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The effectiveness of a mathematics learning model of realistic setting with NHT type on a three-dimensional main theme

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ABSTRACT: This research was conducted by selecting quasi-experiments and treatments in the form of the realistic mathematics learning (RML) model in cooperative settings (Maresko) with numbered heads together (NHT) type in the subject matter of 3D spaces. The research was conducted in grade ten in eight senior high schools in Makassar during the school year 2016/2017. The instruments used in this study were the test results of learning, observation sheets, teachers' ability to manage learning, student activity observation sheets and questionnaire responses of students to the teaching and learning tools. The results show that the learning outcomes of students who are taught by the Maresko model NHT type were included in the higher categories and that it increased significantly the ability of students from the pre-test to post-test. The activities of students in learning are at least in the positive category, as well as the responses of students to the tools and learning are included in the positive category. The NHT type Maresko model was quite effective when implemented in the class, with an effectiveness score of 3.32. Teaching is effective immediately when applied in grade ten with an effectiveness score of 3.0. Therefore, the NHT type Maresko model was more effectively applied in the teaching of the subject matter of three-dimensional spaces at the grade ten high school level.

Keywords: Realistic mathematics education, cooperative NHT type, 3D space

INTRODUCTION

Realistic mathematics learning (RML) constitutes a learning approach, which orients to practical mathematics based upon human activities [1], connecting what the students have learned with what they could imagine [1]. In RML, the process of developing mathematical ideas and the concepts are derived from the real world, i.e. reality-based learning. Real matters and problems or case studies can be used as a stimulus in the process of constructing the concept to be more integrated. Therefore, the teachers are encouraged to assist the students to connect and integrate the mathematical subject matters with their real life knowledge [1].

In cooperative learning, particularly of the NHT type; namely, numerical learning systems, students are supposed to be more prepared for facing the subject matters and problems or case study given by the teachers, as well as being able to find the solutions related to the problems or troubleshooting ability [2]. This enables and encourages students to get together with other students to discuss and figure out solutions to the problems given by the teachers [3]. Thus, the NHT type of cooperative learning could encourage students to be in an active mode in learning, i.e. in terms of understanding and comprehending the given concepts that in the end will improve the students' learning results.

The RML approach can be carried out by forming small groups in the learning process. This is to ensure the typical cooperative learning characteristic, i.e. emphasising group cooperation or mutual assistance based learning. In other words, this means that RML can be applied cooperatively and, therefore, can be integrated with the NHT type of cooperative based learning method and approach. Accordingly, in course of this research, the researchers applied the cooperative setting of realistic mathematic learning RML (Maresko) (hereafter described as RML), particularly the NHT type.

The cooperative setting of RML (Maresko), particularly the NHT type approach, would enable students to explore maximally and more cognitively, especially in terms of understanding the lessons and subject matter more appropriately and this will lead to assisting the students even more comprehensively, so that they will understand better and their knowledge and creativity will be improved, as well as their understanding of the subject matters. This could occur particularly in the cooperative setting of RML (Maresko), specifically the NHT type approach, through different numbers given randomly to the students in each group aimed at pushing and encouraging them to be prepared in a group environment to be more capable of answering questions given by the teachers.

In this kind of situation, the discussion and opinion sharing among students will occur and the knowledge collaboration will enable the students to understand the lessons or subject matter more comprehensively. Similarly, the RML that uses realistic matters as the basis of learning and presents the issues or problems to be solved by the students, so that they can become interested in the learning process as they study through the things they have known previously. The integration between the RML method and the cooperative setting on RML (Maresko), particularly the NHT type approach, would render better results and effects, particularly towards the result of students' learning, where the cooperative setting on RML (Maresko), particularly the NHT type approach, is assumed, considered and believed to be more reliable in optimising the students' role and participation in the learning process, either physically or psychologically. Based on this preview and background knowledge, the researchers were interested in undertaking this research.

METHODOLOGY OF RESEARCH

In conducting this research, the typical research method selected was quasi-experiments and treatments in the cooperative setting RML model (Maresko), NHT type with the three dimensional (3D) spaces as the main theme or basic material. This research was carried out in eight senior high schools, grade 10 Makassar in the education year 2016/2017, semester 2.

The population selected for this research was all the students of eight senior high school, grade 10 Makassar in the education year 2016/2017, semester 2, consisting of 270 students. The research sample consisted of two classes, an experimental class and control class chosen from eight parallel classes available using the simple random sampling technique. The experimental class was given the cooperative setting RML model (Maresko) NHT type and the control class was taught with the direct teaching method, where the ability or capability of the students in both classes, (the experimental class and the control class) was assumed to be the same or similar or homogenous.

The free variable of the research is the learning model consisting of two categories; namely, the cooperative setting of the RML model (Maresko) NHT type approach, and the direct teaching approach. The tied or bound variables used in this research are the students' learning outcomes, students' activity and students' responses. The instruments used in this research were the students' learning outcomes, the observation sheets of the teachers' ability in managing the learning process, observation sheets of the students' activity and the questionnaires of the students' responses about the learning instrument and the learning itself.

RESULTS

The Maresko Model of NHT Type

The result of this research shows that the outcome of students' learning mathematics taught using the cooperative setting RML model (Maresko) NHT type for the experiment class viewed from the capability of the students can be categorised high with the typical accomplishment level reaching up to 80%. The same thing applied to the students' learning ability that showed significant improvement when they learnt using the cooperative setting RML model (Maresko) NHT type approach. The students' activity minimally falls within the *good* category and the responses of the students toward the learning and its instruments fall within the *positive* category.

Overall, the cooperative setting RML model (Maresko) NHT type could improve the students' ability in understanding and comprehending three dimensional (3D) subject matters. This is shown by the classification gain, which was normalised, so that the majority of the students classified fell within the *high* category. This learning style could increase and enhance the students' activity in learning and provide the broad opportunity for them to interact and socialise with the teacher directly, in terms of expressing their opinions and ideas or complaints, as well as the problems they faced on the 3D subject matter, providing the simplicity and ease the students need to understand and comprehend the concept of the materials given, since each concept always connects to real life objects or situations, which is expected to be easily understood and comprehended or imagined and fantasised about by the students.

The activity of the students in this typical kind of learning ran optimally starting from the activity in the group in terms of solving the contextual issues provided in the exercise given or the activity in the class i.e. to interact with the other members of the other groups through class discussion. Generally, in this typical kind of learning, the students are encouraged to educate themselves in structuring and constructing their own self-discovered knowledge and learning through the problem-solving series, which is then formulated in the exercise given. The nature of the exercise given is aimed to stimulate the students to reinvent their knowledge gained in the past. This can be shown when the students were trying to remember the things they have learnt in the past and were attempting to connect to the subject or lesson being taught, as well as discussing with their fellow students.

This generally occurs when comprehending holistic mathematics as the concept of mathematics that is mainly hierarchal and interconnected. It is also argued that when learning mathematics, it is highly advisable that one should learn it continuously, consistently and persistently and never pause in learning, because long pauses will distract the process of learning and teaching [4]. Therefore, it can be concluded that the implementation of the cooperative setting RML model (Maresko) NHT type approach meets the mathematical principle, i.e. the continuity concept.

In the cooperative setting RML model (Maresko) NHT type approach, the realistic learning pattern as designed for the students emphasises the contextual activity connected to the real-life experience. This method or approach would assist the students in understanding the subject or lessons better as they are encouraged to recall or reactivate their knowledge about things they have learnt previously in relation to the things being learnt. For instance, when the students are taught a lesson on distance, simultaneously, they are also taught to recall their knowledge about projection.

The design of realistic patterns helps the students to comprehend better the extent that they could imagine. In order for the learning pattern to be more effective, it is highly advisable that they should learn more realistically or be given more realistic learning patterns [5]. In the cooperative setting RML model (Maresko) NHT type approach, it is known that this typical learning method links with what is being taught to what has been taught previously, i.e. the thing the students have understood before through realistic learning. This would enable the students to comprehend the lesson better and maximise their capacity to undertake the activities that are shown from the accomplishment that fall within the *good* category.

The role and participation of the students in the RML model (Maresko) NHT type approach were quite high. They also become more aware that the quality of the knowledge they will acquire is largely determined by their participation or involvement in the class. The students competitively take part in the learning process and class participation. This is shown by class discussions where at each meeting, the student whose name is mentioned in each group usually raises their finger. Since the time is limited, not all the students can fully participate in group discussions. This does not make the students dislike the lesson or subject matters taught as evidenced by their positive responses towards the lesson taught. Instead, most of the students wished that the teachers would still apply this typical kind of mathematical method.

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The Effectiveness of the Cooperative Setting Realistic Mathematic Learning Model (Maresko) NHT Type and Direct Teaching

The results of the research have shown that the implementation of the cooperative setting RML model (Maresko) NHT type and direct teaching are considered effective in teaching the basic material in 3D to the students of eight senior high schools, grade 10, Makassar. These fall within two categories, i.e. they are considerably effective. The comparison results showed that the implementation of the RML model (Maresko) NHT type is more effective than direct teaching, especially in terms of teaching the basic lesson on 3D subject matter to these students. The indicators used to assess the two types of learning referred to the three indicators mentioned previously i.e. the effectiveness of the learning outcomes of the students learning mathematics, the students' activity in the learning process, and the students' responses to the learning and its instruments.

When viewed from the concept of RML approach, it is known that there are three main principles in RML, i.e. 1) predetermination; 2) didactical phenomena; and 3) own model development. The application and implementation of this principle, particularly in the cooperative setting RML model (Maresko) NHT type to the experimental class has considerably assisted and was helpful said the students, particularly in terms of the exercise book design, containing the steps or stages in solving the problems that directed the students to adopt the three principles of RML mentioned earlier. The predetermined principles enable the students to recall and focus their study merely on what they have learnt previously. The students felt that what they were learning was not something new, so that they would become more optimistic as what they did was just an improvement of the existing knowledge that they already possessed.

The didactical principle is expressed by the implementation of the exercise book and the explanation from the teacher on the contextual situation that interconnects the students from what is being taught and what they have learnt before. The students seemed to enjoy the lesson being taught as they thought that the lesson, which was implemented in the cooperative setting RML model (Maresko) NHT type approach, really eases them in understanding the subject matter, since it was connected to the lesson being taught and their background knowledge. They were guided to solve the problems based on reality, since it related to their experience in real life to the mathematical model. The model development principle is accomplished by the students as a part of settling the problems via the use of the exercise book. This would lead the students to the general conclusion based on what they have done or learnt before.

The implementation of the cooperative setting RML model (Maresko) NHT type is helpful in assisting the students to develop their own potential since they are required to be ready to become the object of learning. They are fully responsible for personally comprehending the lesson that sometimes leads to enjoying the subject being taught. This is because in the cooperative setting RML model (Maresko) NHT type, the teachers give more freedom to the students to express their ideas and concepts and to interact with each other as the teachers merely function as facilitators and mediators to maximise the students' learning process. This is in line with Piaget's opinion that knowledge is indeed formed by the students themselves through interacting continuously with the environment.

The group presentation mechanism using the cooperative setting RML model (Maresko) NHT type is also considered to be very effective when implemented in guiding the students preparing themselves in the group discussions. This is reflected by the enthusiasm demonstrated by each student, i.e. in terms of preparing themselves to understand the lesson. The group assessment implemented by the teachers in the cooperative setting RML model (Maresko) NHT type can serve as the main reason why the students can cooperate maximally in their group. The interaction within the group can be

carried out to the greatest effect by using this learning model. Thus, the cooperative setting RML model (Maresko) NHT type can be one of the best solutions for enhancing the students' learning quality that in the end will help them to improve their learning outcomes. Theoretically, as Slavin stated, the effectiveness of the learning refers to four things i.e. 1) learning quality; 2) the suitability of learning appropriateness; 3) incentive; and 4) time. Each of these is explained in more detail below.

Learning Quality

The assessment of the quality of the cooperative setting RML model (Maresko) NHT type approach in eight senior high schools, grade 10, Makassar can be viewed from the students' test results, in which 80% of the students met the criterion of learning appropriateness, while in the direct learning group, a mere 74% of the students could meet the learning appropriateness criterion. This indicated that from the aspect of learning quality, the cooperative setting RML model (Maresko) NHT type approach is better than the direct teaching method. Besides the number indicated, there is also another factor on why the cooperative setting RML model (Maresko) NHT type approach can be considered to be more effective, i.e. in the implementation process of this method, the students could gain more information related to the lesson being taught.

This has happened as a result of the cooperative setting RML model (Maresko) NHT type approach that places the students as the main actors in the learning process, so that the information transfer is not based mainly on the teachers' knowledge, but also comes from the students' points of view. The cooperative method enabled the students to cooperate more positively under the teacher's guidance. The role of the teacher in the class is mainly to help the students whenever they face the difficulties relating to the subject or lesson being taught.

It is different from the direct learning model, through which the teacher serves as the main source of information in the learning process. This would affect the students' creativity, particularly their knowledge as they must face the authority of the teacher dealing with the information explained during the class. Teaching is a process of interaction between the students and the teachers and its consultation [6].

In the direct teaching, the interaction among students is not apparent as they focus merely on what the teacher explains. Furthermore, the consultation between the students and the teacher is also very limited. The consultation occurred when the asking-answering session happened; therefore, the in-depth consultation between students and teachers rarely occurs. Thus, when viewed from the quality aspect of learning, the cooperative setting RML model (Maresko) NHT type can give more space for the students to gain more information as much as possible related to the lesson. The interaction among the students that happens is more educative as it is supported by the in-depth consultation with the teachers on any problems faced during the lesson.

The Suitability of Learning Level

The cooperative setting of the RML model (Maresko) NHT type provides more guarantees in receiving the new subject or lesson taught since in each meeting the teacher always interacts with the students directly in each group. The principle of the cooperative setting RML model (Maresko) NHT type can be a motivational factor for the students, particularly when facing the new lesson later. During each meeting, the students have to have a discussion either in the group or in the class.

When the class starts, the teacher picks one of the students' numbers randomly and that student has to represent the class in answering questions from the teacher. In the first meeting, the students react awkwardly in responding to the number mentioned randomly. This is shown by the response of the members of group 3, who could not answer the question perfectly and their friends were also encouraged not to help him/her. After that, the teacher explained to the students the role of the group members in assisting the group whose number was mentioned. Afterwards, leading up to the last meeting, the discussion became more educative and cooperative as the students become wiser and able to comprehend the techniques better.

While the implementation of the direct teaching in the control class takes place, the students' motivation in terms of learning in the class is largely determined by the ability of the teacher to motivate them. If motivation is insufficient, this is shown that by the declining number of students coming to the class over time. Whenever the students are ready and more prepared to the lesson means that they are likely to learn better and willing to improve their existing knowledge. This cannot be found in the direct class; the students seem merely passive to receive the lesson being taught and do not seem to prepare themselves before hand to anticipate the questions asked by the teacher.

Time

In the experimental class with the cooperative setting RML model (Maresko) NHT type, the time spent can be used better, because from the beginning up to the end of the learning process, the students are always busy with the educative activity presented in the cooperative setting RML model (Maresko) NHT type. When coming to the main activity, the students are starting to work on the exercise book in each group. They, then, have discussions in order to find the

solution of the problems stated in the exercise book. After that, the results of the group is discussed in the classical way, i.e. they compare their answers with each other to find out who possess the best answer.

The teacher mainly functions as the facilitator to guide the students into using the time more effectively and to stimulate them to give more correct answers. Since the tight schedule and the activities occur in the class, it sometimes feels like the time flies quickly.

With direct teaching in the control class, the time provided in the learning process is used up by the teacher explaining the subject or lesson, so the students merely focus on the explanation of the teacher. The activity of the students is limited. Instead, the number of actively participating students in each meeting was not more than five students. Sometimes the time is used up by warning recalcitrant students. However, in each meeting of the direct teaching, all the subjects or lessons are managed to be accomplished within the targeted time. Thus, in terms of times utilised in the learning process or activities, it has been shown that the time optimisation, particularly in terms of the effectiveness of the learning process, with the cooperative setting RML model (Maresko) NHT type, is considered to be better than the direct teaching method.

CONCLUSIONS

Some of the conclusions derived from this research activity relate to the results of students learning via the Maresko model type NHT in grade ten at eight high schools in Makassar that were in the high category with an average of 72.68, median 75, mode 81 and a standard deviation of 11.068. There was a significant increase in the ability of students from the pre-test to post-test, with a significance level of $0.001 < 0.05$.

The activities of students in the learning process were at least in the positive category, as well as their responses to the tools and learning that were also included in the positive category. The learning outcomes of students taught directly in grade ten at eight high schools in Makassar were in the middle category with an average of 65.55, median 63, mode 60 and a standard deviation of 10.661. An increase in the ability of students from the pre-test to post-test, obtained a significant level of $0.001 < 0.05$. The activities of students in learning were in the poor category, but the response of students to the learning method were in the positive category. The NHT type Maresko model was quite effectively implemented in grade ten in the eight high schools with the effectiveness score of 3.32.

Teaching was effective immediately as demonstrated by the score of 3.0. Based on the scores of student learning outcomes, the student activities and responses that were analysed by descriptive and inferential models showed that learning with the NHT Maresko was more effective than direct instruction in the teaching of the subject matter of three dimensional spaces.

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BIOGRAPHIES



Ruslan graduated with a Bachelor of Mathematics Education from IKIP Ujung Pandang, Indonesia, in 1984. He has spent a lot of his time working as a lecturer of the Study Programme of Mathematics Education in the Mathematics Department with undergraduate students before completing a Masters of Educational Research and Evaluation at IKIP Jakarta in 1991. In 2009, he graduated with a doctoral degree in educational research and evaluation from Universitas Negeri Jakarta. Until now, he has been a lecturer in the Mathematics Department, based in the Faculty of Mathematics and Science at Universitas Negeri Makassar, Makassar, Indonesia. In 2012, he became a professor with expertise in educational mathematical research and evaluation. He has published four international conference papers and three papers in academic journals in the field of mathematics

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Alimuddin graduated with a Bachelor in mathematics education from Universitas Negeri Makassar, Indonesia, in 1987 and completed his Masters of Mathematics at Universitas Gajah Mada, Yogyakarta, Indonesia, in 2001. He has spent some time working as Chairman of the Study Programme of Mathematics Education in the Mathematics Department with undergraduate students before entering the Doctoral Programme. In 2012, he graduated with a Doctorate in mathematics education from Universitas Negeri Surabaya. Until now, he has been a lecturer in the Mathematics Department, in the Faculty of Mathematics and Science at Universitas Negeri Makassar, Indonesia. He is currently Head of the Centre for Assessment and Development Mathematics and Learning in the Mathematics Department, Faculty of Mathematics and Science at Universitas Negeri Makassar. He has conducted six research projects in the field of mathematics education and social sciences. Some of these have been

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Nasrullah graduated with a Bachelor degree of mathematics education from Universitas Negeri Makassar, Indonesia, in 2005 and a Master of Mathematics Education, Indonesia, in 2009. He completed his second Masters in mathematics education at Universitas Sriwijaya, Indonesia, in 2011. He spent some time working in research laboratories before entering academia. From 2009 until now, he has been a lecturer in the Mathematics Department, in the Faculty of Mathematics and Science at Universitas Negeri Makassar, Makassar, Indonesia. He is currently Head of the Laboratory of Learning Media in Mathematics Education in the Mathematics Department, Faculty of Mathematics and Science at Universitas Negeri Makassar. He has published several conference and journal papers in the field of mathematics education and social sciences.

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