teaching material, which consists of, among others, books, tape recorders, cassettes, video cameras, video recorders, films, slides (picture frames), photos, pictures, graphics, television, and computer. In other words, media is a component of learning resources or physical vehicles that contain instructional material in the student environment that can stimulate students to learn. On the other hand, the National Education Association defines media as forms of communication, both printed and audio-visual and their equipment; thus, the media can be manipulated, seen, heard, or read. Media can also be interpreted as a tool that can be used as a messenger to achieve learning objectives. Media is something that is convincing messages and can stimulate the thoughts, feelings, and willingness of the audience or students so that it can encourage the learning process in these students. Media is an inherent or inseparable part of the learning process to achieve learning goals. Media functions and plays a role in regulating the effective relationship between teachers and students in the learning process [11].

From some of the opinions above, it can be concluded that the experts position the media as a tool that can be used as a messenger in learning activities. Emphasis on the meaning of media is something that acts as an intermediary to connect several different parties. It implies that the word linking or intermediary is the main point of this discussion, because its position in the middle indicates that there is a function to facilitate several parties which can lead to deeper integration.

### B. Reciprocal Learning Learning Model

Reciprocal Learning is learning in the form of teaching material to friends. In this learning model students act as "teachers" to deliver material to their friends. Meanwhile, the teacher plays a more role as a model who becomes a facilitator and mentor in scaffolding. Scaffolding is guidance given by people who know better to people who don't know or don't know [12]. Reciprocal Learning or Reciprocal Learning is a learning model to improve reading comprehension. Developed first, Reciprocal Learning is intended to encourage students to develop skills possessed by effective readers and learners, such as summarizing, asking, clarifying, predicting, and responding to what is being read. Students use four comprehension strategies, either in pairs or in small groups, Reciprocal Learning can be applied to learning material fiction, non-fiction, prose, or poetry [5]. According to Nur and Wikandari in [1] Reverse teaching is an approach to teaching students learning strategies. Inverted teaching is a constructivist approach based on the principles of questioning, where metacognitive skills are taught through direct teaching and modeling by teachers to improve reading performance of students with low reading comprehension. From some of the opinions of the experts above, it can be concluded that reciprocal learning is learning that focuses on reading, and trains students to understand reading texts and exchange information between students.

The RL syntax can be seen as follows: [5]

*Step 1 - Initial Demonstration*
Guide students to learn by modeling, following, and applying the effective reader strategies above during the reading process.

*Step 2 - Role Sharing*
In small groups of four students each, assign one role to each member as each member as a summariser, questioner, clarifer, and predictor.

*Step 3 - Reading and Recording*
Ask students to read a few paragraphs from the selected text. Ask them to use note-taking strategies, such as underlining, coding, and so on.

*Step 4 - Conduct the Discussion*
Students who act as predictors are tasked with helping their group connect parts of the text by presenting predictions from the previous section and also helping the group to predict what they will read next by using cues or temporary conclusions in the text. The questioner is in charge of helping the group to ask and answer questions about the text and to remind the group to use all types of questions (high level and low level). Summarisers are tasked with reaffirming the main ideas in the text in their own language. Clarifier helps groups find sections of textwho are not clear and find ways to clarify these difficulties.

*Step 5 - Role Swapping*
The roles in the group must be mutually exclusiveexchanged for one another. Different texts also need to be presented. Students repeat this process with new roles. Keep repeating this process until the selected topic / text has been studied. It can be concluded that the steps of Reciprocal Learning, namely students are developed to help teachers use collaborative dialogues to teach reading comprehension independently and can help other students in the group to find parts of the text that are not clear and find ways to clarify difficulties. -this difficulty.

### C. Edmodo

Understanding Edmodo is a personal microblogging platform developed for teachers and students, with student privacy in mind. Teachers and students can share notes, links, documents. The teacher also has the ability to send alerts, events, assignments to students and can decide to post something in the public viewable time frame [10]. Edmodo is an educational medium that uses the internet for its use. Edmodo was first developed at the end of 2008 by Nic Borg and Jeff O'hara and Edmodo itself is arguably an e-learning program that applies a learning system that is easy, efficient and more enjoyable. Edmodo was created as a social networking learning media for teachers / lecturers, students / students, and parents / guardians. According to Pitoy in [8] edmodo is a social network platform for teachers and students to share ideas, files, agendas, activities and assignments. Edmodo aims to help teachers take advantage of social networking in the learning process. Edmodo has been designed in such a way as

to make users (students) excited to learn so that the environment becomes more familiar. Inside edmodo, teacher / lecturer connects teachers / lecturers, students / students, parents / guardians, administrators and publishers / books. Edmodo uses a similar design to Facebook, and provides teachers / faculty and students / students with safe places to connect, collaborate and share content. Teachers / lecturers can also send grades, assignments and quizzes to students / students. Students can submit homework and view their grades and comments the teacher / lecturer may have posted about their assignments. The teacher / lecturer can also create opinion polls and post topics for discussion among students / students. The teacher / lecturer can differentiate and create independent learning through the creation of sub-groups in the course. After each course period is completed, the teacher / lecturer closes out the network and creates a new one for the next course students / students, parents / guardians, administrators and publishers / books.

Edmodo uses a design similar to Facebook's, and provides teachers / faculty and students / students a safe place to connect, collaborate and share content. Teachers / lecturers can also send grades, assignments and quizzes to students / students. Students can submit homework and view their grades and comments the teacher / lecturer may have posted about their assignments. The teacher / lecturer can also create opinion polls and post topics for discussion among students / students. The teacher / lecturer can differentiate and create independent learning through the creation of sub-groups in the course. After each course period is completed, the teacher / lecturer closes out the network and creates a new one for the next course students / students, parents / guardians, administrators and publishers / books. Edmodo uses a design similar to Facebook's, and provides teachers / faculty and students / students a safe place to connect, collaborate and share content. Teachers / lecturers can also send grades, assignments and quizzes to students. Students can submit homework and view their grades and comments the teacher / lecturer may have posted about their assignments. The teacher / lecturer can also create opinion polls and post topics for discussion among students / students. The teacher / lecturer can differentiate and create independent learning through the creation of sub-groups in the course. After each course period is completed, the teacher / lecturer closes out the network and creates a new one for the next course Edmodo uses a design similar to Facebook's, and provides teachers / faculty and students / students a safe place to connect, collaborate and share content. Teachers / lecturers can also send grades, assignments and quizzes to students / students. Students can submit homework and view their grades and comments the teacher / lecturer may have posted about their assignments. The teacher / lecturer can also create opinion polls and post topics for discussion among students / students. The teacher / lecturer can differentiate and create independent learning through the creation of sub-groups in the course. After each course period is completed, the teacher / lecturer closes out the network and creates a new one for the next course.

Edmodo uses a similar design to Facebook, and provides teachers / faculty and students / students with safe places to connect, collaborate and share content. Teachers / lecturers can also send grades, assignments and quizzes to students / students. Students can submit homework and view their grades and comments the teacher / lecturer may have posted about their assignments. The teacher / lecturer can also create opinion polls and post topics for discussion among students / students. The teacher / lecturer can differentiate and create independent learning through the creation of sub-groups in the course. After each course period is completed, the teacher / lecturer closes out the network and creates a new one for the next course and provide teachers / faculty and students / students a safe place to connect, collaborate and share content. Teachers / lecturers can also send grades, assignments and quizzes to students / students. Students can submit homework and view their grades and comments the teacher / lecturer may have posted about their assignments. The teacher / lecturer can also create opinion polls and post topics for discussion among students / students. The teacher / lecturer can differentiate and create independent learning through the creation of sub-groups in the course. After each course period is completed, the teacher / lecturer closes out the network and creates a new one for the next course and provide teachers / faculty and students / students a safe place to connect, collaborate and share content. Teachers / lecturers can also send grades, assignments and quizzes to students / students. Students can submit homework and view their grades and comments the teacher / lecturer may have posted about their assignments. The teacher / lecturer can also create opinion polls and post topics for discussion among students / students. The teacher / lecturer can differentiate and create independent learning through the creation of sub-groups in the course. After each course period is completed, the teacher / lecturer closes out the network and creates a new one for the next course Students can submit homework and view their grades and comments the teacher / lecturer may have posted about their assignments. The teacher / lecturer can also create opinion polls and post topics for discussion among students / students. The teacher / lecturer can differentiate and create independent

learning through the creation of sub-groups in the course. After each course period is completed, the teacher / lecturer closes out the network and creates a new one for the next course Students can submit homework and view their grades and comments the teacher / lecturer may have posted about their assignments. The teacher / lecturer can also create opinion polls and post topics for discussion among students / students. The teacher / lecturer can differentiate and create independent learning through the creation of sub-groups in the course. After each course period is completed, the teacher / lecturer closes out the network and creates a new one for the next course [10].

### D. Learning outcomes

To measure whether someone has learned or not, an indicator called learning outcomes is used. Defines learning outcomes as an act of behavior that includes cognitive, affective and psychomotor aspects. According to learning outcomes are patterns of actions, values, understandings, attitudes, appreciations, and skills. Referring to Gagne's thought, learning outcomes are in the form of the following:

1. Verbal information, namely the ability to express knowledge in the form of language, both oral and written. The ability to respond specifically to specific stimuli. This ability does not require manipulating symbols, solving problems, or applying rules.
2. Intellectual skills, namely the ability to present concepts and symbols. Intellectual skills consist of the ability to categorize, the ability to analyze, synthesize facts and concepts, and develop scientific principles. Intellectual skills are the ability to perform unique cognitive activities.
3. Cognitive strategies, namely the ability to channel and exert cognitive activity. This ability includes the use of the concept of rules in solving problems.
4. Motor skills, namely the ability to carry out a series of physical movements in matters and coordination so as to realize the automatism of physical movements.
5. Attitude is the ability to accept or reject an object based on an assessment of that object. Attitudes in the form of the ability to internalize and externalize values. Attitude is the ability to make values as standards of behavior

According to [7] learning outcomes are abilities that children get after going through learning activities. Learning itself is a process of someone trying to obtain a relatively permanent form of behavior change. In learning activities or intural activities, teachers usually set learning goals. Students who succeed in learning are students who have succeeded in achieving learning goals or instructional goals. From some of the opinions above, it can be concluded that learning outcomes are an achievement obtained by students for learning activities and evidence of student success involving cognitive, affective and psychomotor aspects conveyed in symbols, letters or sentences.

## RESEARCH METHOD

The research method used in this research is quantitative method. This research is said to be quantitative because the results of this study use a lot of numbers. The type of research used in this research is pre-experiment. This design is said to be an incomplete experiment, because there are external variables that influence the formation of the dependent variable. This is because there is no control variable, and the sample is not randomly selected. In addition, this experiment is said to be not serious because researchers still think that the abilities of the students under study are the same, so there are still external variables that influence. The research design used in the study was one group pre-test post-test design. The pattern of this research design can be illustrated in Figure II. 1 [13].

## RESULTS AND DISCUSSION

This research was conducted at SMA Negeri 7 Bekasi which is located on Jl. Circle of City Planning No. 107, Jatisampurna, Bekasi which was held in the even semester of the 2019/2020 academic year, and conducted research starting on May 4, 2020 to June 1, 2020.

This research was conducted in one class, namely X MIPA 5 as an experimental class that was treated with a reciprocal learning model using Edmodo. This research was conducted in 4 meetings with details of the 1st meeting the introduction of the Reciprocal Learning learning model using Edmodo and the introduction of the features in Edmodo, the second meeting was conducted in a pretest, the 3rd meeting

was treated with a Reciprocal Learning learning model using Edmodo and the fourth meeting was carried out by a posstest and filling out a questionnaire.

Prior to the implementation of the test, 25 items were tried out and then analyzed the validity and reliability, and obtained 20 items that were valid for use in this study to obtain student learning outcomes. The test was given in 2 meetings, namely pretest at the beginning before treatment and posttest at the end after being treated with the Reciprocal Learning learning model using Edmodo on momentum and impulse material. The following is data on student learning outcomes before and after being given treatment with the Reciprocal Learning learning model using Edmodo:

Table IV.1: Learning Outcomes of Class X MIPA 5

| Data | The highest score | Lowest Value | Average |
|---|---|---|---|
| Pretest | 73 | 16 | 40.9 |
| Posttest | 100 | 70 | 89.75 |

The table above explains that the learning outcomes of students in the experimental class have a very significant difference, for the pretest the highest score is 73 and the lowest score is 16 with a mean of 40.9, while for the posttest the highest score is 100 and the lowest score is 70 with a mean of 89.75. Before and after the treatment there was an increase of 28 at the highest value and at the lowest value there was an increase of 54. At the mean value there was also an increase of 48.85, from 40.9 to 89.75. The level of completeness of student learning outcomes in accordance with the Minimum Completeness Criteria (KKM) has increased. At the time of the pretest, there were no students who had completed or 0%. Meanwhile, at the time of the posttest, there were 20 students who completed or 100% of the total number of students. This means that the level of completeness of student learning outcomes has increased by 100%. From these results it can be concluded that the reciprocal learning model using Edmodo has a very strong influence in improving student learning outcomes.

Based on the results of the data normality trial with a significance of 5% or α=0,05, to test data normality test of student learning outcomes Lcount = 0.0951 <0.190 = L table. Then the data on the results of students' learning tests on the pretest and posttest scores were normally distributed.

After being given the treatment, the results of hypothesis testing were obtained using the t-test t count = 10.95, while the significant level α = 0.05 with 38 degrees of freedom, obtained t table = 1.68. Because tcount = 10.95> ttable = 1.68, it means that it can be concluded that the research hypothesis H1 is accepted and the hypothesis H0 is rejected. Thus it is stated that there is an effect of the Reciprocal Learning learning model using edmodo on the learning outcomes of students of SMAN 7 Bekasi on the subject of momentum and impulse.

Based on the research that has been done, the results of the student response questionnaire can be seen in Figure IV. 1:

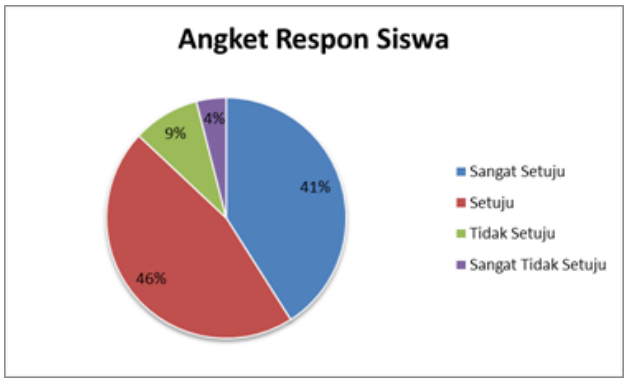



Figure IV.1 Student Response Questionnaire Results

From Figure IV.1 the student response questionnaire is said to be positive. Of the 30 questions, the average percentage questionnaire with very agreeable answers obtained a percentage of 41%, the average percentage with agreed answers obtained a percentage of 46%, the average percentage with

disagreeing answers obtained a percentage of 9%, and the average percentage with the answer strongly disagree, the percentage is 4%. Thus the highest percentage is the average percentage with answers agreeing by 46% and the next highest percentage is the average percentage with very agreeing answers of 41%.

## CONCLUSIONS

Based on the research results, it can be concluded that, the average learning outcomes of students using Edmodo after treatment (Posttest) applied to the Reciprocal Learning learning model were higher than the average learning outcomes of students using Edmodo before treatment (Pretest).

From the results calculated using the t-test, the results obtained tcount = 10.95> 1.68 = t table, which means that the research hypothesis H1 is accepted and H0 is rejected. With the rejection of H0 and acceptance of H1 from testing the t-test hypothesis at a significant levelα = 0.05, it can be concluded that there is an effect of the Reciprocal Learning learning model using edmodo on student learning outcomes on the subject of momentum and impulse. This shows that with

## REFERENCES

[1] Al-tabany, T.I. Designing Innovative, Progressive and Contextual Learning Models. Jakarta: Prenadamedia Group. 2014.
[2] Arsyad, A. Learning Media. Jakarta: PT. Raja Grafindo Persada. 2015
[3] Dharmawati. The use of e-learning media based on edmodo in learning English for business. Information Systems Journal, p. 43. 2017.
[4] Falahudin, I. Use of Media in Learning. Widyaiswara Circle Journal, 2014. p. 104.
[5] Huda, M. Teaching and learning models. Yogyakarta: Student Library. 2014.
[6] Januardi, & Gustiana. The influence of the reciprocal learning model on learning outcomes in economic subjects in SMA Banti Air Pious Nation. Balance Sheet Journal, p. 58. 2018.
[7] Jihad, A., & Haris, A. Learning Evaluation. Yogyakarta: Multi Pressindo. 2013
[8] Kurniasih, R., Sujadi, I., & Subanti, S. The development of teaching materials using edmodo to increase the level of probabilistic thinking of students in class VII SMP Negeri 12 Surakarta. Journal of Electronic Mathematics Learning, 963. p. 2016.
[9] Kustandi, C., & Sutjipto, B. Manual and Digital Learning Media. Bogor: Ghalia Indonesia. 2011.
[10] Rahman, J. Student interest in using Edmodo e-learning in the teaching and learning process. 2017.
[11] Rimawati, E. Variety of Learning Media. Pen said. 2016.
[12] Shoimin, A.68 innovative learning models in the 2013 curriculum. Yogyakarta: Ar-ruz Media. 2014.
[13] Sugiyono. Educational Research Methods with Quantitative Approaches, Qualitative, and R & D. Bandung: Alfabeta CV. 2015.

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

# Thinking Process in Student Vocational Math Problem Solving Based on Personality Type Extrovert-Introvert

**Khoerunnissa Sholihatti[1]**

[1]Faculty of Teacher Training and Education, University of Muhammadiyah Prof. Dr. Hamka
Jl. Tanah Merdeka, Kp Rambutan, Pasar Rebo, East Jakarta 13830

Correspondence email: khoerunnissas@gmail.com

## ABSTRACT

This study aims to describe vocational students thinking process with personality types extrovert and introvert personality type in solving mathematical problems using Polya measures. This research is a qualitative descriptive study. The population in this study were all students of class X in a vocational high school in South Tangerang City, Samples were six vocational students, the which consisted of three students and three personality types extrovert introvert personality type student. The election procedure is done using purposive sampling and snowball sampling. The instrument used was a questionnaire type of personality, problem solving ability test, and interview the subject of research. Based on the findings and discussions can be concluded that the students' ekstovert personality types will use the thought process of assimilation when understanding a problem, make a plan in solving the problem, and check the answers that have existed over. While in implementing the plan on solving problems then use the thinking process of accommodation. Students introverted personality types will use the thought process of assimilation when understanding a problem, and the make plans in problem solving. Meanwhile, make and execute a plan in problem solving using assimilation thought process is not perfect. While in implementing the plan on solving problems then use the thinking process of accommodation. Students introverted personality types will use the thought process of assimilation when understanding a problem, and the make plans in problem solving. Meanwhile, the make and execute a plan in problem solving using assimilation thought process is not perfect. While in implementing the plan on solving problems then use the thinking process of accommodation. Students introverted personality types will use the thought process of assimilation when understanding a problem, and the make plans in problem solving. Meanwhile, make and execute a plan in problem solving using assimilation thought process is not perfect.

**Keywords: T**hinking process, problem solving ability, personality extrovert, introvert

## INTRODUCTION

Mathematics is a basic knowledge of various disciplines. In an increasingly modern era is very important to learn mathematics. That's because having a role in advancing mathematical thinking on human power. At present, the development of mathematics underlying developments in the field of information and communication technology. Mastery of mathematics should have been prepared since in school so that students can create and control technology in the future. This was done to make students ready for the challenges of life are growing. Preparation was done by giving supplies to the students with the ability to think in problem solving.

The curriculum is currently creating a student has the ability in problem solving. Thus, an important aspect in the process of learning mathematics can be developed. Problems in mathematical filled with questions or math problems to be solved. Problems can be regarded as a question to be solved by someone, but someone is not yet know how to use to finish it [4]. Thus, students must merencenakan first procedure used in resolving a problem.

The thought process experienced by students when solving a problem is that he should be able to find an answer from permasalahan given. Principal component in thinking by Mayer there are three, namely: (1) the activity of a cognitive form of thinking, (2) the cognitive system that is the thought process that manipulates some knowledge, and (3) solving problems resulting of the thought process. The thought process that occurs consists of information received either from within or outside the student, later processed and stored, and dig up the information that has been remembered by the students. Ideas and experiences that are within one's mind is part of the initial schematic structure of knowledge that has been filtered and difasilitatori in mind.

From it, Asimiliasi is a union process between the information and experience into a mental structure. Meanwhile, according to [6] assimilation can occur when children can enter a schema information into the existing pattern in mind before. Assimilation develop existing schema without making any changes [5]. By doing so, assimilation is a process to integrate the information into the existing cognitive stukrtur into students' thinking.

Accommodation occurs when students are able to adjust the scheme in accordance with the pattern to new experiences and information they get. [5] states of accommodation is to change old scheme to establish a new scheme. Meanwhile, according to [7] accommodation is a cognitive structure adapted to the new situation. New experience can not be assimilated by the old scheme, because the old scheme does not fit with the new experience.

Knowledge of the strategies used in problem-solving process is a careful thought and reasoning are right for students [2]. During the process of solving problems, students are asked to write a proper explanation of what they have done and why they did it. That way, students can think carefully and appropriately accompanied by logical reasons related solutions to be applied when solving a problem in the future. It is similar to which states that the use of knowledge and skills previously owned a thought process undertaken by students in an attempt to resolve the problem or seeking the solution of a problem are obtained.

The thought process experienced by students when studying mathematics aims to evaluate the learning of mathematics in schools. On the other hand, Marpaung [3] argues that the thinking process undertaken by students in learning math and figure out how to interpret the student's mind is the task of mathematics education. The process of thinking in students is constructed in a way to interpret the source (of information) that has been gathered by observing the patterns of students while studying mathematics. By doing so, the teacher know the location and the type of error that students doing the learning process are known. Students can also make mistakes that often they do as the information learned to understand the material. Errors that often arise vary, so the thought process that there was not the same. It is as said by [1] the thinking of students will vary according to the type of personality he has.

In a person's personality is divided into various types, [8] personality types are classified into two major groups, the type Extrovert and Introvert. While [9] foundextrovert characters growing niche to be Gregorious, while the introverted growing niche to be private, the activity of the extrovert is seen as directed towards the external world and that of the introvert inward upon himself or herself.Thus it can be said that a person who has an extrovert personality type environment determines the patterns of thought, persaan and actions. It can occur in both the social environment and non-social. In other words, the mind which is owned by theextrovert always directed to the outside while the introvert subjective factors determine feelings, actions, and thoughts and less suited to the outside world is not good.

To get information about the thinking processes of students in terms of personality types, it will be investigated how the thinking of studenin solving mathematical problems in terms of personality types extrovert-introvert on vocational students Letris Indonesia 2 Pamulang. The material is applied in this study, namely Systems of Linear Equations Two Variables (SPLDV), because there are students not master the material. The goal of the researchers performed this study is to describe the thought process of vocational students in solving mathematical problems in each personality type.

## RESEARCH METHOD

Pime Frame this study in class X in one of the vocational schools in South Tangerang. This location was chosen on the following grounds: (1) this school has never been a study about the thinking process in vocational students in class X in the material system of linear equations in two variables (SPLDV) that in terms of personality types extrovert-introvert, (2) researchers found data and information needed in school, (3) the school can cooperate well. Samples were taken using purposive sampling techniques and methods snowball (snowball).

The data collected by the research subjects who meet the specified criteria. The data collected in this study uses problem-based interviews in which students work on comprehension tests later interview-based problem solving problem solving. After that, the data obtained is thenanalyzed and validated using triangulation of time. Data obtained with a valid subject of the same triangulation. By doing so,

gained as much as 6 research subjects, namely three of the subject extrovert and introvert 3 of the subject.

## RESULTS AND DISCUSSION

Data from the results of tests carried neither the first nor the second has been obtained, analyzed and triangulated in order to obtain valid data, valid data is then used to determine the thought processes that have been carried out students. The following valid data obtained from each respective group.
Valid data from students extrovert (E1, E2, E3) can be seen in Table 1 below,

**Table 1.** Data subjects E1, E2, and E3 are valid

| | Troubleshooting Steps | | | |
|---|---|---|---|---|
| Subject | Understanding The Problem | Make Plans Troubleshooting | Implementing The Plan Troubleshooting | Checking Back Answers |
| E1 | Can easily and correctly determine what is known and what is being asked of the problem.<br>May determine that it is known already can be used to answer what is asked.<br>Back can reveal problems with sentences or words alone. | Can mention other knowledge that can be used to solve the problem.<br>Can make troubleshooting plan. | May address the issue appropriately by modifying the substitution step | Believing the truth of the results of his work in a way-kan substituting the results obtained in the initial equation has been created. |
| E2 | Can easily and correctly determine what is known and what is dtanyakan of problems<br>May determine that it is known already can be used to answer the questions asked<br>Can turn a problem into a mathematical model | Can mention other knowledge that can be used to solve the problem.<br>Can make troubleshooting plan. | May address the issue properly in accordance with the plan and calculation algorithms used also true | Believing the truth and verifying the answers do the same when determining the answers. |
| E3 | Can easily and correctly determine what is known and what is being asked of the problem.<br>May determine that it is known already can be used to answer what is asked.<br>Back can reveal problems with sentences or words alone. | Can mention other knowledge that can be used to solve the problem.<br>Can make troubleshooting plan. | May address the issue appropriately by modifying the substitution step | Believing the truth of the results of his work in a way-kan substituting the results obtained in the initial equation has been created. |

Valid data from students introvert (I1, I2, I3) can be seen in Table 2 below.

**Table 2.** Data subjects I1, I2 and I3 are valid

| Subject | Troubleshooting Steps | | | |
|---|---|---|---|---|
| | Understanding The Problem | Make Plans Troubleshooting | Implementing The Plan Troubleshooting | Checking Back Answers |
| I1 | Can easily and correctly determine what is known and what is dtanyakan of problems.<br>May determine that it is known already can be used to answer what is asked.<br>Can revisits the problem by creating a mathematical model | Can mention the materials / other knowledge that can be used to solve the problem.<br>Can immediately make plans troubleshooting | May address the issue properly in accordance with the plan and calculation algorithm used is also true. | Believing the truth and verifying the answers do the same when determining the answers. |
| I2 | Can easily and correctly determine what is known and what is dtanyakan of problems.<br>May determine that it is known already can be used to answer what is asked.<br>Can revisits the problem by creating a mathematical model | Can mention the materials / other knowledge that can be used to solve the problem.<br>Can immediately make plans troubleshooting | May address the issue properly in accordance with the plan and calculation algorithm used is also true. | Believing the truth and verifying the answers do the same when determining the answers. |
| I3 | Can easily and correctly determine what is known and what is dtanyakan of problems.<br>May determine that it is known already can be used to answer what is asked.<br>Unable to reveal the back problem (one in creating a mathematical model) | Can mention the materials / other knowledge that can be used to solve the problem.<br>Unable to make a plan for problem solving equations made wrong | Unable to answer problems correctly because the plans are made wrong. | Substituting-kan results obtained in the initial equation and can be confident that the results are not correct, but did not conduct an examination of job measures |

The thought process of the student in problem-solving abilities will be determined from the data above. Starting from understanding a problem, make a plan in solving problems, carrying out a plan that has been made in solving the problem, then the last check the answers from each group (extrovert and introvert).

Extroverts group consisting of 3 students. At the time to understand the issues, all students caneasily and correctly know the problems that are known and asked. Students also can determines that it is known already can be used to answer what is asked. In this section, students can write back using their own words. At this stage, students use the thinking process of assimilation, where the incoming information corresponding knowledge that is in the previous scheme. Furthermore, to make plans in troubleshooting, this section students can mention other knowledge that can be used to solve the problem. Students can plan with good problem solving. In this section, students still use the thinking process of assimilation. Students can easily determine the materials used when solving a given problem. The next phase, execute the plan in solving the problem of students using the thought process of accommodation. It can be seen, when the students get an answer is not directly substituted into the

equation, but the equation that consists of the combined first and second equations. To get the values of other variables to be searched, the student must make modifications at the time of the substitution. It is the same as that expressed by [7] someone that blends with the stimulus in the accommodation is the result of a previous scheme modification process. In addition to the above, there are also students who get the results of these questions by trial and error until he managed to answer correctly. This issue occurs because of the possibility of the material being taught to students not yet well understood by students.

The last stage is the answer obtained from the thought process of assimilation is checked and rechecked. The answers they find are the result of the conviction itself by substituting the answer of the existing equation. After that, the students look back on the existing shortcomings by examining each step in finding answers lengkap.

Another group that is introverted, the group consisted of 3 students. At the time to understand the issues, all students can easily and correctly know the problems that are known and asked. Students also can determines that it is known already can be used to answer what is asked. In this section, students can write back using their own words. At this stage, students use the thinking process of assimilation, where the incoming information corresponding knowledge that is in the previous scheme. Furthermore, to make plans in troubleshooting, this section students can mention other knowledge that can be used to solve the problem. Students can plan with good problem solving. In this section, students still use the thinking process of assimilation. Students can easily determine the materials used when solving a given problem. The next phase, execute the plan in solving the problem of students using the thought process of assimilation is not perfect. Students can execute the plan in solving the problem well. However, during the process of calculating the students do kesalahan. So that the final result obtained was wrong.

The last stage is the answer obtained from the thought process of assimilation is not perfect. At this stage, steps in finding an answer is not checked and checked kembali by students. By doing so, the errors that have students do can't be known for future learning.

## CONCLUSIONS

Based on research telah described above, it can be concluded that the students' personality type ekstovertwill use the thought process of assimilation when understanding a problem, make a plan in solving the problem, and check the answers that have existed over. While in implementing the plan on solving problems then use the thinking process of accommodation. Students introverted personality types will use the thought process of assimilation when understanding a problem, and make rencanan in problem solving. Whereas, in making and implementing plans in problem solving asimiliasi menggunakan thought process is not perfect.

Based on the results that have been described, then there is a suggestion to be conveyed to: (1) a teacher of mathematics in order to teach students how to execute the plan in solving the problem of the plans that have been made before, and remind students to re-examine the problem solving and seeing a shortage of answers obtained, (2) other researchers to be one of the references in developing this article.

## REFERENCES

[1] Dewiyani. "The Thinking Process Profile The Students of Informatics Systems Department in The Mathematics Problem Solving Based on The Personality Type and Gender". *Proceeding STIKOM Surabaya*. pp. 1 – 10. 2012.
[2] Krulik, S. and Posamentier. *Problem Solving in Mathematics, Grades 3-6: Powerful Strategies to deepen Understanding*. United States of America: Corwin. 2009.
[3] Muhammad Rizal. "Elementary Students Thinking Process Capability High Mathematics Counting Problems In Doing Estimates". *Proceedings of the National Seminar on Research, Education, and Mathematics* Application Date May 14, 2011, page 19 -28. Yogyakarta: Natural Sciences, State University of Yogyakarta. 2011
[4] Nuralam. Troubleshooting as Approach to Learning Mathematics. Journal of Education,vol. 5, no. 1, pp. 142-154, 2009.
[5] Paul Suparno. *Theory of Cognitive Development Jean Piaget*. Yogyakarta: Canisius. 2001

[6] Santrock, JW. *Educational Psychology, Educational Psychology*, Issue 3 Books 1. South Jakarta: Salemba Humanika, 2009.
[7] Sugihartono, Nur Kartika Fathiyah, Harahap Farida, Farida Agus Setiawati, and Siti Nurhayati Rohmah. *Educational Psychology*. Yogyakarta: UNY Press. 2007.
[8] Sumadi, S. Personality *Psychology*. Jakarta: King Grafindo Persada. 2008.
[9] Zafar, S. & Meenakshi, K. "A Study on the Relationship Between extroversion-introversion and Risk-Taking in the Context of Second Language Acquisition" *International Journal of Research Studies in Language Learning*, vol. 1, no. 1, pp. 33-40, 2012.

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics ICE-STEM 2020)

# Analysis of Students' Mathematic Problem-Solving Ability Based on Application of Learning Methods Electronic (e-learning)

**Devi Setyarini[1*], Esti Ambar Nugraheni[1], Ayu Tsurayya[1]**

[1]Universitas Muhammadiyah Prof. DR. Hamka,
Jl. Tanah Merdeka, Kampung Rambutan, Jakarta 13830, Indonesia

*Correspondence email: devisetyarini06@gmail.com

## ABSTRACT

This study aims to analyze and describe the mathematical problem solving abilities of students based on the application of electronic learning methods (e-learning). The study was conducted at 199 Junior High School in Jakarta in class VII even semester 2019/2020. This research is a qualitative research. The research subject was 35 students of the VII-5 class, then 5 students were chosen to represent the category of problem solving abilities. Data collection in this study used test, interview, and documentation. The results showed that the mathematical problem-solving abilities of 35 students in class VII-5 were obtained by 1 student or 2.85% included in the very high category, 7 students or 20% included in the high category, 9 students or 25.71% included in the medium category, 14 students or 40% in the low category, and 4 students or 11.42% in the very low category.

**Keywords:** Electronic Learning, problem solving ability, learning methods

## INTRODUCTION

Mathematics is a basic science in the development of science and technology that can be used as a means of developing potential for students [1]. Learning mathematics can develop the potential of students in improving the ability to solve problems both in learning and in everyday life, thinking logically, analytically, and systematically. Students must have problem-solving abilities to solve every problem, one of the lessons that requires problem-solving skills is learning mathematics.

The ability to solve mathematical problems is an important and fundamental thing that needs to be taught so that students can solve mathematical problems with all their knowledge and understanding. Rajkumar dan Hema [2] define mathematical problem solving abilities, namely abilities that can be used to solve problems by applying cognitive skills such as reasoning and logical thinking.

Problem solving in learning mathematics requires effort or a way to find a solution. Mathematical problem solving abilities can be developed in learning through practice questions that have the potential to improve students' mathematical understanding [3]. Besides being useful for increasing knowledge and understanding, mathematical problem solving abilities are also useful as a way of thinking in order to improve logical reasoning in students [4]. Indicator of mathematical problem solving ability expressed by Polya [5].

**Table 1.** Indicators for Mathematical Problem Solving

| Polya's Problem Solving Steps | Indicator |
|---|---|
| Understand the problem | Identifying the elements that are known, asked, and the adequacy of the elements needed. |
| Develop a problem solving plan | Formulating problems or compiling mathematical models |
| Carry out a problem solving plan | Implementing problem solving strategies in or outside mathematics |
| Check again | Explain or interpret the results according to the original problem |

This research will be conducted at SMP Negeri 199 Jakarta, where the school has implemented the 2013 curriculum and uses a scientific approach in the learning process. Based on the results of observations and interviews conducted with mathematics educators who teach in class VII SMP Negeri 199 Jakarta, it is concluded that in learning mathematics the biggest problem lies in solving mathematics problems. Students still have difficulty finding solutions to problems in test questions and exercises. This is because students have difficulty in determining the steps to solve a problem.

Mahase [6] revealed that almost all human beings in all parts of the world including Indonesia are in grief due to the outbreak of a virus, namely Coronavirus Disease (COVID-19). COVID-19is very easy to spread so that the government of the Republic of Indonesia issued a policy to study at home for students. This has an impact on teaching and learning activities, where schools must temporarily be closed but the learning process must still take place.

Efforts made by educators in order to be able to create a conducive learning process even though they do not meet face to face in the classroom, namely conducting distance learning by utilizing information and communication technology. One of them is through the application of electronic learning methods or e-learning methods. In its application, electronic learning or e-learning methods are supported by technologies such as audio, videotapes, computers, and telephones to obtain the required subject matter [7].

E-learning is a modern learning method that utilizes information technology to disseminate information, materials, and exercises needed for learning activities [8]. Alimron [9] revealed the benefits of the e-learning method in learning, including:
a. The amount of time available for educators and students to interact;
b. Learning activities become flexible, because students can adjust the availability of time for learning;
c. Improving the quality of educators to make teaching materials easier for students to learn and understand;
d. Make it easier to store things related to learning.

The use of e-learning methods to create an interesting and enjoyable atmosphere for students in the learning process cannot be separated from the advantages and disadvantages.Several advantages and disadvantages of the e-learning method were expressed by Fadrianto [7] including:
a. Easy interaction without being limited by time, distance and place;
b. Students can re-learn the subject matter at any time;
c. Able to form independent learning patterns in students;
d. Relatively efficient, because the learning process can be carried out without having to gather in the same place.

The disadvantages of the e-learning method in the learning process including:
a. Lack of interaction between educators and students because they do not meet face to face directly;
b. Educators must master conventional learning techniques and learning techniques using electronic tools;
c. Students who have low learning motivation will have difficulty following the learning process;
d. Lack of skills in mastering electronic devices.

Based on the description above, the researcher conducted a study entitled "Analysis of Students' Mathematical Problem Solving Ability Based on the Application of Electronic Learning Methods (E-Learning)".

## RESEARCH METHOD

The method used in this research is descriptive method with a qualitative research approach. Supremum Journal of Mathematics Education (SJME) explains that qualitative research is descriptive research that has a deep purpose to analyze, describe and understand a phenomenon or problem [10]. The research was conducted at SMP Negeri 199 Jakarta. The object of this research is students' mathematical problem solving abilities based on the application of electronic learning methods (e-learning). The subjects in this study involved one class, namely students of class VII-5 SMP Negeri

199 Jakarta who were treated with the electronic learning method (e-learning) in the even semester of the 2019/2020 academic year, totaling 35 people. The data collection techniques used were tests, interviews, and documentation.

Tests given to students to measure students' ability to solve math problems. The test used in this study is in the form of a description with the subject matter of a quadrilateral consisting of 6 items. The type of interview in this study is a semi-structured interview. Interviews were conducted to obtain data

from students regarding the ability of mathematical problems based on the answers to the tests given. The documentation needed in this study is the student's answer sheet related to the ability of mathematical problems.

## RESULTS AND DISCUSSION

The test of mathematical problem solving abilities is done individually by students. The categories for the level of mathematical problem solving abilities of students in class VII-5 SMP Negeri 199 Jakarta can be seen in the following table.

**Table 2.** Categories of Students' Mathematical Problem Solving Ability

| Score | Category | Total Students | Percentage |
|---|---|---|---|
| 80 – 100 | Very high | 1 | 2,85% |
| 64 – 79,9 | High | 7 | 20% |
| 55 – 64,9 | Medium | 9 | 25,71% |
| 40 – 54,9 | Low | 14 | 40% |

The results of the test of mathematical problem solving abilities amounted to 6 items and interviews conducted by students with very high, high, medium, low, and very low categories were analyzed based on the problem solving stage revealed by Polya.

a. The category of students' mathematical problem solving ability is very high
   Very high category students can understand the problem by determining what is known and asked correctly for 6 items. Students can make plans by writing down how to determine problem solving that leads to the correct answer to 5 items. Students can carry out plans that have been prepared in the calculation process by obtaining the correct answers to 4 items. Students can re-check the process and answer correctly for 5 items.
b. The category of students' mathematical problem solving ability ishigh
   High category students can understand the problem by determining what is known and asked correctly for 6 items. Students can make plans by writing down how to determine problem solving that leads to correct answers to 5 items. Students can carry out the plans that have been prepared in the calculation process by obtaining the correct answers to 4 questions. Students can re-check the process and answer correctly for 3 items.
c. The category of students' mathematical problem solving ability is medium
   Medium category students can understand the problem by determining what is known and asked correctly for 6 items. Students can plan by arranging problems that lead to correct answers to 3 items. Students can appropriately carry out the plans that have been compiled in the calculation process by obtaining the right answers to 5 items. Students can re-check the process and answer correctly for 3 items.
d. The category of students' mathematical problem solving ability is low
   Low category students can understand the problem by determining what is known and asked appropriately for 6 items. Students can make plans by writing down how to determine problem solving that leads to correct answers to 3 items. Students can carry out plans that have been prepared in the calculation process by obtaining the correct answer to 1 item of question. Students can re-check the process and answer correctly for 2 items.
e. The category of students' mathematical problem solving ability is very low
   Very low category students can understand the problem by determining what is known and asked correctly for 6 items. Students can make plans by writing down how to determine problem solving that leads to the right answer to 2 items. Students can carry out plans that have been prepared in the calculation process by obtaining the correct answer to 1 item of question. Students tend not to re-check the processes and answers that have been obtained.

## CONCLUSIONS

The results of the research related to the analysis of students' mathematical problem solving abilities based on the application of the electronic learning method (e-learning), it is known that from 35 students of class VII-5 SMP Negeri 199 Jakarta, 1 student or 2.85% had the mathematical problem solving ability category very high, 7 students or 20% have high category mathematical problem solving abilities, 9 students or 25.71% have medium category mathematical problem solving abilities, 14

students or 40% have low category mathematical problem solving abilities, and 4 students or 11.42% have a very low category of mathematical problem solving ability.

## REFERENCES

[1] Parulian, R. A., Manundar, D. R., & Ruli, R. M. "Analysis of Mathematical Problem Solving Ability in Completing Integer Material in Junior High School Students". *In Sesiomadika 2019* (Vol. 1, pp. 215–228), 2019

[2] Rajkumar, R., & Hema, G. "Factors Affecting Mathematical Problem Solving Competence of Undergraduate Students in Facing Competitive Examinations" *International Journal of Research in Humanities, Arts and Literature (IMPACT: IJRHAL)*, vol. *7 no.* (2), pp. 319–328, 2007.

[3] Fitriana, D. A., & Supahar. "Developing an Assessment Instrument of Mathematical Problem-Solving Skills in Senior High School" *International Journal of Trends in Mathematics Education Research*, vol. *2, no.* 3, pp. 138–148, 2019.

[4] Yayuk, E., & Husamah, H. "The Difficulties of Prospective Elementary School Teachers in Item Problem Solving for Mathematics : Polya ' s Steps". *Journal for the Education of Gifted Young*, vol.*8, no.*1, pp. 361–378, 2020.

[5] Rostika, D., & Junita, H. "Improved Elementary Students Problem Solving Ability in Learning Mathematics with Models Multy Representation Discourse (DMR)" *EduHumaniora : Jurnal Pendidikan Dasar*, vol. *9, no.* 1, pp. 35–46, 2017. https://doi.org/10.17509/eh.v9i1.6176

[6] Mahase, E. "Coronavirus : Covid-19 has Killed More People Than SARS and MERS Combined, Despite Lower Case Fatality Rate" *British Medical Journal*. 2020

[7] Fadrianto, A. "E-Learning in the Rapid Advancement of Science and Technology. *Indonesian Journal on Networking and Security*, vol. *8 no.* 4, pp. 1–6, 2019

[8] Cidral, W. A., Oliveira, T., Di Felice, M., & Aparicio, M. "E-Learning Success Determinants: Brazilian Empirical Study". *Computers and Education*, *122*, pp. 1–35, 2018.

[9] Alimron, A. "Application of E-Learning in the Learning Process at the PAI Study Program at Raden Fatah State Islamic University, Palembang" .*Hayula: Indonesian Journal of Multidisciplinary Islamic Studies*, vol *3*, no. 1, pp. 105–120, 2019

[10] Sariah, S., & Hidayati, N. "Analysis of Mathematical Problem Solving Ability for Class VII Students of SMPN 8 Karawang Barat on Quadrilateral Material" *In Prosiding Seminar Nasional Matematika dan Pendidikan Matematika Sesiomadika* pp. 1088–1093), 2019. https://doi.org/10.31004/cendekia.v3i1.74

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics ICE-STEM 2020)

# Development of Worksheet to Improve Learning Independence

**Anisa Nur Ekasari[1*], Esti Ambar Nugraheni[1], Ayu Tsurayya[1]**

[1]Departement of Mathematics Education, University of Muhammadiyah Prof. DR. HAMKA
Jl. Tanah Merdeka, Kp Rambutan, Pasar Rebo, East Jakarta 13830

Correspondence email: anisanurekasari@gmail.com

## ABSTRACT

The purpose of this research is to produce a product of worksheet on differential orde materials for measuring increased self-reliance learning from before using a worksheet and after using a worksheet. Research and Development, the methods used in this research are the three stages of Define, Design, Develop, and Disseminate. This worksheet is validated by four people, two materials experts, and two media experts. Moreover, 2020's four-year academic math student is involved. The result of this worksheet is assessed by material experts 70.46 in the "feasible" category and media experts 87.01 in the "highly feasible" category. Self-reliance is learning increased with results obtained on both previous and post worksheets experiencing a 9.33% increase.

**Keywords:** Development of Worksheet, Independent learning,

## INTRODUCTION

Math is a college that helps students improve and build the ability to solve problems both creatively and independently. Students must have the ability to solve the problem both independently and publicly [1]. Scholars and teachers must apply learning self-reliance to improve skills on student learning on their own [2]. Lack of self-reliance in learning can result in a lack of learning motivation, learning results, and value in the community [3].

Self-reliance is a state and an attitude where one can stand alone and set the matter order without relying on the help of others. The purpose of self-reliance learning are (1) the student's desire to increase knowledge and skill, (2) A desire to look after yourself, (3) a passion for commitment to duty [4]. Self-reliance learning is a thought, feeling, and action that result according to the plan and purpose that a person wants to achieve within himself. self-reliance embalming may depend on the activity of many aspects of the applied phase [5]. The phase-in designing self-reliance is not only free to learn but helpful to think in composing a learning design, choosing a strategy, and purpose in learning [6].

Learning self-reliance is required for the department of Mathematics Education. It happened at one of those differential equations, in which this subject is a mandatory course studied with a total of three-semester credits. Differential equations are equations that involve derivative of an unknown function [7]. Based on the experience of learning differential equations in the fourth semester, insight ability and the ability to accomplish differential equations independently are essential.

Student skills in understanding the problems of subjects, differential equations are still relatively low [8]. Factor errors in the problem of differential equations in both the inside and the outside factors [9]. The inside factors involving a student forget its self-solution, while the outside factors include a lack of learning tools or media. The issues that occurred suggest that most students are still in the low category in their comprehension ability and think about the completion steps. Apart from the lack of insight ability and the ability to accomplish a task independently that causes low ability to solve differential equations, there is also the problem of the sustainability students use during study. One of the problems that occur in the textbooks is that they lack interactive and do not attract student attention, and thus the students' learning motivation is low [10].

Students still use textbooks that focus exclusively on material presentation only without scenting other sources. At differential equations are still very rare in the teaching materials designed by lectures to facilitate students and build learning self-reliance. Consistent with the fact that a model or learning strategy alone is not sufficient in DSN learning to use appropriate media assistance [11]. One effort educators make is to have expertise and skills in teaching using a worksheet expected to be able to increase student self-reliance [12].

A student's worksheet is a guide to helping students in the learning process of pages with tasks complete. The benefit of the worksheet are (1) students can learn and understand materials according to the given steps, (2) students can practice material concepts that have been studied, (3) add insight and learning tools to be motivated, (4) the learning process becomes more clear, exciting, and enjoyable and then creates a positive attitude during self-study.

## RESEARCH METHOD

The research method used Reseach and Development with the model 4-D presented by Thiagarajan and Semmel. Sugiono said that research methods and development as a scientific way to study, design, produce, and test the validity of the products that have been produced. This is the stage of the research of Define, Design, and Develop. This stage of research is limited to the Development stage. At the defining stage, researchers outline the need to compile a worksheet of analysis. During the design stage, research begin compiling the worksheet by starting a good format from design to writing ordinance at the stage of the worksheet development is validated by material experts and then reading and presentation response to small scale trials. In the result of the initial stage analysis, the worksheet in the trial in the field by measuring the increases responses to self-study students before and after using the worksheet. Validation assessment refers to BSNP 2006. Expert validation scores, group trials, and field trials are assessed and netted on the likert scale and then searched for an average value. As for the rate on the average result of the likert scale results indicated at the following table:

**Table 1.** Validation Sheet Score Criteria

| Interval | Categori |
|---|---|
| 84 – 100 | Very Good |
| 68 – 83 | Good |
| 52 – 67 | Quite Good |
| 36 – 51 | Not Good |
| 20 – 35 | Very Bad |

## RESULTS AND DISCUSSION

Product development.

a. Result of Expert Validation
The prototype one is the first product of planning made up of initial analysis, analysis of the students, concept, and purpose analysis. Further, after this is produced prototype one, is validated by both material experts and media experts. The process of validation by assessing the feasibility of the worksheet based on the instrument assessment sheet of the BSNP 2006 with google form format is accompanied by suggestions, comments, and conclusions on the worksheet's worthiness. The result of the validating assessment of the material expert are illustrated in the following pictures:

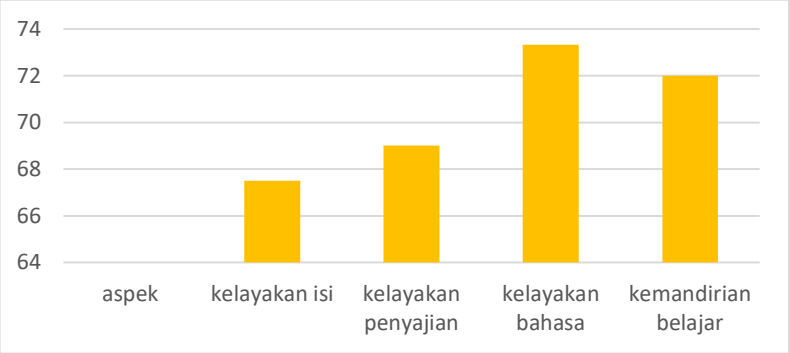



**Figure 1.** The Validation Assessment of Material Experts

And the result of the validation assessment of media experts are illustrated in this image:

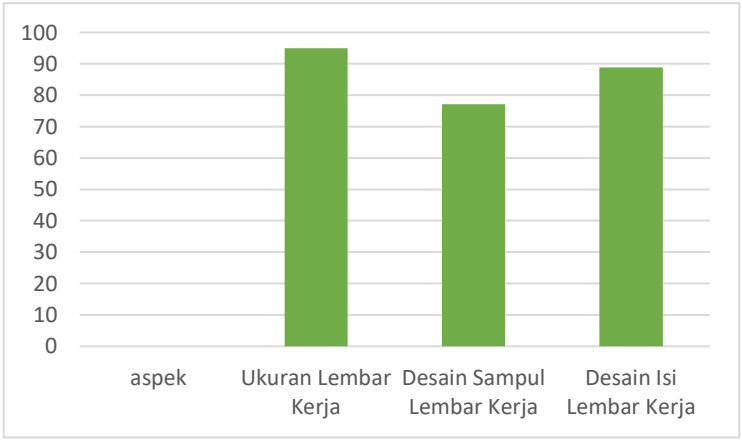


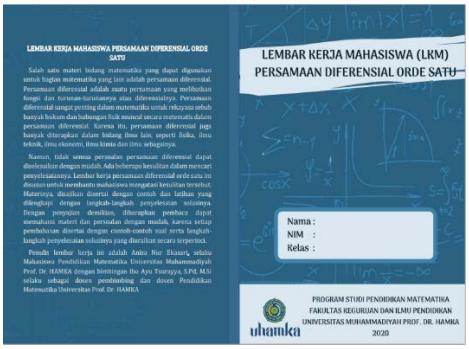

**Figure 2.** The Validation Assessment of Media Experts

As for the excapitulation of experts validation according to the following chart:

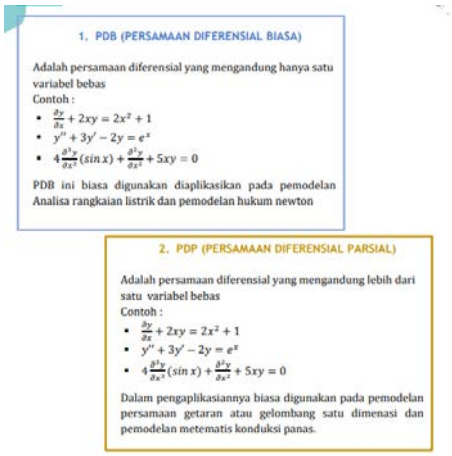
**Table 2.** The Score of the Expert's Assessment

| Experts | Validator 1 | Validator 2 | Score Average | Criteria |
|---|---|---|---|---|
| Material Experts | 266,78 | 296,89 | 70,46 | Feasible |
| Media Experts | 280,83 | 241,43 | 87,01 | Very Feasible |

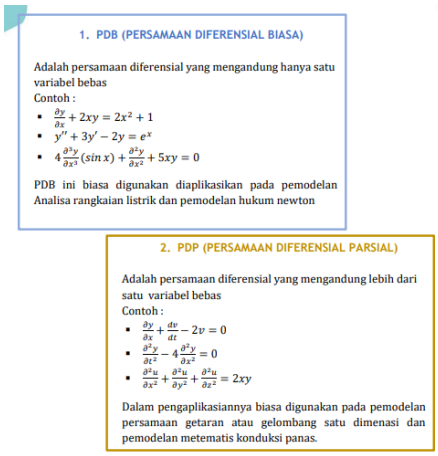
Based on the results of the validation recapitulation in the table, it can be seen that the result of the assessment of the prototype one student worksheet show the result of the material expert's assessment of 70,46 which in include in the "feasible" criteria and for the results of the media expert's assessment of 87.01 which is included in the "very feasible" criteria. As for comments and suggestions were given by experts to improve worksheets, namely adding content to the worksheet, cover illustrations must reflect the content of the material, complete the worksheet answer keys, add some examples and material to the worksheet. Improvements from these suggestions to produce worksheets so that they become the final product.

| **Initial Prototype** | **Revised Protype** |
|---|---|
| Cover prototype one   | Cover prototype one align with the material in the worksheet   |
| Example problems on ordinary differential equations and partial differential equations | After the revision, Example problems on ordinary differential equations and partial differential equations |

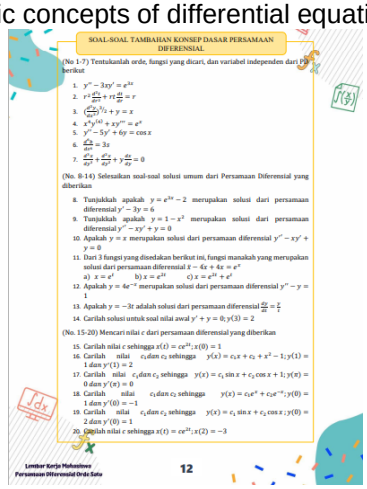
*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics ICE-STEM 2020)



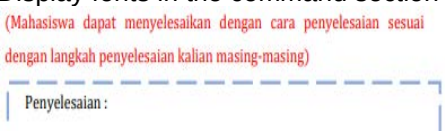

The placement of additional problems on the basic concepts of differential equations.

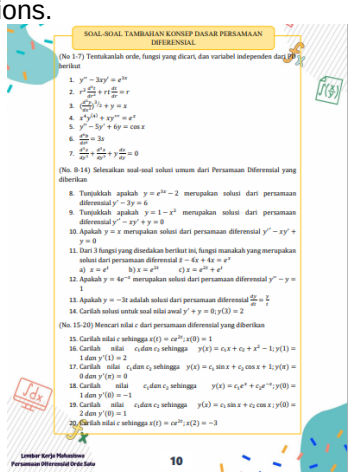



Change in the placement of additional problems on the basic concepts of differential equations.



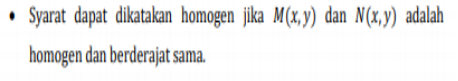

Display fonts in the command section



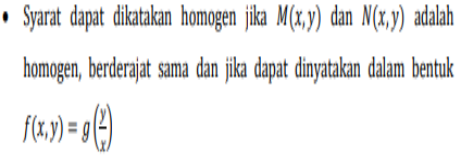




Change the font in the command section in answering questions


The requirement for a homogeneous differential equation is less complete



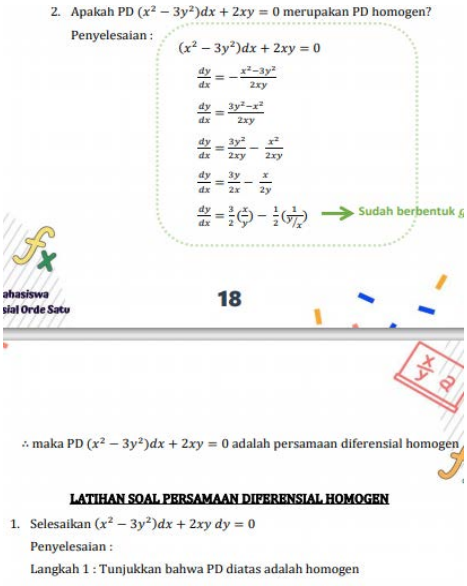

Adding one condition to the homogenal differential equation




Example of homogeneous differential equations only prove that the PD is homogenous

Added examples of problems on how to solve homogeneous differential equation

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics ICE-STEM 2020)



2. Apakah PD $(x^2 - 3y^2)dx + 2xy = 0$ merupakan PD homogen?

Penyelesaian :

$(x^2 - 3y^2)dx + 2xy = 0$

$\frac{dy}{dx} = -\frac{x^2-3y^2}{2xy}$

$\frac{dy}{dx} = \frac{3y^2-x^2}{2xy}$

$\frac{dy}{dx} = \frac{3y^2}{2xy} - \frac{x^2}{2xy}$

$\frac{dy}{dx} = \frac{3y}{2x} - \frac{x}{2y}$

$\frac{dy}{dx} = \frac{3}{2}(\frac{x}{y}) - \frac{1}{2}(\frac{1}{y/x})$ → Sudah berbentuk $g$

Mahasiswa
...sial Orde Satu

18

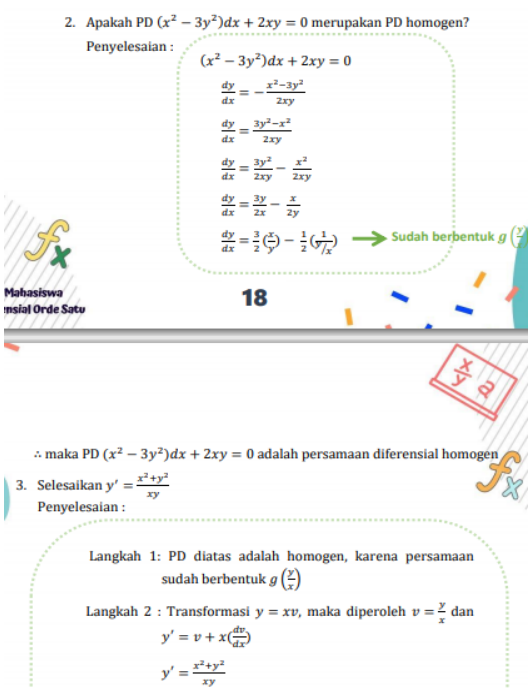
$\therefore$ maka PD $(x^2 - 3y^2)dx + 2xy = 0$ adalah persamaan diferensial homogen

**LATIHAN SOAL PERSAMAAN DIFERENSIAL HOMOGEN**

1. Selesaikan $(x^2 - 3y^2)dx + 2xy\,dy = 0$

Penyelesaian :

Langkah 1 : Tunjukkan bahwa PD diatas adalah homogen



2. Apakah PD $(x^2 - 3y^2)dx + 2xy = 0$ merupakan PD homogen?

Penyelesaian :

$(x^2 - 3y^2)dx + 2xy = 0$

$\frac{dy}{dx} = -\frac{x^2-3y^2}{2xy}$

$\frac{dy}{dx} = \frac{3y^2-x^2}{2xy}$

$\frac{dy}{dx} = \frac{3y^2}{2xy} - \frac{x^2}{2xy}$

$\frac{dy}{dx} = \frac{3y}{2x} - \frac{x}{2y}$

$\frac{dy}{dx} = \frac{3}{2}(\frac{x}{y}) - \frac{1}{2}(\frac{1}{y/x})$ → Sudah berbentuk $g$

Mahasiswa
...sial Orde Satu

18

$\therefore$ maka PD $(x^2 - 3y^2)dx + 2xy = 0$ adalah persamaan diferensial homogen

3. Selesaikan $y' = \frac{x^2+y^2}{xy}$

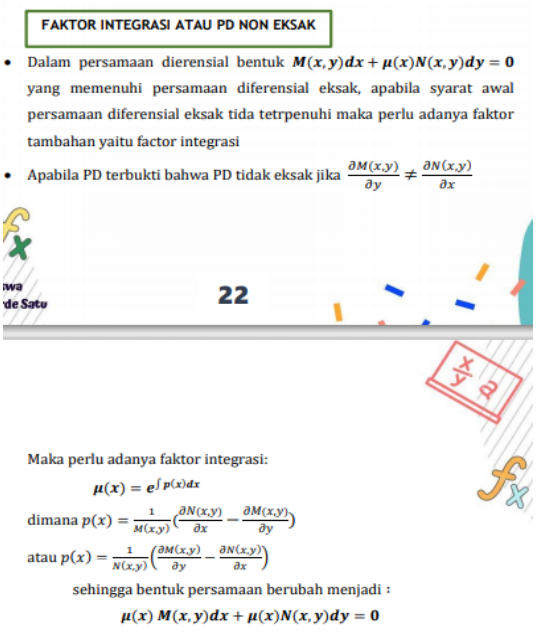
Penyelesaian :

Langkah 1: PD diatas adalah homogen, karena persamaan sudah berbentuk $g\left(\frac{y}{x}\right)$

Langkah 2 : Transformasi $y = xv$, maka diperoleh $v = \frac{y}{x}$ dan $y' = v + x(\frac{dv}{dx})$

$y' = \frac{x^2+y^2}{xy}$

There is only one type of integration factor or non-exact OD in this solution



**FAKTOR INTEGRASI ATAU PD NON EKSAK**

- Dalam persamaan dierensial bentuk $\boldsymbol{M(x,y)dx + \mu(x)N(x,y)dy = 0}$ yang memenuhi persamaan diferensial eksak, apabila syarat awal persamaan diferensial eksak tida tetrpenuhi maka perlu adanya faktor tambahan yaitu factor integrasi
- Apabila PD terbukti bahwa PD tidak eksak jika $\frac{\partial M(x,y)}{\partial y} \neq \frac{\partial N(x,y)}{\partial x}$

...wa
...de Satu

22

Maka perlu adanya faktor integrasi:

$\boldsymbol{\mu(x) = e^{\int p(x)dx}}$

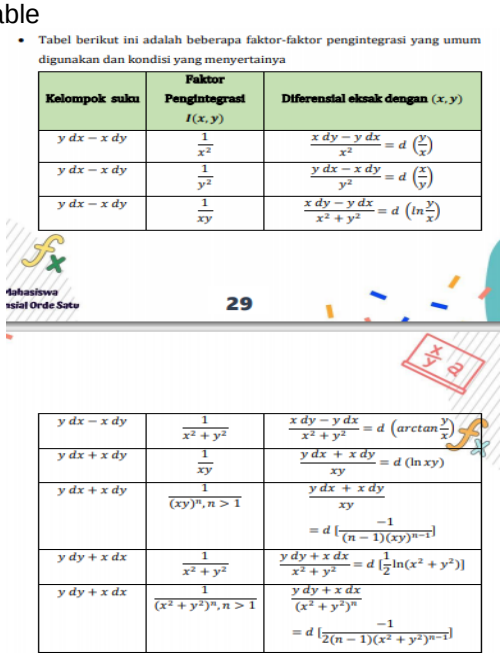
dimana $p(x) = \frac{1}{M(x,y)}(\frac{\partial N(x,y)}{\partial x} - \frac{\partial M(x,y)}{\partial y})$

atau $p(x) = \frac{1}{N(x,y)}(\frac{\partial M(x,y)}{\partial y} - \frac{\partial N(x,y)}{\partial x})$

sehingga bentuk persamaan berubah menjadi :

$\boldsymbol{\mu(x)\,M(x,y)dx + \mu(x)N(x,y)dy = 0}$

Additions regarding the types of integration factor or non-exact PD that are listed in the table



- Tabel berikut ini adalah beberapa faktor-faktor pengintegrasi yang umum digunakan dan kondisi yang menyertainya

| Kelompok suku | Faktor Pengintegrasi $I(x,y)$ | Diferensial eksak dengan $(x,y)$ |
|---|---|---|
| $y\,dx - x\,dy$ | $\frac{1}{x^2}$ | $\frac{x\,dy - y\,dx}{x^2} = d\left(\frac{y}{x}\right)$ |
| $y\,dx - x\,dy$ | $\frac{1}{y^2}$ | $\frac{y\,dx - x\,dy}{y^2} = d\left(\frac{x}{y}\right)$ |
| $y\,dx - x\,dy$ | $\frac{1}{xy}$ | $\frac{x\,dy - y\,dx}{x^2 + y^2} = d\left(ln\frac{y}{x}\right)$ |

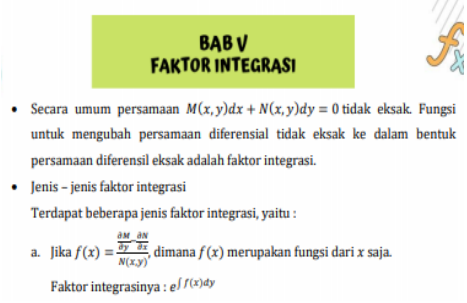
...dahasiswa
...sial Orde Satu

29

| | | |
|---|---|---|
| $y\,dx - x\,dy$ | $\frac{1}{x^2 + y^2}$ | $\frac{x\,dy - y\,dx}{x^2 + y^2} = d\left(arctan\frac{y}{x}\right)$ |
| $y\,dx + x\,dy$ | $\frac{1}{xy}$ | $\frac{y\,dx + x\,dy}{xy} = d\,(\ln xy)$ |
| $y\,dx + x\,dy$ | $\frac{1}{(xy)^n, n>1}$ | $\frac{y\,dx + x\,dy}{xy} = d\left[\frac{-1}{(n-1)(xy)^{n-1}}\right]$ |
| $y\,dy + x\,dx$ | $\frac{1}{x^2 + y^2}$ | $\frac{y\,dy + x\,dx}{x^2 + y^2} = d\left[\frac{1}{2}\ln(x^2 + y^2)\right]$ |
| $y\,dy + x\,dx$ | $\frac{1}{(x^2 + y^2)^n, n>1}$ | $\frac{y\,dy + x\,dx}{(x^2 + y^2)^n} = d\left[\frac{-1}{2(n-1)(x^2 + y^2)^{n-1}}\right]$ |

Chapter for exact differential equation and integration factors are combined in one chapter

Separation for exact differential equations chapter and integration factor chapter



**BAB V**
**FAKTOR INTEGRASI**

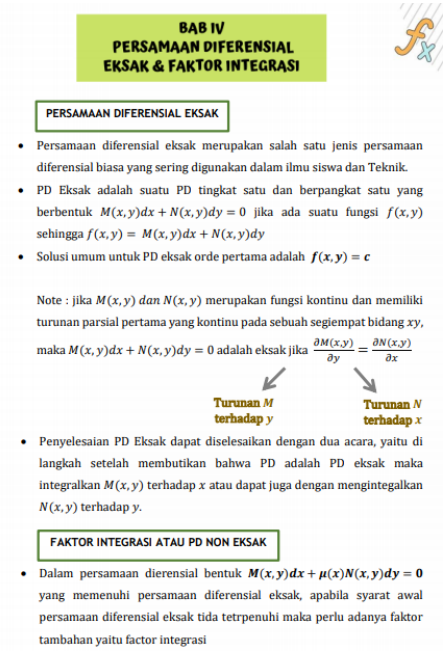
- Secara umum persamaan $M(x,y)dx + N(x,y)dy = 0$ tidak eksak. Fungsi untuk mengubah persamaan diferensial tidak eksak ke dalam bentuk persamaan diferensil eksak adalah faktor integrasi.
- Jenis – jenis faktor integrasi

Terdapat beberapa jenis faktor integrasi, yaitu :

a. Jika $f(x) = \frac{\frac{\partial M}{\partial y} - \frac{\partial N}{\partial x}}{N(x,y)}$ dimana $f(x)$ merupakan fungsi dari $x$ saja.

Faktor integrasinya : $e^{\int f(x)dy}$

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics ICE-STEM 2020)



**BAB IV**
**PERSAMAAN DIFERENSIAL**
**EKSAK & FAKTOR INTEGRASI**

**PERSAMAAN DIFERENSIAL EKSAK**

- Persamaan diferensial eksak merupakan salah satu jenis persamaan diferensial biasa yang sering digunakan dalam ilmu siswa dan Teknik.
- PD Eksak adalah suatu PD tingkat satu dan berpangkat satu yang berbentuk $M(x,y)dx + N(x,y)dy = 0$ jika ada suatu fungsi $f(x,y)$ sehingga $f(x,y) = M(x,y)dx + N(x,y)dy$
- Solusi umum untuk PD eksak orde pertama adalah $\boldsymbol{f(x,y) = c}$

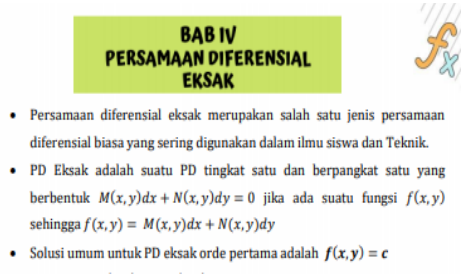
Note : jika $M(x,y)$ dan $N(x,y)$ merupakan fungsi kontinu dan memiliki turunan parsial pertama yang kontinu pada sebuah segiempat bidang $xy$, maka $M(x,y)dx + N(x,y)dy = 0$ adalah eksak jika $\frac{\partial M(x,y)}{\partial y} = \frac{\partial N(x,y)}{\partial x}$

Turunan $M$ terhadap $y$ — Turunan $N$ terhadap $x$

- Penyelesaian PD Eksak dapat diselesaikan dengan dua acara, yaitu di langkah setelah membutikan bahwa PD adalah PD eksak maka integralkan $M(x,y)$ terhadap $x$ atau dapat juga dengan mengintegalkan $N(x,y)$ terhadap $y$.

**FAKTOR INTEGRASI ATAU PD NON EKSAK**

- Dalam persamaan dierensial bentuk $\boldsymbol{M(x,y)dx + \mu(x)N(x,y)dy = 0}$ yang memenuhi persamaan diferensial eksak, apabila syarat awal persamaan diferensial eksak tida tetrpenuhi maka perlu adanya faktor tambahan yaitu factor integrasi

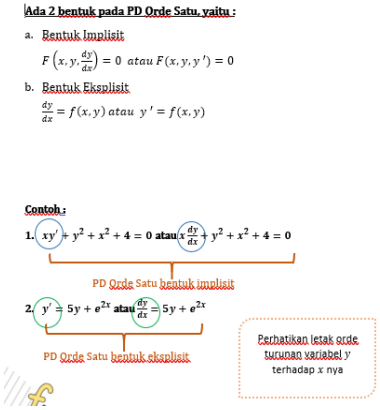


**BAB IV**
**PERSAMAAN DIFERENSIAL**
**EKSAK**

- Persamaan diferensial eksak merupakan salah satu jenis persamaan diferensial biasa yang sering digunakan dalam ilmu siswa dan Teknik.
- PD Eksak adalah suatu PD tingkat satu dan berpangkat satu yang berbentuk $M(x,y)dx + N(x,y)dy = 0$ jika ada suatu fungsi $f(x,y)$ sehingga $f(x,y) = M(x,y)dx + N(x,y)dy$
- Solusi umum untuk PD eksak orde pertama adalah $\boldsymbol{f(x,y) = c}$

The content in this worksheet is still too simple

(1)



**Ada 2 bentuk pada PD Orde Satu, yaitu :**

a. Bentuk Implisit

$F\left(x, y, \frac{dy}{dx}\right) = 0$ *atau* $F(x, y, y') = 0$

b. Bentuk Eksplisit

$\frac{dy}{dx} = f(x,y)$ *atau* $y' = f(x,y)$

**Contoh :**

1. $xy' + y^2 + x^2 + 4 = 0$ **atau** $x\frac{dy}{dx} + y^2 + x^2 + 4 = 0$

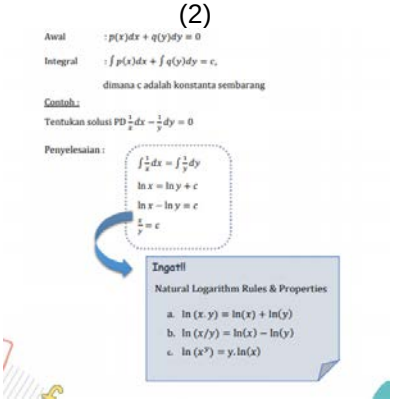
PD Orde Satu bentuk implisit

2. $y' = 5y + e^{2x}$ **atau** $\frac{dy}{dx} = 5y + e^{2x}$

PD Orde Satu bentuk eksplisit

Perhatikan letak orde turunan variabel $y$ terhadap $x$ nya

(2)



Awal : $p(x)dx + q(y)dy = 0$

Integral : $\int p(x)dx + \int q(y)dy = c,$

dimana c adalah konstanta sembarang

Contoh :

Tentukan solusi PD $\frac{1}{x}dx - \frac{1}{y}dy = 0$

Penyelesaian :

$\int \frac{1}{x}dx = \int \frac{1}{y}dy$

$\ln x = \ln y + c$

$\ln x - \ln y = c$

$\frac{x}{y} = c$

**Ingat!!**

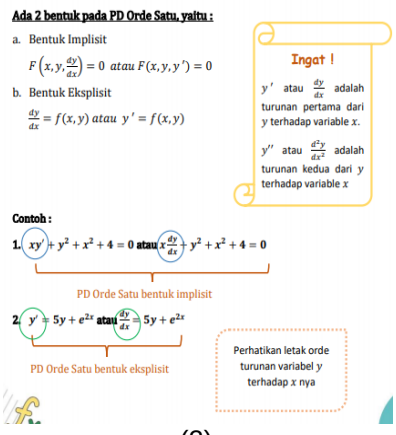
Natural Logarithm Rules & Properties

a. $\ln(x.y) = \ln(x) + \ln(y)$
b. $\ln(x/y) = \ln(x) - \ln(y)$
c. $\ln(x^y) = y.\ln(x)$

(3)

Additions to content on a worksheet

(1)



**Ada 2 bentuk pada PD Orde Satu, yaitu :**

a. Bentuk Implisit

$F\left(x, y, \frac{dy}{dx}\right) = 0$ *atau* $F(x, y, y') = 0$

b. Bentuk Eksplisit

$\frac{dy}{dx} = f(x,y)$ *atau* $y' = f(x,y)$

**Ingat !**

$y'$ atau $\frac{dy}{dx}$ adalah turunan pertama dari $y$ terhadap variable $x$.

$y''$ atau $\frac{d^2y}{dx^2}$ adalah turunan kedua dari $y$ terhadap variable $x$

**Contoh :**

1. $xy' + y^2 + x^2 + 4 = 0$ **atau** $x\frac{dy}{dx} + y^2 + x^2 + 4 = 0$

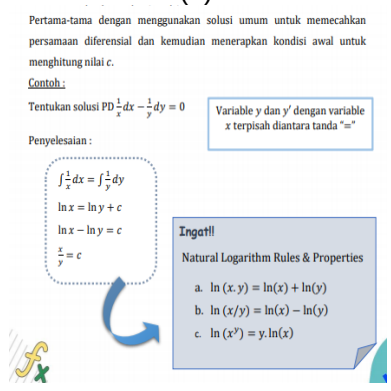
PD Orde Satu bentuk implisit

2. $y' = 5y + e^{2x}$ **atau** $\frac{dy}{dx} = 5y + e^{2x}$

PD Orde Satu bentuk eksplisit

Perhatikan letak orde turunan variabel $y$ terhadap $x$ nya

(2)



Pertama-tama dengan menggunakan solusi umum untuk memecahkan persamaan diferensial dan kemudian menerapkan kondisi awal untuk menghitung nilai $c$.

Contoh :

Tentukan solusi PD $\frac{1}{x}dx - \frac{1}{y}dy = 0$

Variable $y$ dan $y'$ dengan variable $x$ terpisah diantara tanda "="

Penyelesaian :

$\int \frac{1}{x}dx = \int \frac{1}{y}dy$

$\ln x = \ln y + c$

$\ln x - \ln y = c$

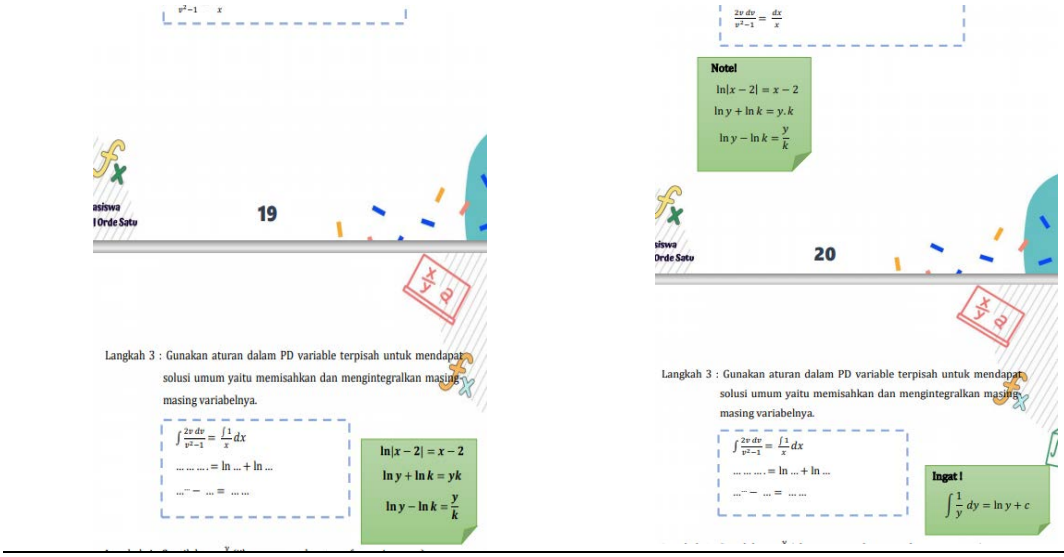
$\frac{x}{y} = c$

**Ingat!!**

Natural Logarithm Rules & Properties

a. $\ln(x.y) = \ln(x) + \ln(y)$
b. $\ln(x/y) = \ln(x) - \ln(y)$
c. $\ln(x^y) = y.\ln(x)$

(3)




b. Limitid Trial

Limited trial testing was carried out on 15 UHAMKA mathematics education students in semester IV of the 2019/2020 academic year. This limited test is in the form of student responses to perfecting the worksheet into prototype two which is assessed by indicators of presentation and interest in the worksheet. The responses of 15 students are depicted in the following figure:

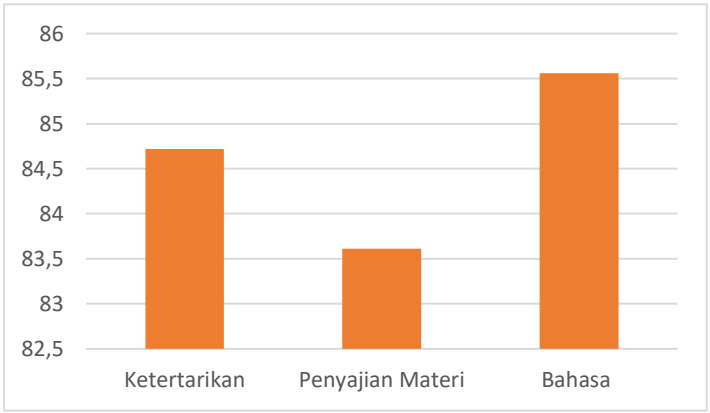



**Figure 3.** Limited Trial Response Result

Based on the picture above, the average students gave a response of 84.63, which means that the worksheet developed has “good” criteria. The next step is to make repairs before the worksheets are field-tested according to the suggestions given by students to produce prototype three which can be field-tested.

c. Field Trials

Field trials were carried out on UHAMKA Mathematics Education students who occupied the fourth semester of 2019/2020 class IVB with thirty students as respondents. There are two stages in the field trial, namely the student learning independence questionnaire before using the worksheet and the student learning independence questionnaire after using the worksheet. Aspects that become the assessment of the independent learning questionnaire are aspects of self-confidence, aspects of discipline behavior, aspects of having a sense of responsibility, aspects of behaving based on one’s initiative, and aspects of using worksheets. The result of the calculation of the learning independence questionnaire data covering these five aspects from thirty students can be concluded in the following figure:

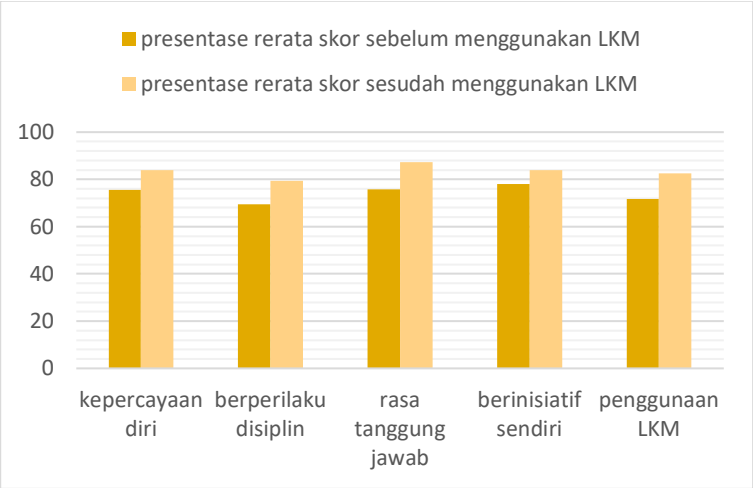



**Figure 4.** Field Test Response Data Results

In the above picture, the average percentage of each aspect indicates increased self-reliance learned from before and after using a worksheet. The average result is an increase in the overall aspect of 9,33%.

## CONCLUSIONS

The research was a Research and Development with a 4-D model and a stage Define, Design, Develop. The result of this study is a worksheet on a one-order differential equations matter that is believed to increase student independence. So that students can learn independently without the teacher's direction first. This is shown on the results od an average self-reliance response study before and after using a worksheet that there is an overall increase in all aspects of learning self-reliance as of 9,33%.

## REFERENCES

[1] Hapizah. "Pengembangan Instrumen Kemampuan Penalaran Matematis Mahasiswa Pada Mata Kuliah Persamaan Diferensial" *Jurnal Kreano*, vol. 5, no. 1, pp. 73-81, 2014.

[2] Panadero, E., Jonsson, A., & Botella, J. "Effects of Self-Assesment on Self-Regulated Learning and Self Efficacy:Four Meta-Analyses" *Educational Review*, vol. 22, pp. 74-98, 2017. https://doi.org/10.1016/j.edurev.2017.08.004

[3] Tasaik, H. L., & Tuasikal, P. "Peran Guru Dalam Meningkatkan Kemandirian Belajar Peserta Didik Kelas V SD Inpres Samberpasi" *Metodik Didaktik,* vol. 14, no. 1, pp. 45-55, 2018. https://doi.org/10.17509/md.v14i1.11384

[4] Musso, M. F., Boekaerts, M., Segers, M., & Cascallar, E. C. "Individual Differences In Basic Cognitive Processes And Self-Regulated Learning: Their Interaction Effects On Math Performance". *Elsevier*, vol. 71, pp. 58-70, 2019.

[5] Hacker, D. J., & Bol, L. *Calibration and Self-Regulated Learning Making the Connections*. *The Cambridge Handbook of Cognition and Education*. pp. 647-677, 2019. https://doi.org/10.1017/9781108235631.026

[6] Sumarmo, U. *Kemandirian Belajar: Apa, Mengapa, dan Bagaimana Dikembangkan pada Peserta Didik*. *Academia.Edu*, pp. 1–9. 2004. https://doi.org/10.1111/j.1095-8312.2011.01677

[7] Hadi, A. N., Djauhari, E., Supriatna, A. K., & Johansyah, M. D. "Teknik Penentuan Solusi Sistem Persamaan Diferensial Linear Non-Homogen Orde Satu" *Jurnal Matematika*, vol. 18, no. 1, pp. 29-40, 2019.

[8] Lumbantoruan, J. H. "Pengembangan Bahan Ajar Persamaan Diferensial Berbasis Model Brown" *Jurnal EduMatsains*, vol. 3, no. 2, pp. 147–168, 2019.

[9] Nurlaili, & Rifanti, U. M. "Analisis Kesalahan dalam Penyelesaian Permasalahan Persamaan Diferensial Linier Orde Pertama: Studi Kasus Mahasiswa Teknik Telekomunikasi ITTP" *Jurnal Gantang*, vol. 5, no. 1, pp. 29–37, 2020. https://doi.org/10.31629/jg.v5i1.1742

[10] Yunita, A., & Septia, T. "Efektifitas Lembar Kerja Mahasiswa (Lkm) Struktur Aljabar" *Jurnal Pelangi*, vol. 6, no. 2, pp. 101-111, 2015. https://doi.org/10.22202/jp.v6i2.295

[11] Hastari, R. C. "Analisis Kesulitan Penyelesaian Soal Matematika Ditinjau Dari Kecerdasan Emosional Mahasiswa Di Kabupaten Tulungagung" *JNPM (Jurnal Nasional Pendidikan Matematika)*,vol. 2, no. 2, pp. 180, 2018. https://doi.org/10.33603/jnpm.v2i2.829

[12] Basuki, W. A., & Wijaya, A. "The Development of Student Worksheet Based on Realistic Mathematics Education" *Journal of Physics: Conference Series*, vol 1097, no. 1, pp. 1–7 2018. https://doi.org/10.1088/1742-6596/1097/1/012112

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

# Anatomy Structure of Pericarpium and Pome Fruit

**Rina Hidayati Pratiwi[1]**

[1]Department of Mathematics and Natural Sciences, Post Graduated Program, Universitas Indraprasta PGRI, South Jakarta 12530, Indonesia

Correspondence email: rina.hp2012@gmail.com

## ABSTRACT

Research on anatomical structure of pericarpium and pome fruit have not been done yet. The aim of this study is to know the anatomical structure from pericarpium and pome fruit. The sample for pericarpium fruit is apple and pear, while tomato and orange are used for the pome fruit sample. The anatomical structure were observed microscopically using transverse and longitudinal slices of the developing pericarp. The results of this study indicated the presence of stomates on the epidermis tissue and is founded epicarp of pome fruit. Another anatomical structures are supporter tissue i.e. sclerenchyme with lignified sclereides in it, and parenchyma with pigmentation. The anatomical structure of epicarp on pericarpium fruit consisted of epidermis cell, parenchyma cell and secretory cells. Mesocarp of four kinds of fruits consisted of parenchyma tissues that each of the cell contained starch grains with pigmentation (antosianin) and ergastic compounds. There are ergastic compounds i.e. crystal, and atsiri oil substances. Antosianin can be found in apple and tomato fruit skin, whereas pear and orange fruit contained more ergastic substances. The invention from the anatomical research can be associated for the function and the advantage from the plant or something special that affected by adaptation pattern.

**Keywords:** Pome fruit, pericarp, mesocarp, endocarp

## INTRODUCTION

Fruits are found in three main anatomical categories: aggregate fruits, multiple fruits, and simple fruits. Simple fruits are formed from a single ovary and may contain one or many seeds. They can be either fleshy or dry. In fleshy fruit, during development, the pericarp and other accessory structures become the fleshy portion of the fruit [1]. The types of fleshy fruits are berries, pomes, and drupes [2]. The fleshy portion of the pomes is developed from the floral tube and like the berry most of the pericarp is fleshy but the endocarp is cartilaginous, an apple is an example of a pome [1].

In berries and drupes, the pericarp forms the edible tissue around the seeds. In other fruits such as Citrus and stone fruits (Prunus) only some layers of the pericarp are eaten. In accessory fruits, other tissues develop into the edible portion of the fruit instead, for example the receptacle of the flower in strawberries.

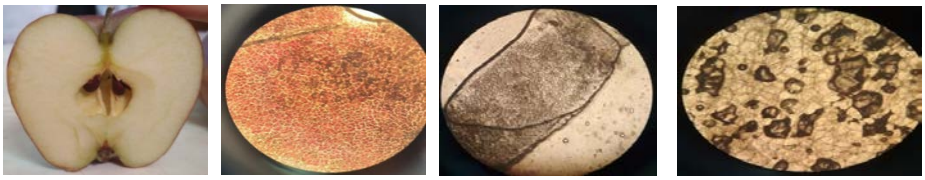
In fleshy fruits, the pericarp is typically made up of three distinct layers: the epicarp (also known as exocarp), which is the outermost layer; the mesocarp, which is the middle layer; and the endocarp, which is the inner layer surrounding the ovary or the seeds. In a citrus fruit, the epicarp and mesocarp make up the peel. Lately, the literature about fleshy fruits anatomy structure is still limited. Research about anatomy structure of plant organ is important for knowing tissue composition or structure, cell, and ergastic substances in the plant organ. The knowledge about anatomy structure can explain the reason for taste, odor, colour, and the merit of the plant organ hopely. The research anatomy structure of fruit is important for adding the information about the literature of fruit anatomy for teaching and research sources.

## RESEARCH METHOD

Investigations were carried out using fragments of fruit and peel sampled from the equatorial part of the fruit. Hand-cut samples obtained from fresh material were also viewed under light microscope to detect the distribution of the cuticle, chlorophyll, and lignified stone cell walls. Hand-cut cross-sections from fragments of apple, pear, tomato, and orange fruit. The anatomical description was made analyzing semi-permanent and permanent slides made with transverse and longitudinal sections of the pericarp part. The slides were made in agreement with methodology described by Mourao & Beltrati [2].

## RESULTS AND DISCUSSION

A pome is an accessory fruit composed of one or more carpels surrounded by accessory tissue. The accessory tissue is interpreted by some specialists as an extension of the receptacle and is then referred to as "fruit cortex"and by others as a fused hypanthium. It is the most edible part of this fruit. Although the epicarp, mesocarp, and endocarp of some other fruit types look very much like the skin, flesh, and core respectively of a pome, they are parts of the carpel. The epicarp and mesocarp of a pome may be fleshy and difficult to distinguish from one another and from the hypanthial tissue. The endocarp forms a leathery or stony case around the seed, and corresponds to what is commonly called the core. Pome-type fruit with stony rather than leathery endocarp may be called a polypyrenous drupe. The shriveled remains of the sepals, style and stamens can sometimes be seen at the end of a pome opposite the stem, and the ovary is therefore often described as inferior in these flowers.

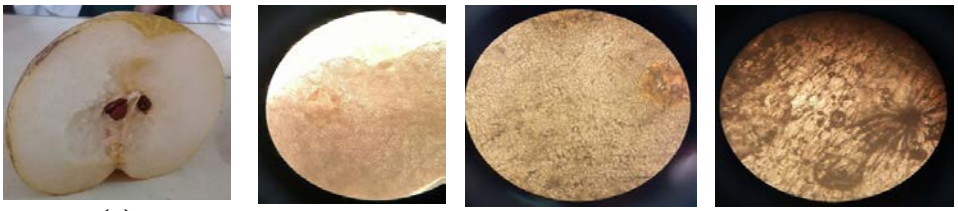


(a) (b) (c) (d)

**Fig 1.** The emergence of apple fruit sections: Apple in macroscopically (a); Apple outer epicarp in microscopically (b); Apple inner epicarp in microscopically (c); Apple mesocarp in microscopically (d)

A cross section of a apple shows the star-shaped endocarp housing the seeds (Figure 1). Each of the 5 chambers houses 1-2 seeds. The total number of seeds per apple (5-10) depends on the energy resources of the tree.

Around the star-shaped seed capsules are ten yellow-green dots that are the remnants of the flower stamens. The sepals surrounding the petals of the flower are at one end of the apple. Hypanthium that grows up and around the ovary housing the soon-to-be seeds, and filled with starch granules synthesized by the leaves over a summer's worth of sunlight.



(a) (b) (c) (d)

**Fig 2.** The emergence of pear fruit sections: Pear in macroscopically (a); Pear outer epicarp in microscopically (b); Pear inner epicarp in microscopically (c); Pear mesocarp in microscopically (d)

Pears, like apples, are members of the rose family, Rosaceae. Members of this family have fleshy fruits, known in botanical circles as pomes. The major parts of the pear are the core, the hypanthium and the stalk. The pear's core is the seed-bearing ovary of the fruit. Surrounding the numerous seeds is the ovary wall. Although the ovary wall is edible, its texture is a bit thick and dry. When you core a pear, you remove both the ovary wall and the seeds. The part of the pear that you eat is the hypanthium. In pears, this structure is referred to as accessory tissue because it is not part of the actual ovary. A pear's hypanthium contains numerous stone cells with thick walls. These cells give the pear its unique, grainy texture. The skin is part of the hypanthium. The stalk connects the fruit to the tree and supports the leaves. This part of the fruit is not edible.

The epidermis in both cultivars was formed by rectangular cells, whose height (length of anticlinal walls) was greater than the width (length of periclinal walls) (Figure 2). In this stage of fruit development, the epidermis exhibited features of meristematic tissue, as divisions of its cells were noted. At some sites, the epidermis was single-layered and divisions were visible along anticlinal walls; at other sites, the epidermis formed two cell layers as a result of division along the periclinal walls.

The hypodermis cells contained numerous chloroplasts and the cytoplasm of the epidermis cells contained cell nuclei, mitochondria, chloroplasts containing a few starch grains, and endoplasmic reticulum. The hypodermis in the fruits of both cultivars exhibited.

According to Tao et al. [4], the number of sclereids in pear parenchyma determines longterm storability of fruits and the length of their shelf life. Cultivars with stone cells (with lignified cells in the skin) lose lower amounts of water through microcracks and lenticels than these with nonlignified cells [5]. The emergence of pears (Figure 2.d) indicates the presence of secondary metabolites. Tannin is one of secondary metabolites. Lees et al. [6] have found that a high content of tannin compounds, which have preservative-bactericidal activity, enhances fruit storability. In the present paper it has been observed that high amounts of tannin materials are frequently accompanied by great numbers of stone cells.

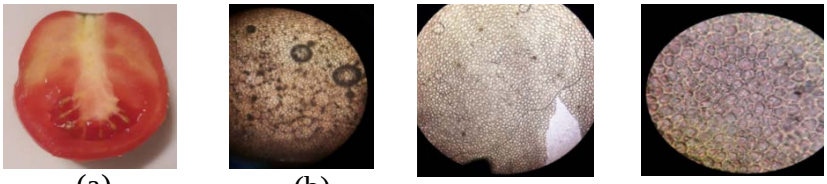



**Fig 3.** The emergence of tomato fruit sections: Tomato in transverse section of five locule tomato fruit macroscopically (a); Tomato epicarp in microscopically (b); Tomato mesocarp in microscopically (10x) (c); Tomato mesocarp in microscopically (40x) (d)

The tomato though commonly classified as a vegetable is really a fruit, a berry in fact. Tomato fruits exibit all of the common characteristics of berries. The fruit develops from the ovary of the flower. The tomato is fleshy due to the pericarp walls and skin (Figure 3). Finally there are several seeds in each tomato. Tomatoes can be either bilocular or multilocular. Most cultivated varieties except cherry tomatoes have four or five locules. The locules are surrounded by the pericarp. The pericarp includes the inner wall, columella; the radial wall, septa; and the outer wall. The pericarp and the placenta comprise the fleshy tissue of the tomato. The seeds are located inside of the locular cavities and are enclosed in gelatinous membranes.

There are vascular bundles throughout the outer wall of the pericarp and travelling from the stem to the center of the tomato and from there radiating to each seed. Tomato fruit consists of pericarp and seeds. Pericarp is composed from: exocarp, mesocarp and endocarp. Outer layer of cells in the exocarp is epidermis and below there are two to three layers of hypodermal cells with thick cell walls. Epidermis hasn't stomata and has relatively thin cuticle, and the thickness of cuticle increases with the fruit growth.

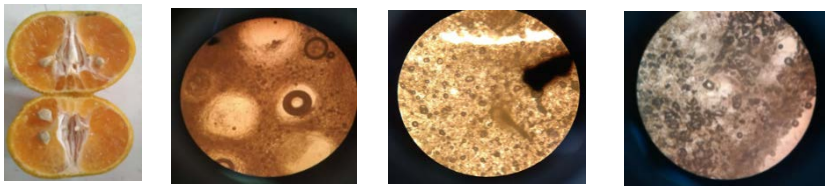
Mesocarp is the fleshy middle layer of the pericarp of a fruit that made from large thin wall cells and vascular tissue. The mesocarp is found between the epicarp and the endocarp and usually the part of the fruit that is eaten. For example, the mesocarp makes up most of the edible part of a peach, and a considerable part of a tomato. Mesocarp may also refer to any fruit that is fleshy throughout. Fruit vascular tissue is connected to pedicel vascular tissue. One vascular branch pass trough central and radial mesocarp to the seeds, while other vascular branches radialy pass through outer layer of mesocarp parallel to fruit surface, with week branching on proximal side, but more on distal side with simultaneously decreasing ratio of xylem and increased ratio of phloem.

Endocarp is unicellular layer boundaring locular cavity. Carpelar septe divide ovarium into two or more loculi. Elongated central placenta, with attached seeds, is made of parenchima tissue and represents primary tissue which later fills the locular cavities.

In citrus fruit, the mesocarp is also referred to as albedo or pith. It is the inner part of the peel and is commonly removed before eating. In citron fruit, where the mesocarp is the most prominent part, it is used to produce succade.

Endocarp is a botanical term for the inside layer of the pericarp (or fruit), which directly surrounds the seeds. It may be membranous as in citrus where it is the only part consumed, or thick and hard as in the stone fruits of the family Rosaceae such as peaches, cherries, plums, and apricots. The endocarp is separated into sections, which are called segments. These segments are filled with juice vesicles, which contain the juice of the fruit. Citrus fruit is considered a berry because it has many seeds (pips),

is fleshy, soft and develops from a single ovary. Citrus fruit is characterized by nonclimacteric development. Pericarp tissue surrounding a seed that develops from the ovary wall of the flower.



(a) (b) (c) (d)

**Fig 4.** The emergence of orange fruit sections: Orange in macroscopicaıly (a); Orange epicarp in microscopically (b); Orange endokarp in microscopically (c); Orange mesocarp in microscopically (d)

The exocarp is the orange rind contains numerous pits containing volatile oil glands. Albedo mesocarp is a spongy white tissue on the inside of the rind. Albedo consists of spongy layers of perenchymatus cells rich of glycosides (flavanones). Pectin and pectic enzymes make it bitter. The thread-like vascular bundles run from the albedo along the fruit's axis forming a network outside the carpels. They are rich in peroxidase.

## CONCLUSIONS

The anatomical structure of epicarp on pericarpium all fruit consisted of epidermis cell, parenchyma cell and secretory cells. The invention from the anatomical research can be associated for the function and the advantage from the plant or something special that affected by adaptation pattern.

## REFERENCES

[1] R.F. Evert RF, S.E. Eichhorn, J.B. Perry, P.H. Raven, Laboratory topics in botany: to accompany Raven Biology of plants (8th ed.). New York, NY: W.H. Freeman and Co. ISBN 9781464118104. OCLC 820489734, 2013.

[2] C. Dardick and A.M. Callahan, "Evolution of the fruit endocarp: molecular mechanisms underlying adaptations in seed protection and dispersal strategies". Frontiers in Plant Science. 5: 284. doi:10.3389/fpls.2014.00284. PMC 4070412. PMID 25009543, 2014.

[3] K. S. M. Mourão, C. M. Beltrati, “Morphology and Anatomy of Developing Fruits and Seeds of Mammea Americana L. (Clusiaceae)”, *Revista Brasileira de Biologia*, vol. 60, no. 4, 2000.

[4] S. Tao, S. Khanizadeh, H. Zhang, and S. Zhang, “Anatomy, ultrastructure and lignin distribution of stone cells in two Pyrus species,” Plant Science, **176**(3), 413–419 (2009).

[5] C. Amarante, N. H. Banks, and S. Ganesh, “Relationship between character of skin cover of coated pears and permeance to water vapour and gases,” Postharvest Biology and Technology, **21**(3), 291–301 (2001).

[6] G. L. Lees, K. M. Wall, T. H. Beveridge, and N. H. Suttill, “Localization of condensed tannins in apple fruit peel, pulp, and seeds,” Canadian Journal of Botany, **73**(12), 1897–1904 (1995).

[7] Johnson, L. R., & Sandhu, D. S. (2007). Isolation, adjustment, and acculturation issues of international students: Intervention strategies for counselors. In H. Singaravelu & M. Pope (Eds.), *A handbook for counseling international students in the United States* (pp. 13-35). Alexandria, VA: American Counseling Association.

[8] Komiya, N., & Eelss, G. T. (2001). Predictors of attitudes toward seeking counseling among international students. *Journal of College Counseling, 4,* 153-160. doi:10.1002/j.2161-1882.2001.tb00195.x

[9] Kuo, W. H., & Tsai, Y. M. (1986). Social networking, hardiness and immigrant's mental health. *Journal of Health and Social Behavior, 27,* 133-149. doi:10.2307/2136312

*Proceeding books:*
The 2nd International Conference of Education on Science, Technology, Engineering, and Mathematics (ICE-STEM 2020)

# Analysis of Mathematical Connection Ability on the Probability Material for XI Grade SMK

**Purwanti[1], Mardiyana[1], D. Indriati[1]**

[1]Magister of Mathematics Education, Faculty of Education, Sebelas Maret University
Jl. Ir. Sutami No.36, Kentingan, Kec. Jebres, Kota Surakarta, Jawa Tengah 57126

Correspondence email: purwanti17ipoo@gmail.com

## ABSTRACT

The purpose of this study was to analyze the mathematical connection ability of class XI students of SMK Negeri 1 Wonoasri. This type of research is descriptive qualitative. The subjects of the study were students of class X SMK 1 Wonoasri Academic Year 2019/2020. The instruments of this study were observation and interview sheets as well as mathematics connection ability tests. The results showed that learning in schools is learning discussed by teachers, with conventional methods that minimally involve students who are active in learning. Connection test results show the percentage of mathematical connection ability on the first indicator is 54,37%, the second indicator is 18,75%.

**Keywords:** Connection ability, mathematic, probability

## INTRODUCTION

Mathematics is a science that has an important role in human life [1], [2]. Various problems and activities carried out by humans cannot be separated from Mathematics [3]. Learning mathematics in schools has an important role because mathematics is a discipline that relies on thought processes. NCTM (2000) states that five basic mathematical skills that become standard in learning mathematics, namely problem solving, reasoning, communication, connections, and representation [3]. The five basic skills that students must possess to achieve maximum learning outcomes. Considering that, the mathematical connection becomes one of the basic skills that play an important role in the process of solving mathematical problems. This is because in understanding students are required to be able to understand more than one concept and relate it [4], [5].

Mathematical connection ability is the ability of students to look for relationships of representations of concepts and procedures, understanding between mathematical topics, and the ability of students to apply mathematical concepts in other fields of everyday life. NCTM [3] also states that a mathematical connection is a link between mathematical topics with other disciplines and the relationship of mathematics with the real world or everyday life. Through connection skills students can understand that mathematics is a broad science, not only used in the scope of mathematics itself but also the other sciences and everyday life.

Thus, the ability to be able to connect mathematics can be used as an important measure to see success in learning mathematics, the ability to connect mathematics with various other sciences is called mathematical connection ability. [6] states that the ability of mathematical connections is the ability to connect between concepts in mathematics and connect mathematical concepts and non-mathematical concepts. That is, mathematics is not partitioned apart on various topics, but is a unity that is interconnected between concepts.

To create this kind of learning orientation, a supportive learning atmosphere is needed, but based on the results of researchers' observations in the field, learning done in schools has not been oriented that way. Learning in schools is learning that is dominated by teachers, with conventional methods that minimally involve students actively in learning. So it is difficult for students to develop their ideas and knowledge. [7] also states that learning mathematics in Indonesia is still too monotonous and less stimulating for students and makes students forced to learn in ways they don't like.

Therefore, learning mathematics must be able to see that ideas in mathematics are interrelated. Mathematical connections need to be applied in learning mathematics related to connections with

everyday life to build students' knowledge and skills [8]. Thus students will better understand the usefulness of mathematics if learning is also associated with daily student experiences..

The connection is derived from the word connection which means relationship or connection, while the connection associated with mathematics is called a mathematical connection. Mathematical connection ability is the ability of students to connect or associate various problems with mathematical concepts, the relationship is included in the context of mathematics or outside mathematics [9].

Mathematical connections become more important because they support students to understand concepts substantially and help them to improve their understanding of other disciplines through the mutual relationship between mathematical concepts and conceptions of other disciplines. Besides, mathematical connections help students provide mathematical models that illustrate the relationship between concepts, data, and situations. People who have understood a rule can understand several concepts. Connection, in other words, can be interpreted as a linkage, in this case, mathematical connections can be interpreted as a link between internal mathematical concepts that is related to mathematics itself or external linkages, namely mathematics with other fields both other fields of study and with everyday life day. Therefore, for students to be more successful in learning mathematics, many opportunities must be given to see the connections.

Mathematical concepts must be learned in a structured manner by paying attention to a certain order of matter. In mathematics, there are topics or prerequisite concepts to understand the next topic. Not only are these concepts interconnected with each other, but mathematical concepts in everyday life are also interrelated. This connection is called a mathematical connection.

Mathematical connections are divided into 3 aspects of connection groups that will be indicators of students 'mathematical connection abilities, namely: 1) aspects of connections between mathematical topics, 2) aspects of connections with other sciences, 3) aspects of connections with students' real-world / connections with daily life - day [3].

There is an activity phase in mathematical connections, According to [3], these activities include: a) recognizing and using relationships between mathematical concepts; b) understand how mathematical ideas are interconnected and constructive to produce something intact; c) understand and apply mathematics in other fields (outside mathematics).

Whereas [10] stated that the activities involved in the mathematical connection task are as follows: a) understanding the representation of a mathematical concept, process, or procedure; b) looking for relationships between various mathematical concepts, processes, or procedures; c) understanding the mathematical relationships between mathematics; d) applying mathematics in other fields of in everyday life; e) looking for the relationship of one procedure with other procedures in equivalent representation; f) apply the relationship between mathematical topics with mathematical topics, or with other scientific disciplines.

Based on the above theoretical study, in general, there are three aspects or indicators of mathematical connection ability, namely:

1. Through problems in everyday life, students can write mathematical modeling. At this stage, students are expected to be able to connect between existing forms of problems with mathematical concepts.
2. Write down the mathematical concepts that underlie the answers. In this aspect, students are expected to have answers that are by the mathematical concepts used.
3. Connecting between mathematical objects and concepts. In this aspect, students are expected to be able to connect between mathematical objects and concepts used in answering problems, as well as completing mathematical operations that have been written previously based on knowledge or concepts that have been obtained.

The three indicators can be seen briefly in Table 1. below:

**Table 1.** Indicators of Mathematical Connection Capabilities

| No | Activity |
|---|---|
| 1. | Able to write mathematical modeling |
| 2. | Write down the mathematical concepts that underlie the answers |
| 3. | Connecting between mathematical objects and concepts |

From some of the indicators above, it can be concluded that the indicators of a mathematical connection are as follows:
1. The relationship between mathematical concepts and everyday life
2. Relationships between mathematical concepts
3. Relationship of mathematical concepts with other disciplines.

In this study only used the method to analyze the ability of mathematical connections in the material opportunity class XI at SMK 1 Wonoasri. There are three indicators of mathematical connection analyzed, namely, the relationship between mathematics and everyday life, and the relationship between objects and mathematical concepts, and Relationship of mathematical concepts with other disciplines. However, this study is limited by two indicators, namely: the relationship between mathematics and daily life and the relationship between objects with mathematical concepts.

## RESEARCH METHOD

The research method used is qualitative descriptive, this research was conducted at SMK NEGERI 1 Wonoasri with the subject of this study were 32 students of class XI. The material used is the class xi probability material. This study uses a mathematical connection ability test instrument. The ability test instrument consists of one problem with two questions. the assessment techniques used in this study use the following guidelines in **Table 2** to mathematical ability capability grid and T**able 3 to t**est scoring guidelines mathematical connection ability:

**Table 2.** Mathematical Ability Capability Grid

| Number | Indicators of Mathematical Connection Ability | Indicators of Probability |
|---|---|---|
| 1. | The relationship between mathematics and daily life | Students can apply the concept of probability in daily life problems |
| 2. | The relationship between objects with mathematical concepts | Students can state the concept used and its relationship to the problem |

**Table 3.** Test Scoring Guidelines Mathematical Connection Ability

| Rated Aspect | Reaction to the problem | Score |
|---|---|---|
| The relationship between mathematics and daily life | No Answer | 0 |
| | The answer is almost inconsistent with questions or problems | 1 |
| | Some answers according to the question or with the problem but the connection is not clear | 2 |
| | Some answers according to questions or with problems and connections clear but not complete | 3 |
| | The answer according to questions or with problems but not complete | 4 |
| | The answer according to questions or with problems and complete | 5 |
| The relationship between objects with mathematical concepts | No Answer | 0 |
| | The answer is almost inconsistent with questions or problems | 1 |
| | Some answers according to the question or with the problem but the connection is not clear | 2 |
| | Some answers according to questions or with problems and connections clear but not complete | 3 |
| | The answer according to questions or with problems but not complete | 4 |
| | The answer according to questions or with problems and complete | 5 |

$$\text{Score(N)} = \frac{\text{obtained score}}{10}\ x\ 100$$

With references like the following:

| Percentage | Category |
|---|---|
| $85 \leq N \leq 100$ | Very good |
| $70 \leq N < 85$ | Well |
| $55 \leq N < 70$ | Good Enough |
| $40 \leq N < 55$ | Less |
| $0 \leq N < 40$ | Very Less |

## RESULTS AND DISCUSSION

In this study, used questions to measure the mathematical connection ability of students as follows: Anis, Bela, and Citra take pictures together in different positions. If they want to print all the photos with each different position. Determine:
1. The costs they incur if the price of each photo is Rp 10,000?
2. Write down the concepts used and connect with problems!

The results showed the ability of mathematical connections for class XI students of SMK 1 Wonoasri was still very low. The results of Percentage of mathematical connection capabilities can showed at **Table 4**. Most students do not understand the relationship between objects and mathematical concepts to meet the indicators of mathematical connection ability. The ability of mathematical connections can be obtained by considered the ability to associate basic concepts or knowledge acquired with new concepts or knowledge gained.

**Table 4.** Percentage of Mathematical Connection Capabilities

| Indicators | Score | Total Score | Percentage | Category |
|---|---|---|---|---|
| The relationship between mathematics and daily life | 87 | 160 | 54,37% | Less |
| The relationship between objects with mathematical concepts | 30 | 160 | 18,75% | Very Less |

The research that is relevant to this research is a study conducted by Siregar & Surya (2017) which shows that the results of the study show that the percentage of students' mathematical connection ability in the first indicator is 51.11%, the second indicator is 17.78%.

Likewise with the research of Kenedi, et al (2019), which showed 6.67% of the sample chose between 60 and 69 in the fair category. As many as 98 students or 81.67% scores between 45 and 59 are included in the category below the average, and 14 students or 11.67% get scores between 0 and 44 that are classified as poor categories. These results prove that the mathematical connection ability of elementary school students in solving mathematical problems is still low.

## CONCLUSIONS

From the above description and relevant research, this study has analyzed the ability of mathematical connections with this indicator and the results, the ability of students of class XI of 1 Wonoasri Vocational School is still very low by using the method of Mathematics connection ability indicators.

## REFERENCES

[1] K. Kenedi, A, Y. Helsa, Y. Ariani, M. Zainil, and S. Hendri, “Mathematical Connection of Elementary School Students to Solve Mathematical Problems,” *J. Math. Educ.*, vol. 10, no. 1, pp. 69–80, 2019.
[2] A. D. Sapto, H. Suyitno, and B. E. Susilo, “The Effectiveness of Learning Reacting Strategies with The SSC Model Against Ability of Communication Communication Mathematics and Trust in Student Class VII,” *Unnes J. Math. Educ.*, vol. 4, no. 3, pp. 223–229, 2015.

[3] N. National Council of Teachers of Mathematics, *Principle and Standards for School Mathematics*. Reston, VA: NCTM, 2000.
[4] E. E. Rohaeti and M. Bernard, "The Students'mathematical Understanding Ability Through Scientific-Assisted Approach of Geogebra Software," *Infin. J.*, vol. 7, no. 2, pp. 165–172, 2018.
[5] S. Isnaeni, A. Ansori, P. Akbar, and M. Bernard, "Analysis Of Mathematical Connection Of Junior High School Students on Equation and Equation In Linear One Variables," *J. Educ.*, vol. 1, no. 2, pp. 309–316, 2019.
[6] Saminanto and Kartono, "Analysis of Mathematical Connection Ability in Linear Equation with One Variable Based on Connectivity Theory," *Int. J. Educ. Res.*, vol. 3, no. 4, pp. 259–270, 2015.
[7] D. Rohendi, "Developing E-Learning Based on Animation Content for Improving Mathematical Connection Abilities in High School Students," *IJCSI Int. J. Comput. Sci. Issues*, vol. 9, no. 1, pp. 1–5, 2012.
[8] N. Islamiah, W. E. Purwaningsih, P. Akbar, and M. Bernard, "Relationship Analysis of Mathematical Problem Solving Ability and Self Confidence of Middle School Students," *J. Educ.*, vol. 1, no. 1, pp. 47–57, 2018.
[9] S. N and S. E., "Analysis of Students' Junior High School Mathematical Connection Ability," *Int. J. Sci. Basic Appl. Res.*, 2017.
[10] H. Hendriana and U. Soemarmo, *Penilaian Pembelajaran Matematika*. Bandung: PT Refika Aditama, 2014.