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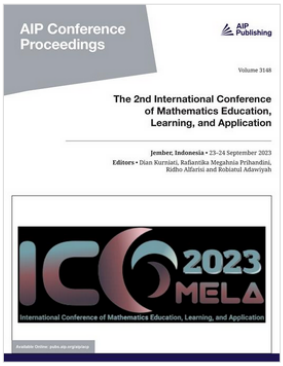

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Development of learning applications on mobile phones based on RME for permutation of several same elements

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The huge use of mobile phones needs to be utilized to improve student learning outcomes. For this reason, it is necessary to develop interesting learning on mobile phones. In order for the presentation of learning on mobile phones to be interesting, especially for learning mathematics, it is necessary to make connections with human activities. Mathematics learning activities that connect with human activities are known as Realistic Mathematical Education (RME). The novelty of this research is to create an RME-based mobile phone application for permuting several of the same elements. The research method used is development research which consists of 4 stages, namely; (1) planning; (2) development; (3) evaluation; and (4) testing and production. RME-Based Mobile Phone Learning Application for Permutations of the Same Elements, consists of 5 parts, each part consists of RME model learning stages, namely presenting real problems and displaying several model levels towards mathematical concepts.

Development of Learning Applications on Mobile Phones Based on RME For Permutation of Several Same Elements

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Abstract. The huge use of mobile phones needs to be utilized to improve student learning outcomes. For this reason, it is necessary to develop interesting learning on mobile phones. In order for the presentation of learning on mobile phones to be interesting, especially for learning mathematics, it is necessary to make connections with human activities. Mathematics learning activities that connect with human activities are known as Realistic Mathematical Education (RME). The novelty of this research is to create an RME-based mobile phone application for permuting several of the same elements. The research method used is development research which consists of 4 stages, namely; (1) planning; (2) development; (3) evaluation; and (4) testing and production. RME-Based Mobile Phone Learning Application for Permutations of the Same Elements, consists of 5 parts, each part consists of RME model learning stages, namely presenting real problems and displaying several model levels towards mathematical concepts.

INTRODUCTION

The huge use of mobile phones needs to be utilized to improve student learning outcomes. For this reason, it is necessary to develop interesting learning on mobile phones. The advantage of mobile phone-based learning is that students have the opportunity to repeat learning anywhere and at any time. Several studies show the effectiveness of learning using mobile phone facilities, such as research by Astra (2015) [1], Uwais (2015) [2], Amin (2021) [3], Watomakin (2017) [4], Shuib (2015) [5], and Ruhimat (2020) [6].

In order for the presentation of learning on mobile phones to be interesting, especially for learning mathematics, it is necessary to make connections with human activities. Mathematics learning activities that connect with human activities are known as Realistic Mathematical Education (RME). The characteristic of RME is that learning starts with real problems and continues by generating several models leading to mathematical formulas [7]. Several studies show that RME can improve mathematics learning outcomes, such as Saleh's research et. al[8] , Altaylar [9], Laurent [10], Rasmussen [11], Majeed [12], Kusumah Ningsih [13] , Aksu [14], Putri [15], and Uyen et. al [16].

State of Art

Several studies show the effectiveness of using mobile phones in learning. Astra Research (2015) developed an application on mobile phones for "properties of ideal gases such as Boyle's law, Charles's law, and Gay Lussac's law"[1]. Uwais (2015) developing learning applications on mobile phones for chemistry lessons [2]. Amin's research (2021) on The Effectiveness of Mobile Blended Problem Based Learning on Mathematical Problem Solving for the subject of sequences and series at Senior High School [3]. Watomakin's (2017) research on Mobile Application Design for Ordering Clean Water [4]. Study Shuib (2015) Designing an Intelligent Mobile Learning Tool for Grammar Learning [5]. Study Ruhimat (2020) developing Interactive Mobile Learning Software for electronics lessons [6].

By looking at research on the use of mobile phones for learning, it inspired the author to create interesting mathematics learning on mobile phones. Learning mathematics will be interesting if the learning of mathematical concepts is linked to human activities. This learning activity is known as Realistic Mathematic Education (RME). Several studies show that RME can improve mathematics learning outcomes. Saleh et al researched RME learning for fraction material in elementary school [8], Altaylar researched RME learning for statistics material in elementary school (Elementary School)[9], Laurent did RME research for geometry material in junior high school

[10], Rasmussen researched RME for differential equations in college [11], Majeed researched RME for functional materials in 5th grade elementary school, this research shows that RME-based teaching materials make learning interesting [12], Kusumah Ningsih researched RME for algebra material in Class VII Middle School [13], Aksu researched RME learning for geometry in junior high school [14] Putri researched RME for spatial abilities and motivation of junior high school students [15], Uyen et al's research on RME learning for statistics material in junior high school (Grade 7) [16], Azhar researched the influence of RME on Madrasayah Aliyah students' mathematical communication skills [17] , Azhar developed an RME-Based Opportunity Theory Learning learning tool [18]. From the trial results, it can be seen that teachers and students enjoy using this learning tool. [19]

Guided by the learning tools that Azhar has created [18] developed 10 learning applications on mobile phones based on RME for Probability which can be downloaded at the link https://play.google.com/store/apps/details?id=com.uhamka.aplikasi_rme. This article is the fourth application of 10 applications created.

Contribution of This Paper to the Literature

There has been a lot of research developing applications on mobile phones for learning, as stated in the previous section. There is also a lot of research on RME. However, there has been no research to develop an RME-based mobile phone application for Probability content in Senior High School, especially Permutation. RME-Based Mobile Phone Learning Application for Permutations of the Same Elements, is one of the results of 3 years of research funded by the Director General of Higher Education 2019-2021. The results of this research can be downloaded on Google Playstore with the link https://play.google.com/store/apps/details?id=com.uhamka.aplikasi_rme. The contribution of this article is to explain the process and results of developing an application model on a mobile phone based on the concept of permutation if there are several elements that are the same. The contribution of this article to the literature study can be illustrated by Figure.1

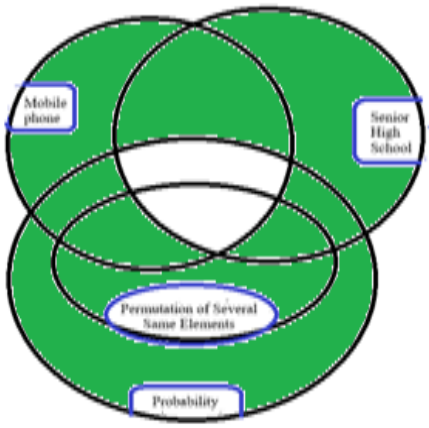


FIGURE 1. Novelty of Research

METHODOLOGY

To produce a permutation concept learning application if there are elements that are the same as the RME model on a mobile phone, the method used is the research and development method. According to Astra (2015) research and development method has four main steps: 1) planning, 2) development, 3) evaluation, 4) application product in the form of simulation, see Figure.2.

The first stage is designing a display scenario on a mobile phone. The second stage develops the application based on the scenario that was created in the first stage. The third stage is application evaluation involving mathematics experts, teachers and several students. The final stage is simulation and improvement according to teacher and student input during the simulation. Improvements made according to suggestions from teachers and students during the simulation were to make the display colors more contrasting.

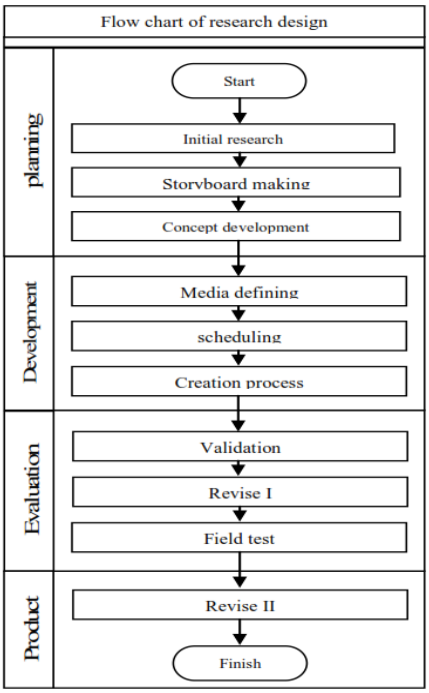


FIGURE 2. Research Desain from Astra (20115:1083)

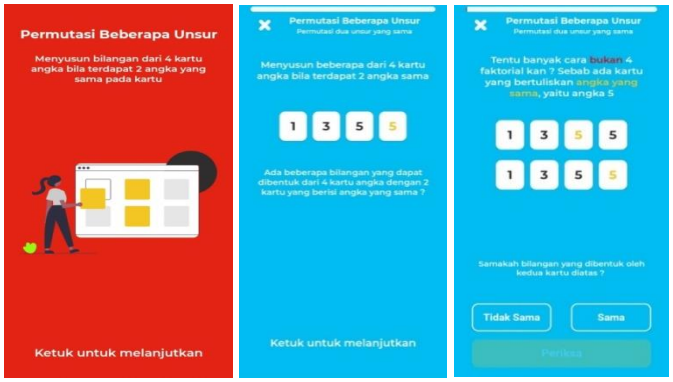
RESULTS AND DISCUSSION

RME-Based Mobile Phone Learning Application for Permutations of the Same Elements, consisting of 5 parts, namely:

- the first part about arranging numbers from 4 number cards if there are 2 of the same numbers on the card;
- the second part is about arranging numbers from 4 number cards if there are 3 of the same numbers on the card;
- the third part about arranging numbers from 4 number cards if there are 2 pairs of the same numbers on the card;
- the fourth part about arranging numbers from 5 number cards if there are 2 of the same numbers on the card;
- the fifth part is about arranging numbers from 5 number cards if there are 3 of the same numbers on the card.

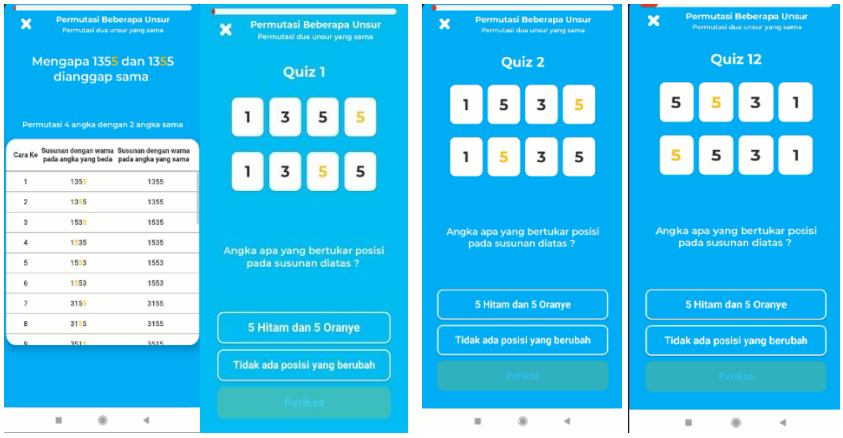
Explain the arrangement of numbers from 4 number cards if there are 2 of the same numbers

The presentation begins by presenting a real problem more Figure. 3. Continued with several model levels such as Figure.4 and Figure.5. The table in Figure.4.a is the first model, followed by the second model from Quiz 1 to Quiz 12 which are displayed in Figure.4.b, Figure.4.c, and Figure. 4.d. Ending with the final model leading to the concept $\frac{4!}{2!}$.



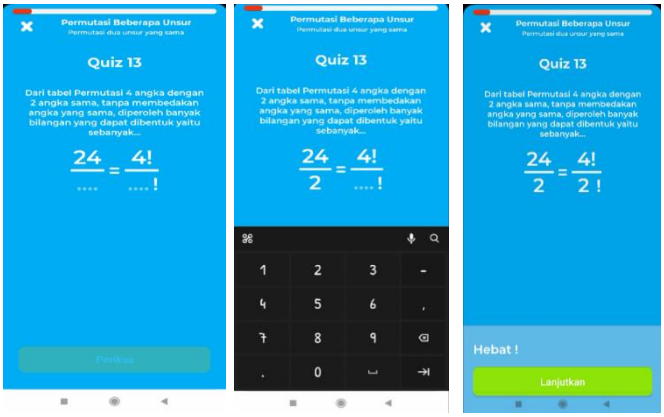
(a) (b) (c)

FIGURE 3. Present real problems for students



(a) (b) (c) (d)

FIGURE 4. Models appear as a link between real problems and mathematical concepts

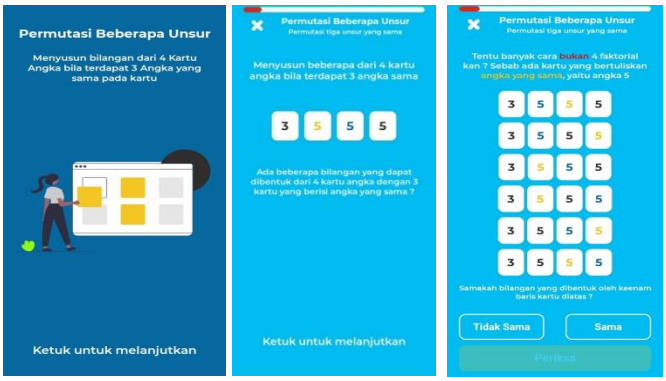


(a) (b) (c)

FIGURE 5. The final model goes to the $\frac{4!}{2!}$

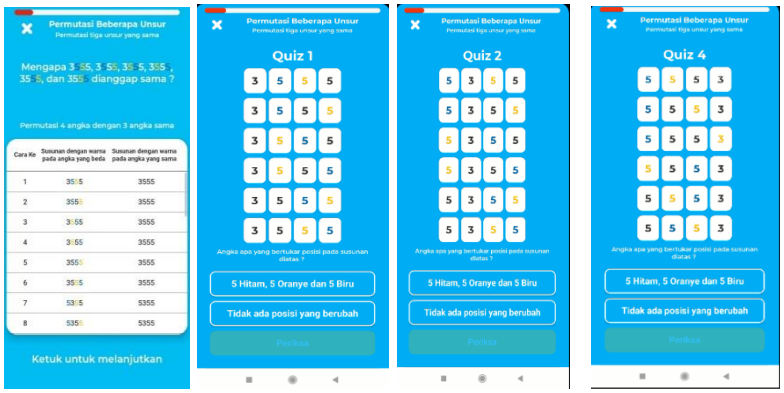
Explains the arrangement of numbers from 4 number cards if there are 3 of the same numbers on the card

The presentation begins by presenting a real problem more Figure. 6. Continued with several model levels such as Figure.7 and Figure.8. The table in Figure.7.a is the first model, followed by the second model from Quiz 1 to Quiz 4 which are displayed in Figure.7.b, Figure.7.c, and Figure. 7.d. Ending with the final model leading to the concept $\frac{4!}{3!}$



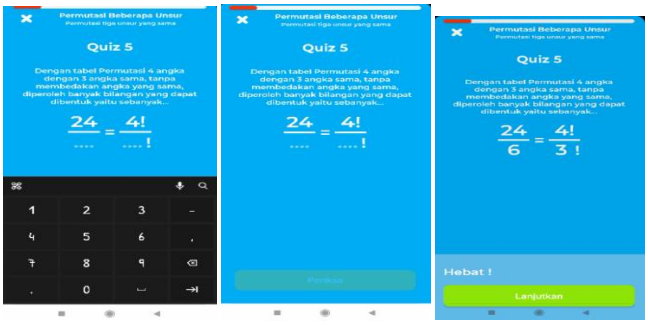
(a) (b) (c)

FIGURE 6. Present real problems for students



(a) (b) (c) (d)

FIGURE 7. Models appear as a link between real problems and mathematical concepts

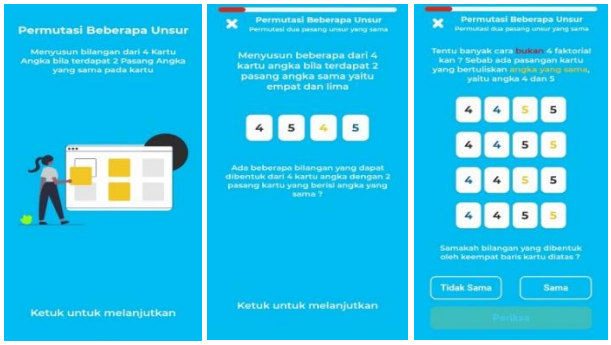


(a) (b) (c)

FIGURE 8. Final model to concept $\frac{4!}{3!}$

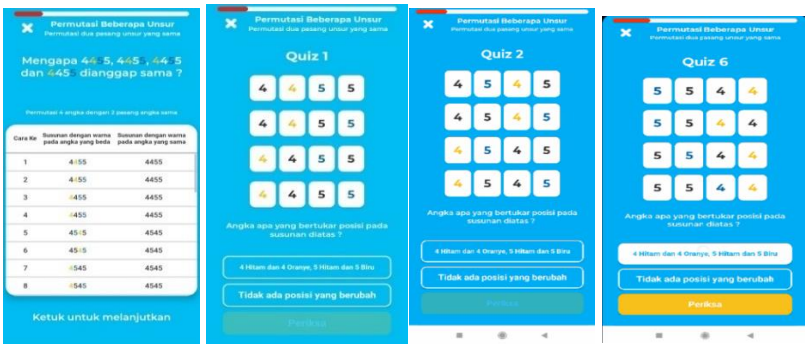
Explains the arrangement of numbers from 4 number cards if there are 2 pairs of the same numbers

The presentation begins by presenting a real problem more Figure. 9. Continued with several model levels such as Figure.10 and Figure.11. The table in Figure.10.a is the first model, followed by the second model from Quiz 1 to Quiz 6 which are displayed in Figure.10.b, Figure.10.c, and Figure.10.d. Ending with the final model leading to the concept $\frac{4!}{2!}$, see Figure.11.



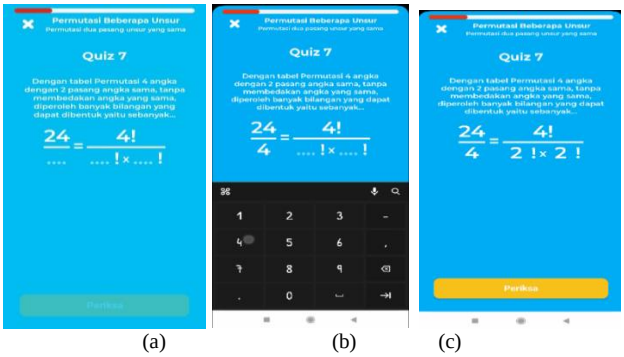
(a) (b) (c)

FIGURE 9. Present real problems for students



(a) (b) (c) (d)

FIGURE 10. Models appear as a link between real problems and mathematical concepts



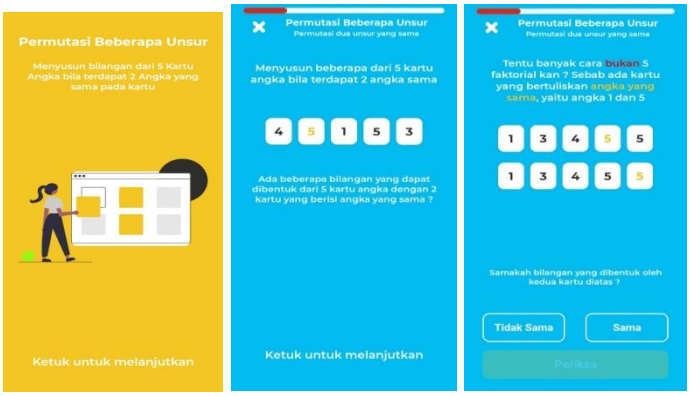
(a) (b) (c)

FIGURE 11. The last model Into the concept of $\frac{4!}{2!\,2!}$

Explains the arrangement of numbers from 5 number cards if there are 2 of the same numbers

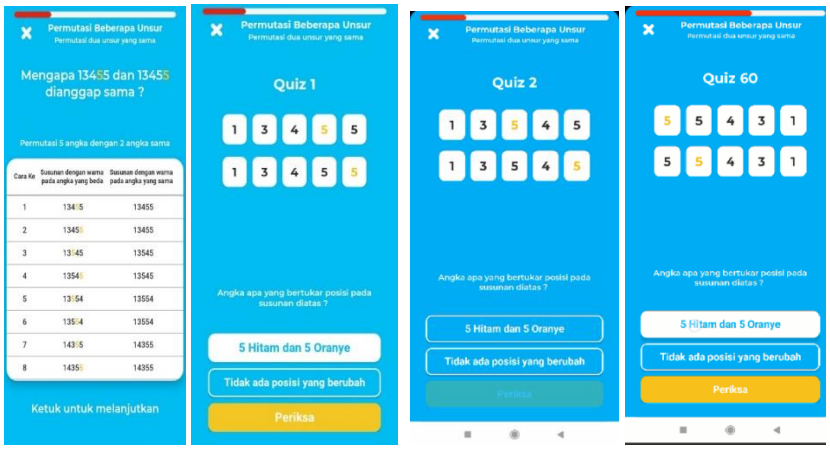
The presentation begins by presenting a real problem more Figure. 12. Continued with several model levels such as Figure.13 and Figure.14. The table in Figure.13.a is the first model, followed by the second model from Quiz 1

to Quiz 60 which are displayed in Figure.13.b, Figure.13.c, and Figure. 13.d. Ending with the final model leading to the concept $\frac{5!}{2!}$, see Figure.14.



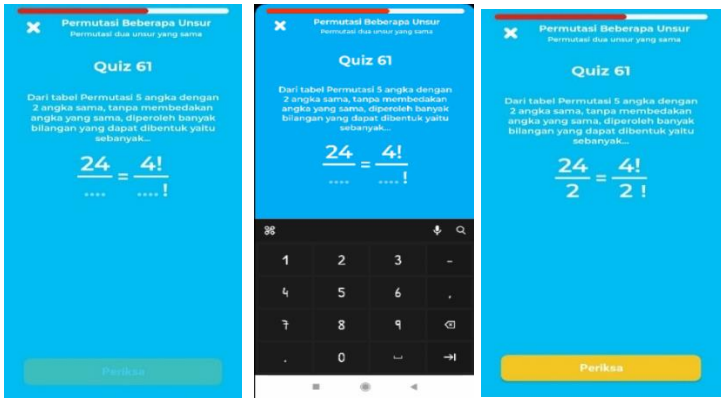
(a) (b) (c)

FIGURE 12. Present real problems for students



(a) (b) (c) (d)

FIGURE 13. Models appear as a link between real problems and mathematical concepts

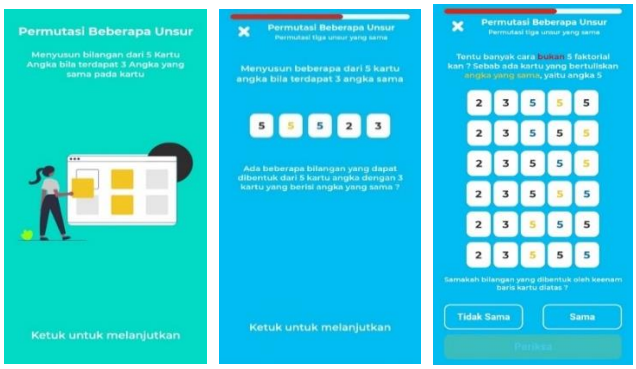


(a) (b) (c)

FIGURE 14. Final model to concept $\frac{5!}{2!}$

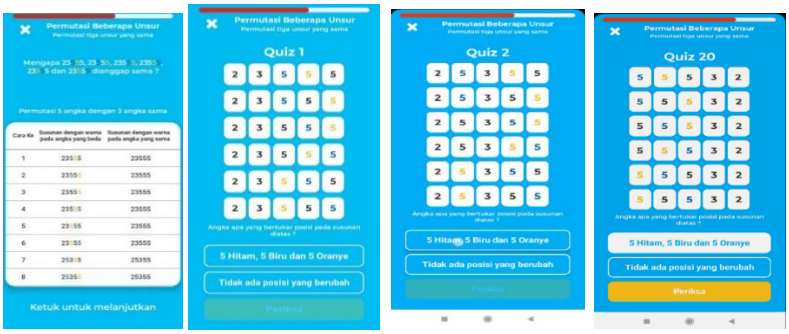
Explain the arrangement of numbers from 5 number cards if there are 3 of the same numbers

The presentation begins by presenting a real problem more Figure. 15. Continued with several model levels such as Figure.16 and Figure.17. The table in Figure.16.a is the first model, followed by the second model from Quiz 1 to Quiz 20 which are displayed in Figure.16.b, Figure.16.c, and Figure. 16.d. Ending with the final model leading to the concept $\frac{4!}{2!}$, see Figure.17.



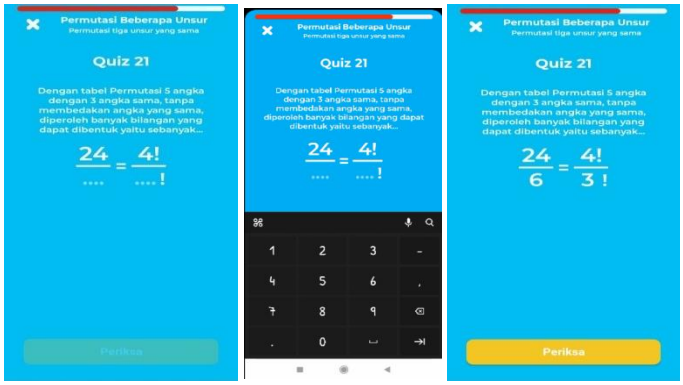
(a) (b) (c)

FIGURE 15. Present real problems for students



(a) (b) (c) (d)

FIGURE 16. Models appear as a link between real problems and mathematical concepts



(a) (b) (c)

FIGURE 17. Final model to concept $\frac{5!}{3!}$

CONCLUSION

Research is a development research that produces learning applications on mobile phones. The presentation of material on mobile phones follows the RME learning model. This application consists of 5 parts. The first part is about arranging numbers from 4 number cards if there are 2 of the same numbers on the card. The second part is about arranging numbers from 4 number cards if there are 3 of the same numbers on the card. The third part is about arranging numbers from 4 number cards if there are 2 pairs of the same numbers on the card. The fourth part is about arranging numbers from 5 number cards if there are 2 of the same numbers on the card. The fifth part is about arranging numbers from 5 number cards if there are 3 of the same numbers on the card. The presentation of each section follows the RME model, namely presenting real problems for students, followed by an interaction process by generating several levels of models leading to mathematical concepts.

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