24 (4), 2023, 594-602
Jurnal Pendidikan MIPA
e-ISSN: 2685-5488 | p-ISSN: 1411-2531
http://jurnal.fkip.unila.ac.id/index.php/jpmipa/

Learning Design For Combinatoric With Realistic Mathematics Education Approach

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Abstract: The purpose of this research is to design learning combinatorics sub-material factorial, permutation, combination and chance with RME approach. This research is a qualitative research. With this research method using design research. The research techniques used are measurement techniques, direct observation and documentation with tools in the form of objective tests, observation sheets and document sheets. The research subjects were 2 classes, namely A1 and A2 classes in the Mathematics Education Mathematics Statistics course specifically combinatorics material totaling 35 students with the learning trajectory in the form of numbers that were applied alternately to students. The conclusion of this research is obtained: 1) in the factorial sub-material, students are introduced to the RME approach that $4!=24$, $3!=6$, $2!=2$, $1!=1$ until it is proven that $1!=1$ in the permutation and combination sub-material, students are directed to be examples of the same numbers and letters that form the rules of permutation and combination in the opportunity sub-material, students are exemplified about coins and dice, both in one, two, and three pieces in the context of the problem.

Keywords: learning design, rme approach, design research

Abstrak: *Tujuan dari penelitian ini adalah mendesain pembelajaran materi kombinatorika sub materi factorial, permutasi, kombinasi dan peluang dengan pendekatan RME. Penelitian ini berjenis penelitian kualitatif. Dengan metode penelitian ini menggunakan design research. Teknik penelitian yang digunakan adalah teknik pengukuran, observasi langsung dan dokumentasi dengan alatnya berupa tes objektif, lembar pengamatan dan lembar dokumen. Subjek penelitiannya ada 2 kelas yaitu kelas A1 dan A2 pada mata kuliah Statistika Matematika Pendidikan Matematika terkhusus materi kombinatorika berjumlah 35 mahasiswa dengan lintasan belajarnya berupa Number-Number yang diterapkan secara bergantian ke mahasiswa. Kesimpulan dari penelitian ini diperoleh: 1) pada sub materi factorial, peserta didik dikenalkan dengan pendekatan RME bahwa* $4!=24$, $3!=6$, $2!=2$, $1!=1$ *sampai dibuktikan bahwa* $1!=1$ *pada sub materi permutasi dan kombinasi, peserta didik diarahkan for menjadi contoh Number dan huruf yang sama sehingga membentuk aturan permutasi dan kombinasi tersebut pada sub materi peluang, peserta didik dicontohkan tentang mata uang logam dan dadu, baik dalam sebuah, dua buah, maupun tiga buah dalam konteks masalah.*

Kata kunci: *desain pembelajaran, pendekatan rme, penelitian desain*

▪ INTRODUCTION

The education system in the 21st century is heading towards a revolution in producing quality human resources. The influence of the industrial revolution 4.0 and preparation for the 21st century skills system specifically includes digital era literacy, creative thinking, inventive thinking, effective communication, high productivity, and spiritual norms and values (Kusumawardani, Ramli, & Muzzazinah 2020); (Hamid & Haka 2021). When improving the quality of education and the quality of human resources,

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DOI: http://dx.doi.org/10.23960/jpmipa/v24i1.pp594-602
Received: 10 October 2023
Accepted: 10 November 2023
Published: 28 November 2023

efforts are needed from higher education institutions as the owner of authority in the world of education. As prospective teachers, students are specifically required to have excellence in knowledge and skills (Irawan, Mursito, & Purnomo 2021); (Hamid & Haka 2021).

Mathematics learning in the school curriculum is organized into several areas that classify mathematics as a compartmentalized discipline with an overemphasis on calculations and formulas. As a result of this organization, it is difficult for learners to see mathematics as a scientific field that is constantly evolving and spreading to new fields of application (Ahmad & Asmaidah 2018); (Wittmann 2020). Learners are positioned to see overarching concepts and relationships, so mathematics appears as a collection of fragmented pieces of factual knowledge. Today's mathematics is a growing activity around the world. It is an essential tool for many other fields such as banking, engineering, manufacturing, medicine, social sciences, and physics (Manurung, Windria, & Arifin 2019); (Wijers & de Haan 2020).

The goal of OECD/PISA (Lange 2006); (Rahmawati and Mahdiansyah 2014) to assess students' ability to solve real problems, the strategy is to define the scope of material to be assessed with a phenomenological approach to describe mathematical concepts, structures, or ideas. This means describing the content in relation to the phenomenon and type of problem being created. This approach ensures a focus in the assessment that is consistent with the domain definition, but includes a range of what is typically found in other mathematics assessments and in the national mathematics curriculum. Meanwhile, through TIMSS (Prastyo 2020); (Novianawati & Nahadi 2015) there are three cognitive domains that students are expected to have, namely knowing, applying, and reasoning. In the domain of knowing includes students' understanding of the concepts and procedures required by students. The applying domain includes the ability of learners to use knowledge and concepts to solve problems. The reasoning domain includes the ability of students to solve problems that are not routine and require several steps to solve.

The material in the study is combinatorics (Afifah & Dachi 2022); (Uripno & Rosyidi 2019) is a branch of mathematics that is useful for calculating the number of possible arrangements of objects without having to count all possible arrangements. If a set A is divided into sets of parts , then the number of elements in set A will be equal to the sum of all elements in each set of parts . Indirectly based on the principle of addition every set of non-overlapping sets the principle of addition no longer applies and this must be solved by the principle of inclusion-exclusion. As for overlapping sets, the material presented is very closely related to the RME approach because it is often found in everyday life (Febriyanti, Bagaskorowati, and Makmuri 2019).

The selection of RME (Realistic Mathematics Education) is one of the right learning alternatives to solve these problems because learning does not directly present finished goods obtained by educators into the minds of students with the process of discovering this knowledge through activities or basic illustrative examples (Fitri, Sukirwan, & Jaenudin 2022). RME is an approach to mathematics education that engages learners in developing their understanding by engaging in problems set in contexts that interest them, with educators helping learners to rediscover the mathematics they encounter (Bray and Tangney 2016). Since its emergence in the 1960s, RME has become internationally influential in mathematics curriculum and pedagogy with five characteristics specifically associated with RME (Durand-Guerrier et al. 2012): 1) the use of meaningful contexts; 2) the development of models to help move from the original context to the formal mathematical context; 3) the guided rediscovery of mathematical concepts by learners; 4) interactivity between learners and educators; 5) viewing mathematics as an interrelated subject (Fredriksen 2020); (Ulfah and Rejeki 2022).

The RME approach to combinatorial learning design in this study is divided into four levels in accordance with the opinion of (Wahyudi 2016). The four levels are described as follows:

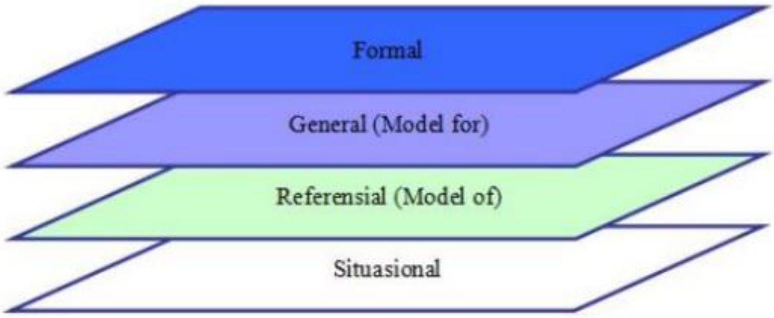

Figure 1. Four levels in rme

The RME levels run sequentially with the following explanation: The Situational Level is the foundational part which means learners apply their prior knowledge to the situation. In this study, learners were exposed to an RME context with a number sequence context. For example, it is described with 18 learners with 6 people each holding the same numbers, namely numbers 1, 2 and 3 which will be arranged into 6 arrays, namely; Refensional level in the form of informal knowledge owned by learners bridged to the context of the problem. Learners create a model based on the context of the problem associated with their initial situation. The model is called a model of the problem situation. In this study, the level occurred in the first to third meetings carried out with each holder of the number, for example numbers 1, 2, and 3 of the 18 participants presented their respective tasks; The General level is directed towards finding a mathematical solution. The model obtained at this level is called a model for solving problems. This level aims to explain to learners that the model they made before can be used in general to solve daily problems related to combinatorial in this case specifically about Factorial, Permutation and Combination. In this meeting, the general level occurred in the fourth and fifth meetings where students used the models they had to solve other contexts, namely story problems. So, the researcher gives a story problem and learners use the model they have made before to solve (model for) the problem in the story problem; The Formal Level uses mathematical symbols and representations in the mathematical concepts they build. Researchers formulate and affirm the concept of building then together with students conclude learning systematically. At this level, students are expected to have understood the definition of factorial, permutation, combination to basic probability. Then with the guidance of researchers, learners are able to develop mathematical models that resemble the basic concepts of factorial, permutation, combination, and chance.

▪ METHOD

This research is a qualitative research type namely: The research subjects were 2 classes, namely A1 and A2 classes in the Mathematical Statistics course from all third semester students of the Mathematical Statistics course totaling 4 classes, namely A1, A2, A3, and B with the sample taken randomly; the research method used design research with procedures as shown below; The collection techniques used are measurement techniques, direct observation and documentation with tools in the form of objective tests, observation sheets and document sheets; data analysis in the form of qualitative data analysis. With this research method using design research. There are two reasons, first, researchers want to apply and develop theories in mathematics learning in Indonesia in the form of local instruction theory or local instruction theory for combinatorics material that can be applied in learning with the RME approach (Wahyudi 2016) and second because researchers want to be directly involved in understanding the way students think both in learning and solving problem problems.

(Aleslami, Minarni, and Fauzi 2021) explained that design research has three phases that must be carried out, namely, preparation for experiments, literature studies, and hypothesizing learning trajectories, teaching experiments, retrospective analysis, comparing hypothesized learning trajectories and actual learning trajectories in the form of learning processes that will occur.

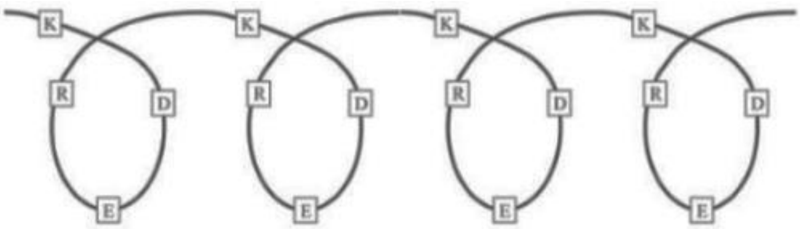

Figure 2. Design research cycle

▪ RESULT AND DISSCUSSION

The first meeting aimed to get learners to understand combinatorials such as factorials, permutations, combinations, and probabilities. Based on the learner activity sheet given, they make groupings based on the characteristics they can think of. The researcher guides the learners to find the combinatorial concept by using the grouping that has been made by the learners. Then the researcher provided confirmation and information about the symbols of combinatorial writing.

In the second meeting, learners were guided to find the concepts of factorial, permutation, combination, and chance through number grouping. For the factorial concept, learners are divided into groups of numbers for each presentation of the material which is exemplified in the following table!

From the table above, it is agreed that there is a combined class of A1 and A2 classes totaling 35 people in one set of universes. This means that in that class 35 people will be involved in turn to hold numbers and logically there is an empty set that accompanies it.

Table 1. Arrangement of students holding each number of factorial sub-materials

Faktorial	Number of students each	Structure of RME	Amount
4!	Number 4 held by6 orang Number 3 held by6 orang Number 2 held by6 orang Number 1 held by6 orang	{(4.3.2.1)(4.3.1.2)(4.2.3.1)(4.2.1.3)(4.1.3.2)(4.1.2.3) (3.4.2.1)(3.4.1.2)(3.2.4.1)(3.2.1.4)(3.1.2.4)(3.4.2.1) (2.3.4.1)(2.3.1.4)(2.4.3.1)(2.4.1.3)(2.1.3.4)(2.1.4.3) (1.4.3.2)(1.4.2.3)(1.3.4.2)(1.3.2.4), (1.2.4.3)(1.2.3.4)}	24 Cara
3!	Number 3 held by2 orang Number 2 held by2 orang Number 1 held by2 orang	{(3.2.1)(3.1.2) (2.3.1)(2.1.3) (1.3.2)(1.2.3)}	6 Cara
2!	Number 2 held by1 orang Number 1 held by1 orang	{(2.1) (1.2)}	2 Cara
1!	Number 1 held by1 orang	{(1)}	1 Cara
0!	Does not involve students	{ }	1 Cara

Table 2. Arrangement of students holding each number of permutation and combination sub-materials

Arrangement	Number of students each	Permutation	Kombination
3	As per Quantity required	123.132.213.231.312.321 124.142.214.241.412.421 134.143.314.341.413.431 234.243.324.342.423.432	123 124 134 234
2	As per Quantity required	12.21 13.31 14.41	12 13 14

		23.32 24.42 34.43	23 24 34
1	As per Quantity required	1 2 3 4	1 2 3 4
0	No need for students		{ }

In the third meeting, students learn about permutations and combinations. A permutation is an arrangement of a set of objects with respect to their order. While Combination is an arrangement of a set of objects without regard to their order. Their rules follow the set which is a collection of all possible objects and is certain according to predetermined rules (Nar Herrhyanto dan Tuti Gantini 2009). Learners hold each number from 1 to 4 and then collect them according to the rules of permutation and combination.

Table 3. Arrangement of students holding each number of chance sub-material

Sample Room	Number of students each	Probability
One Currency Coin	1 Student holding Numbers 1 Student holding Letters	$1/2$ for Numbers $1/2$ for Letters
Two Currency Coin	4 Students holding A 4 Students holding H	$1/4$ for AA $1/4$ for AH $1/4$ for HA $1/4$ for HH
One Dice	1 Students holding Numbers 1 1 Students holding Numbers 2 1 Students holding Numbers 3 1 Students holding Numbers 4 1 Students holding Numbers 5 1 Students holding Numbers 6	$1/6$ for Numbers 1 $1/6$ for Number 2 $1/6$ for Number 3 $1/6$ for Number 4 $1/6$ for Number 5 $1/6$ for Number 6
Two Dice	6 Students holding Numbers 1 6 Students holding Numbers 2 6 Students holding Numbers 3 6 Students holding Numbers 4	$1/36$ for Arrangement (1.1) . . . $1/36$ for Arrangement (6.6)

	6 Students holding Numbers 5
	6 Students holding Numbers 6

In the fourth meeting, students learn in RME about set material. Learners are given an example of a coin and a dice to illustrate the situation. With learners also sharing roles regarding the results of the numbers and letters into an exemplified opportunity. For example, S denotes the sample space of an experiment and A denotes the set of all events that can be formed from S. Probability is a function with domain A and result area that satisfies the following properties: 1) for , 2)

Furthermore, in the fifth meeting, the researcher exemplifies many permutation, combination, and chance problems into the context of the real world in everyday life, so that it is hoped that students will be able to interpret combinatorial in more detail and thoroughly. This is in line with previous research, namely: 1) (Ulfah and Rejeki 2022) regarding the design of LKPD with the RME approach which is very feasible to use in supporting the learning process; 2) (Manurung et al. 2019) suggested that the RME approach is very suitable for use in the design of set material; 3) (Fitri et al. 2022) concluded that the RME approach was able to improve student learning outcomes.

Based on the results of research and discussion, it is obtained that the design of learning mathematics combinatorial material using the Relalistic Mathematic Education (RME) approach is by utilizing the arrangement of numbers or letters. The selection of these numbers is conditioned by the usefulness of each sub-material taught, for example, factorial sub-materials, permutations, combinations, and opportunities with different interactions and steps used in each teaching. The following conclusions were obtained: 1) in the factorial sub-material, students are introduced to the RME approach that , , , until it is proven that ; 2) in the permutation and combination sub-material, students are directed to be examples of the same numbers and letters that form the rules of permutation and combination; 3) in the opportunity sub-material, students are exemplified about coins and dice, both in one, two, and three pieces in the context of the problem. The researcher also drew the conclusion that the RME approach is very well used and applied in learning mathematics, especially set material, logic, and combinatorial.

Suggestions from this study are: 1) The Realistic Mathematics Approach invites readers, researchers, and teachers to think realistically in learning so that the author hopes that all basic mathematics materials can apply it for students' real conceptual understanding; 2) in addition to combinatorics material, the author hopes that there are many mathematical materials that are easy to understand if applied in RME and then continued in a mathematical context.

▪ CONCLUSION

Based on the results of research and discussion, it is obtained that the design of learning mathematics combinatorial material using the Relalistic Mathematic Education (RME) approach is by utilizing the arrangement of numbers or letters. The selection of these numbers is conditioned by the usefulness of each sub-material taught, for example, factorial sub-materials, permutations, combinations, and opportunities with different interactions and steps used in each teaching. The following conclusions were obtained: 1) in the factorial sub-material, students are introduced to the RME approach that $4! = 24$

, $3! = 6$, $2! = 2$, $1! = 1$ until it is proven that $1! = 1$; 2) in the permutation and combination sub-material, students are directed to be examples of the same numbers and letters that form the rules of permutation and combination; 3) in the opportunity sub-material, students are exemplified about coins and dice, both in one, two, and three pieces in the context of the problem. The researcher also drew the conclusion that the RME approach is very well used and applied in learning mathematics, especially set material, logic, and combinatorial.

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