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Development of multiple representation based mechanics lectures using dependent and independent field (MR-FD & FI)

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Abstract. This study aims to develop mechanics lectures based on multiple representations using field dependent and field independent cognitive styles (MR-FD & FI), in understanding the mastery of the concept of mechanics. In the context of physics learning based on multiple representations is to combine two or more representations as a form of learning development that is used to understand and convey physics concepts. Cognitive style can be divided into two, namely: dependent field cognitive style (FD) and independent field cognitive style (FI). The third semester student research subjects numbered 21 students from a university in Jakarta Indonesia. The first instrument used consisted of modules containing MR-based content consisting of 4 mechanical contents namely; gravity and central force (GGS), particle system dynamics (DSP), rigid body rotation (RBT) and rigid body rotation in three dimensions (RBT3D) that must be filled. The second instrument is a student worksheet (LKM) in which there are questions in accordance with the indicators and objectives of MR-based lectures undertaken by students. Descriptive quantitative and qualitative research methods were carried out to get a clear picture of the implementation of MR using the cognitive styles of FD and FI. The results showed that most students have a field dependent thinking style (FD) seen in the post-test results on GGS material 61.90%, RBT 61.90%, DSP 57.14% and RBT3D 57.14%. For independent field thinking (FI), the results of post-test results were 42.86% DSP, RBT 38.10%, RBT3D 38.10% and GGS 33.33%. It is concluded that students' thinking styles can change from thinking styles that were initially field dependent (FD) can change to field independent (FI). This can occur due to various factors, including; 1) Health conditions, classrooms and students focus; 2) The level of difficulty and ease of conceptualization of the material being studied; 3) Basic math and physical abilities. Limitations in this study involve only subjects from small classes from one university, so the results are not strong enough to represent the overall situation, this could be a way to conduct further research with more students and various subjects. This study is the first to map the understanding of the concept of mechanics based on multiple representations using the cognitive style of FD and FI, the results of the study find new discoveries, where all students have a cognitive style of either FD or FI.

1. Introduction

The lecture process for the past 5 years resulted in unsatisfactory learning outcomes. This is based on the findings that students encounter difficulties when attending lectures with many abstract concepts



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that they must understand with in-depth explanations so that the impact on teaching and learning processes that are less interesting, less motivated to learn deeper mechanics, weak mastery of mathematical calculus which in the end will cause the overall learning outcomes of mechanics to be low [1]. The low learning outcomes student may occur because learning is more often using the lecture and question and answer methods and problem solving. Students more often only listen and record what is explained by the lecturer. Examples and practice questions provided are only using mandatory books or power points of teaching material made by lecturers. So it can be concluded that the understanding of the concept of mechanics is not complete. A full understanding of the concept of physics is needed to form graduates who are able to compete and be professional in accordance with the objectives of the Physics Education study program. With an understanding of the concept of mechanics as a whole can be understood, analyzed, and interpreted correctly. Based on the problems above the development of the lecture system by showing several steps in the preparation of the lecture system as an application of a simple system approach. The first step is identifying the lecture needs, the objectives of the lecture in general, the student's behavior and initial characteristics. The second step is developing a lecture instrument, consisting of developing a semester lecture plan (RPS), lecturing modules, developing student worksheets (LKM), and test questions. The solution to the steps in preparing the lecture system will be outlined in the development of the preparation of multiple representation-based RPS (MR), the MR-based mechanics module uses thinking style (cognitive style) independent field type (*FI*) and field dependent (*FD*), and the development of student worksheets (LKM) based on MR.

Each individual has unique characteristics, which are not shared by other individuals. Therefore, it can be said that each individual is different from one another. In addition to being different in their level of problem solving skills, level of intelligence, or ability to think, students can also differ in how they acquire, store and apply knowledge. They can differ in the way they approach learning situations, in how they receive, organize and relate their experiences, in how they respond to certain teaching methods. These interpersonal differences that persist in the way they organize and process information and experiences are known as cognitive styles [2]. Cognitive style refers to the way a person processes, stores or uses information to respond to a task or respond to various types of environmental situations. Called style and not ability because it refers to how a person processes information and solves a problem and not to the best solution. There are several notions of cognitive style (cognitive style) put forward by some experts, but in principle the understanding is relatively the same. Cognitive style is the typical ways individuals build or shape their beliefs and attitudes about the world around them and the ways they process and react to information that is received or received [3].

Classifying students into independent field types (*FIs*) if they are able to separate substances from their context or from the global area, they have analytical tendencies. Whereas students are categorized as Field dependent (*FD*) if they have a better tendency to recall social information such as conversation and an overall picture of the given context [4]. Summarizing the general tendencies of the learning styles of FI and FD students, namely FI students during the learning process do not follow the standard procedures stated in a problem, he better understands it by transferring the problem to a new structure based on the main concept of the problem [5]. Cognitive style is a typical way of functioning perceptual activities, namely: the habit of giving attention, receiving, capturing, feeling, selecting, organizing stimulus or information and functioning intellectual activities, namely: interpreting, classifying, changing the form of intellectual information. This particular method is consistent and can enter into all behaviors, both in the cognitive and affective aspects [6,7]. Cognitive style can be divided into two, namely: dependent field cognitive style and independent field cognitive style. In learning activities each individual can be divided into two groups, namely global and analytic.

Individuals who are global are individuals who accept something more globally and have difficulty separating themselves from their surroundings or are more influenced by the environment. Individuals who are like this are called cognitive style Dependent Field (FD). While individuals who are analytic are individuals who tend to express something apart from the background of the image, and are able to distinguish objects from the surrounding context [8]. They look at their surroundings more analytically. Individuals who are like this are called Independent Field cognitive style (FI). Witkin describes

cognitive style based on global-analytical. Witkin determines the extent to which a person copes with the effects of deceptive background elements when they try to distinguish relevant aspects of a particular situation. The more independent someone is about being deceitful, the more analytic. People who can operate in an analytical way are called independent fields and people who operate in a global way are called dependent fields. Based on the description above, Witkin distinguishes a person's cognitive style into two types, namely: a. Independent field. People who can overcome the effects of deception by analytic. b. Field dependent.

People who overcome the effects of deception in a global way. Characteristics of individuals who are dependent fields and independent fields, as follows: a) In carrying out a task or solving a problem, an independent field individual will work better if given freedom. Whereas individuals who are dependent fields will work better if given extra instructions or guidance (more). b) Individuals who are independent fields have a tendency not to be easily influenced by the environment, and conversely individuals who are dependent fields have a tendency to be more easily influenced by the environment. c) In completing a task or solving a problem (problem solving) that requires a skill, individuals who are independent fields will produce better than individuals who are field dependent. The classification of individuals into one cognitive style is done by giving a perceptual test. states that The Embedded Figures Test (EFT) is a perceptual test that uses images. The reference to the outer framework which is substituted in the form of a complex picture, which hides a simple picture [9,10].

Characteristics of FI students; 1) Tend to be more comfortable learning by themselves and find (discovery), 2) In proving something more concepts using reasoning skills and have autonomy for their actions, 3) Learning inquiry-based experimental methods, 4) Articulation will perceive analytically, 5) In learning tend not to need intensive guidance, autonomy for their actions, and in proving something the concept can use more reasoning skills, 6) Can separate stimuli in the context, but perceptions are weak when context changes occur, 7) Usually use internal factors as direction in process information, 8) In social situations it is better to feel external pressure, and respond to situations coldly, distance, insensitive. Individuals who have the Field Independent cognitive style have their own characteristics: (1) have the ability to analyze in separating objects from things contained in their environment; (2) has the ability to organize an object; (3) impersonal oriented; (4) choosing a profession that tends to be individual; (5) objectives described individually; and (6) internal reinforcement and intrinsic motivation are preferred. Field dependent if they have a better tendency to recall social information such as conversation as well as an overall picture of the given context.

Characteristics of FD students; 1). In addition to enjoy learning in groups, 2) Students are influenced by figures and pay attention to others, 3) Global perceptual feels a heavy burden difficult to process, easy to perceive if information is manipulated according to context, 4) Need to get guidance and reinforcement from the teacher when learning take place, 5) Tends to be more kind, including being warm, sociable, friendly, responsive, always wanting to know more, when compared to FI people, 6) As often as possible interacting with the teacher and requiring extrinsic reinforcement. 7) In proving something tends to lack the ability of reasoning. Field Dependents have characteristics including: (1) tend to have global thinking; (2) the tendency to accept existing structures, due to lack of restructuring capabilities; (3) has a social orientation so that it looks good, friendly, wise, kind, and loving towards others; (4) tend to choose professions that emphasize skills; (5) tend to follow the goals that already exist; and (6) tend to work with the importance of external motivation and more interested in strengthening external motivation such as praise, gifts, or external motivation from others.

2. Methods

The research subjects are students of Physics Education FKIP - UHAMKA academic year 2018/2019, semester. The study design uses modified development research. The research was conducted at one private university in Jakarta, involving third year undergraduate students (N=21) as participants, started from December 2018 to January 2019. This is a mixed method research quantitative and qualitative triangulation approach.

3. Results

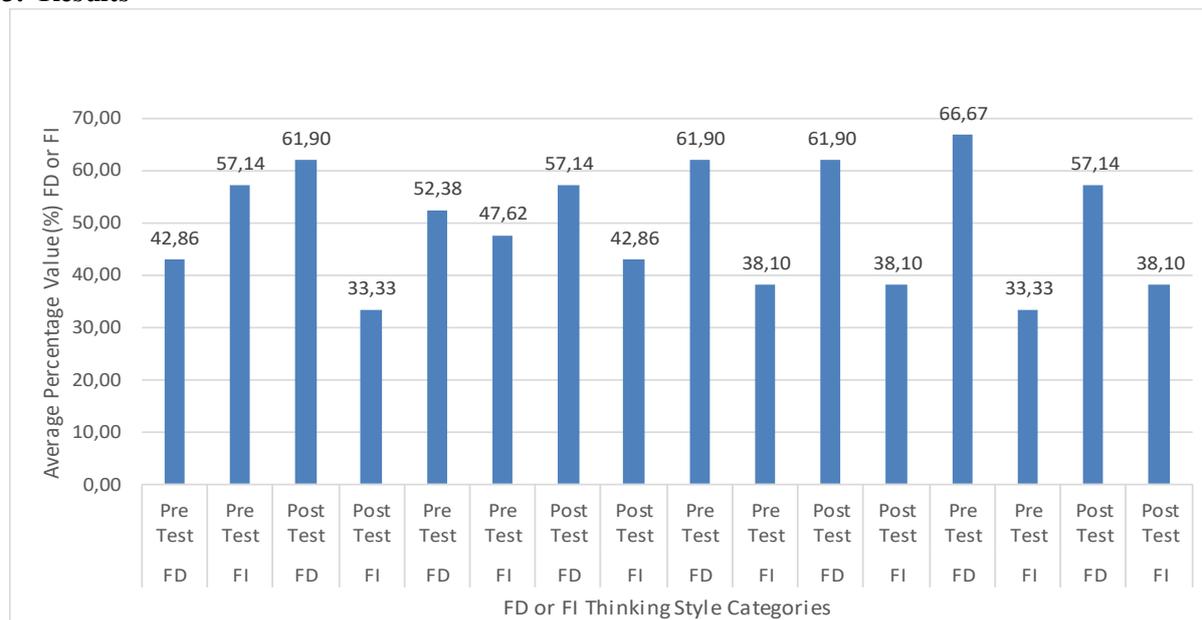


Figure 1. Analysis results thinking Field Dependent (FD) and Field Independent (FI).

On the data graph analysis of students' thinking patterns, the results are obtained:

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- On the particle system dynamics material (DSP) the percentage of students pre-test results obtained with FD thinking style is 52.38% and FI 47.62%. After being given treatment and post test results in the percentage of FD 57.14% thinking style and 42.86% FI.
- In the material rotation of rigid objects (RBT), the results obtained percentage of pre-test students with FD 61.90% thinking style and 38.10% FI. After being given treatment and carried out post-tests produced a percentage of FD 61.90% thinking style and 38.10% FI.
- In the material rigid objects in three dimensions (RBT3D) obtained the results of the percentage of pre-test students with FD 66.67% thinking style and FI 33.33%. After being given treatment and carried out post-tests produced a percentage of FD 57.14% thinking style and 38.10% FI.

It is concluded that students' thinking styles can change from thinking styles that were initially field dependent (FD) can change to field independent (FI). This can occur due to various factors, including; 1) Health conditions, classrooms and students focus; 2) The level of difficulty and ease of conceptualization of the material being studied; 3) Basic math and physical abilities.

4. Conclusion

From this it can be concluded that students' thinking styles can change from thinking styles that were initially field dependent (FD) can change to field independent (FI) this can occur due to various factors, including; 1) Health conditions, classrooms and students focus; 2) The level of difficulty and ease of conceptualization of the material being studied; 3) Basic math and physical abilities. Overall, it can be concluded that the students used as research samples show that most students have a field dependent thinking style (FD) seen in the post-test results on GGS material 61.90%, RBT 61.90%, DSP 57.14% and RBT3D 57.14%. For independent field thinking (FI), the results of post-test results were 42.86% DSP, RBT 38.10%, RBT3D 38.10% and GGS 33.33%.

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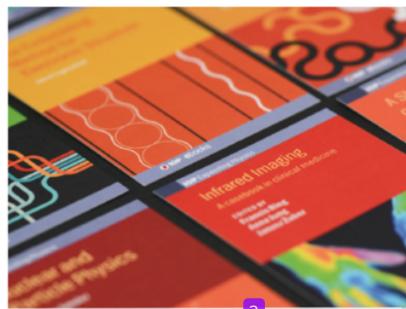
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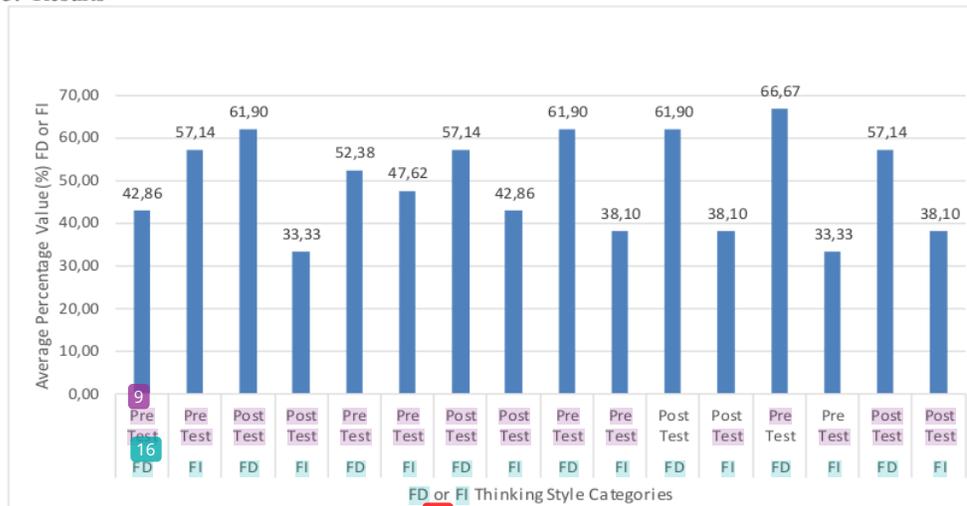


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From this it can be concluded that students' thinking styles can change from thinking styles that were initially field dependent (FD) can change to field independent (FI) that can occur due to various factors, including; 1) Health conditions, classrooms and students focus; 2) The level of difficulty and ease of conceptualization of the material being studied; 3) Basic math and physical abilities. Overall, it can be concluded that the students used as research samples show that most students have a field dependent thinking style (FD) seen in the post-test results on GGS material 61.90%, RBT 61.90%, DSP 57.14% and RBT3D 57.14%. For independent field thinking (FI), the results of post-test results were 42.86% DSP, RBT 38.10%, RBT3D 38.10% and GGS 33.33%.

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