Learning design using PMRI to teach central tendency materials

A Meitrilova¹ and R I I Putri*¹

¹*University of Sriwijaya, Jl. Srijaya Negara, Bukit Besar, Palembang, Indonesia

Email: *ratu.ilma@yahoo.com

Abstract. This study aims to determine the role of activities in learning the central tendency materials (mean, median, and mode), which is expected to be able for helping students understanding the concept of statistical learning in grade VIII. The method used in this study is Validation Studies type Design Research involving students of MTs Negeri 1 Palembang. There are three stages in the design research type of validation studies, namely Preparing for the experiment; The design experiment in the form of a Preliminary Teaching Experiment (Pilot Experiment) and Teaching Experiment; and Retrospective analysis. In this study only that of preliminary teaching experiment is considered. The activity begins with questions about remind the presentation of data in the diagrams, then understanding the concept of the mean, the median, and mode, the question of associating the mean and median to determine the mode. The results of the learning experiment show that through the given questions can support students to understand the concept of the central tendency and know the relevance. Errors in doing activities because students are not careful in reading information on the questions, weak in the ability to count, and don’t remember or not understand about the materials given.

1. Introduction

Central tendency is the value that represents the data, the size of the centralized data include the mean, mode, and median [1]. Mean is the value that characterizes and the center of a data set [2]. Mean is one of the most basic and important things in statistics [3], median and mode are the two commonly used measures of central tendency [4]. It can be concluded that the mean is an important thing in statistics and is a value that represents a set of data, and the two commonly used measures of central tendency are median and mode.

In the 2017 revised curriculum in 2017, statistical learning on central tendency was studied in class VIII [5]. At the elementary school level, students have a measure of data concentration but only support about the mean, median or mode that represents a data [6]. Based on the Minister of Education and Culture Regulation Number 65 of 2013, the curriculum must be relevant to daily life [7].

The education system in Indonesia today has a gap between desire and reality, the reasons are evaluation standards, effectiveness and efficiency in learning were weak [8]. In line with the previous opinion, the reasons of the weak education development in Indonesia is not only due to the reasons mention above, but also due to the low quality of facilities, the quality and welfare of teachers, students achievements as well as the cost of higher education and high unemployment [9]. The education system in Indonesia currently discriminates against the poor and rich [10, 11]. One solution to the problem of education in Indonesia can be solved by cooperation from all parties, namely parents, the community, and schools [12]. A part that deals directly with students is the teacher, the teacher must have creativity in choosing methods and learning media that are suitable for students.
The education system in the 21st century or better known as 4C’s (Creativity and Innovation, Critical Thinking and Problem Solving, Communication, and Collaboration) requires students to have global community competencies, namely communication, creative, critical thinking, and collaboration [13].

Lesson Study (LS) is an activity carried out in groups and requires cooperative cooperation [14]. LS is not a learning method but a system that aims to improve the professionalism of teachers through learning communities, LS aims to improve the readiness of teachers in conducting the learning process and help teachers know their weaknesses [15]. The education system in the 21st century is in line with LS which includes all the competencies that students must have. Steps in Lesson Study namely plan, do, and see, but must be improved with the re-design process [16]. In LS there is a model teacher who conducts learning activities, while other teachers become observers [17]. There are two activities that students need to do during in LS learning, namely sharing task and jumping task [18]. Sharing task is a level of problem that can be done and understand by 50% of students from the problem given while jumping task is a problem that is more difficult than sharing task and it's given to training the way students to think [19]. Sharing task is a routine level problem and jumping task is a non-routine level [20]. Based on the above definition, it can be concluded that task sharing is a routine problem whose level is not too difficult and 50% of students understand the problem given while jumping task is a matter of difficult levels in order to develop students' problem solving skills.

One of solutions to help students understand learning materials is using Indonesian Realistic Mathematics Education (PMRI). PMRI is an effort to improve student interest, attitudes and learning outcomes [21]. PMRI is a learning approach that aims to help students understand mathematical concepts from abstract to real by connecting things in everyday life as learning contexts, so students find themselves the concept of learning material from the context given as a reference, context used as a source of mathematical applications so that the understanding gained becomes more meaningful [22, 23], the students would not learn formulas [24, 25, 26]. Context is used in every activity designed at PMRI [27]. PMRI is adapted from Realistic Mathematics Education (RME) [28, 29], but PMRI is developed based on the context of local culture and conditions in Indonesia [29]. The 2013 curriculum has some characteristics the same as PMRI [30].

This study aims to determine the role of activities in learning the central tendency materials (mean, median, and mode), which is expected to be able for helping students understanding in the concept of statistical learning on grade VIII.

2. Method
Ideally, this study should be conducted in the 8th grade. Because the materials has been taught when researcher do the research, so the designed learning and activities are tested in grade seven. The research was carried out in MTs Negeri 1 Palembang.

Data collection techniques in this study, namely classroom observation, interviews, literature review, documentation, and field notes.

The method in this study is design research type of validation studies. Design research is used because this research aims to develop local instruction theories (LIT) with collaboration between researcher and teachers to improve the quality of learning, and the role of activities in learning the central tendency materials (mean, median, and mode), which is expected to be able for helping students understanding in the concept of statistical learning on grade VIII.

The stages of Design Research (DR) type validation studies are Preparing for the experiment (Preliminary), Design experiment in the form of a Preliminary Teaching Experiment (Pilot Experiment) and Teaching Experiment; and Retrospective analysis [30, 31]. At the Preparing, for the experiment (Preliminary) stage the researcher examines the literature about the curriculum in junior high schools, journals related to LSLC, PMRI, and material about central tendency for the past few years. With these documents, researcher designed learning devices. Then, doing observation to know the students' initial abilities; interviews about matters relating to learning material (class observation), interviews and validation of learning devices with several teachers (stage plan on LSLC). Design
experiment in the form of a Preliminary Teaching Experiment (Pilot Experiment) as cycle 1 and Teaching Experiment as cycle 2; tested the Hypothetical Learning Trajectory that had been designed beforehand to see the extent to which the conjectures and instruments researcher had made were carried out (Stage do on LSLC). The last stages is Retrospective analysis; analyze data obtained from pilot experiments and teaching experiments to develop local learning theory based on observations (Stage see on LSLC). In this study only that of preliminary teaching experiment (pilot experiment) is considered.

The results of observations, interviews, and documentation were analyzed. Data analysis was carried out by researcher and supervisor to improve the validation and reliability of the research conducted.

3. Result and Discussion
The researcher designed three activities in the learning device, Activities 1 and 2 were task sharing and Activity 3 was a jumping task. Activities 1 and 2 are sharing tasks, because more than 75% of students are able to answer questions correctly. The number 1 of jumping task question (advice from the teacher) is not a matter of jumping task because more than 50% of students answer correctly. Jumping task number 2 is a matter of jumping task because 50% of students are unable to answer questions even though they have been given a direction [18-20].

The activities are validated by peers in Focus Group Discussion (FGD), peers begin validation by working on the questions the researcher has made, which produce conclusions on activities 1 for the mean questions guided per step (don't immediately ask about mean), in the activities of 2 questions that are made more difficult than the problems in activity 3 because the calculation results are too many numbers behind the comma which requires a lot of time in the calculation. Peers give advice that Activity 2 be made a jumping task, in Activities 3 the question number 1 is too easy (it should be used as a sharing task), the question number 2 can be used for jumping tasks. Based on the results of the FGD, researchers decided to redesign the HLT by changing the number in activity 2 to a number that is easier to count, and eliminate 1 question from activity 3.

3.1. Validation
In activity 1, the researcher makes questions use the cost of the travel package provided in the table, students are asked to make a diagram based on the table and calculate the mean from cost of the travel package. Activity 1 aims to make students able to remember kinds of diagrams and determine diagrams that are suitable for a given problem, then based on the analysis of information on the problem can understand the mean.

| Packages          | Fee (Rp.) |
|-------------------|-----------|
| Individual Tour   | 500,000   |
| Honeymoon         | 1,500,000 |
| Family Group Tour | 3,500,000 |
| Group Tour        | 7,500,000 |

1. Make a diagram based on the table cost of travel!

Figure 1. Activity 1 after being validated with the teachers, the amount of the cost in the table is reduced and the questions related to the table are added to the sentence "based on the table above(Question number 2 and 3)".
In activity 2, the researcher makes questions with the school context that students choose after graduating from junior high school, the questions given are still related to presenting data (making diagrams), determining the mean, determining the median, and determining the mode.

Figure 2. Activity 2 after being validated with the teacher, the number of students was changed to make it easier to calculate (120 to 100) and the number of percentages known to have different numbers from each other (don’t have the same numbers).

In activity 3, the researcher develops the mean question (from activity 2, Figure 3) and the problem determines the mode based on the mean and median using the context of the victims of natural disasters (Figure 4).

Figure 3. Development of the question about the mean (from activity 2).

Before validation with the teacher (Figure 3) is a problem in activity 2, but after validation, the teacher suggests using the question in the next activity. For the questions in Figure 4 when validating one of the teachers does not recommend using the problem because the teacher assumes students will not be able to answer (the reason is students are still having difficulty in calculating, for ordinary questions it is likely that many cannot answer).

Figure 4. Development of the question about central tendency materials.

The researcher predicts that students can do all activities in activities 1 and 2 well, but difficulties in activity 3 especially in central tendency development questions (known as mean and median, asked mode). The mistakes that may be made by students include the diagram problem of some students...
making intervals based solely on the known problem, on the mean, median, and calculation error mode caused by the analysis of the wrong problem. The teachers has the same predictions as the researcher.

3.2. Small Group
In Activity 1 in determining the mean, students who experience difficulties are mostly caused by students' weak numeracy skills. For the problem of presenting data in a table in the form of a diagram, most students write the interval of the trip cost as known in the question (only one student can make the trip cost interval well, not based on what is known to be questioned).

From the results of student answers (Figure 5 and Figure 6), it can be concluded that there are still students who do not understand how to present data properly (especially at interval making), and some students do not understand the use of diagrams (for example, there are students who cannot distinguish line and stem diagrams).

![Figure 5. Students make a diagram (bar chart), with the intervals based on the numbers in the table on problem given (but the intervals from highest to the lowest number)](image)

![Figure 6. Students make a diagram of the numbers in the table on the problem given](image)

Less than 10% of students make correct diagrams based on data and determine the same intervals for diagrams that are made, less than 30% of students make diagrams that do not match the data provided or make intervals like figure 6, and the rest make correct diagrams but intervals which is used the same as what is known about the problem. It can be concluded that in making bar charts most students do not pay attention to the intervals and some students do not use diagrams that match the data provided.

In activity 2 in presenting data some students are mistaken in analyzing information on the question so that for the calculation of the mean, median, and mode there are some students who answer wrongly.
Figure 7. Student answers are correct, but some students are wrong in determining the median due to incorrectly analyzing information on the question.

Figure 8. Student don’t understand the concept of median.

Figure 9. Student answers are correct, but some students are wrong in determining the mode due to incorrectly analyzing information on the question.

Figure 10. Students are not careful in analyzing information on the problem (only see the percentages that are known).

For median questions (figure 7 and figure 8), less than 30% of students did not understand the concept of the median well (some students only emptied the answer sheets and the rest wrote answers in the form of percentages where some of the percentage numbers written were already known about the question). In solve the mode problem (figure 9 and 10), the student answer mode is wrong because when reading the information on the problem wrong so the solution of what was done is also wrong.

From the results of students answers to activity 2, many students were wrong in analyzing information on the questions so that the calculations for the following questions were wrong (due to lack of thorough analysis of information, some students were confused about the questions relating to the median and mode).
Figure 11. The mode scores obtained depend on the distribution of data created by students in the process to solving a problem given.

Figure 12. Students make incorrect data distribution.

For question number 1 (Activity 3) in determining and understanding the mean, students do not experience difficulties (calculation errors caused by inaccurate analysis of information on previous activities).

In the number 2 jumping task problem (Activity 3), initially all students were unable to work on the problem but after being given instructions on how to work several students were able to solve the problem correctly, while the errors of some students were not making the correct data distribution on the data.

All students have the same perception to find the solution of problem number 2 in jumping task, based on the information from the problem after getting the amount of data, students then continue to determine the data. some students find different solutions from Figure 11 (only different data values, but the mode obtained can differ based on the data values specified by students), students are wrong (in figure 12) in answering questions because they do not understand the information they get, so wrong in determining the value of the data (only in the form of numbers, not paying attention to the information obtained).

Figure 13. At the beginning of learning students make the letter U and the teacher explains learning in the middle of the student (Apperception given no more than 7 minutes).

Implementation of learning designed with lesson study, class structuring must resemble a seminar model (the letter U as figure 13) so that each student can be active in learning and continued with collaborative learning in small groups (Figure 14) [16].
Figure 14. After apperception, in the core activity (small group) students are divided into two groups, where each group consists of four people (two men and two women, whose seats have been arranged according to LSLC).

If in the learning process students do not participate in discussions with group members, the teacher must remind students to start discussions with members of the group (let students learn together, without any intervention from the teacher). If all students do not understand the given problem, the teacher only gives instructions to solve the problem (not teaching students to solve it directly).

Figure 15. Students who have difficulty in resolving a given problem are asked to ask group members (who are considered helpful) by saying "please, teach me".

Figure 16. Students who are asked to help are required to teach group members who ask for help in solving the problems given.

After each activity is completed, the teacher asks students who have difficulty during learning to represent their groups in presenting the results of the discussion to the class.

Before closing the lesson, the teacher guides students to conclude the learning that has been carried out and gives students the opportunity to ask questions if there are things that have not been understood by students during the learning process.

This study aims to determine the role of activities in learning the central tendency materials (mean, median, and mode), which is expected to be able for helping students understanding the concept of statistical learning. PMRI is proven capable of helping students to understand the learning concepts provided and develop student’s knowledge [33-41]. Teachers are necessary to using real-world phenomena in learning mathematics [42], so students can change and develop their knowledge.
(informal knowledge to formal knowledge) by connecting things in everyday life and the understanding gained becomes more meaningful and [22, 23, 26].

4. Conclusion
Based on the results of the analysis of student answer sheets and interviews with students, the researcher concluded that LSLC can be applied in MTs Negeri 1 Palembang but the teacher must be given training about LSLC and PMRI. Students are not familiar with level four questions and above (Jumping Task), the design of learning that is made helps students understand statistical materials about mean, median, mode, and development of central tendency material problems (mean, median and mode). Suggestions for future researchers use different contexts in designing learning devices and take more observers in a teaching experiment. Suggestions for teachers, ask teachers to be more open and have a curiosity about the learning system and new learning methods.

Activities 1 and 2 are sharing task because more than 75% of students can answer questions correctly. The number 1 of jumping task questions (advice from the teacher) is not a matter of jumping task because more than 50% of students answer correctly. Jumping task number 2 is a matter of jumping task because 50% of students are unable to answer questions even though they have been given a direction.

Acknowledgements
I would like to express my deep gratitude to Prof. Dr. Ratu Ilma Indra Putri, M.Si as my research supervisor, for their patient guidance, enthusiastic encouragement and useful critiques of this research work and would also like to extend my thanks to Penelitian Hibah Profesi Dana PNBP Tahun 2019, and all teachers (Mr. Andi and Mrs. Su’a’idah) who involved in my research.

References
[1] Siregar S 2015 Statistika Terapan untuk Perguruan Tinggi (Jakarta: Kencana)
[2] Spiegel M R and Stephens L J 2004 Teori dan Soal-soal Statistik Edisi ketiga (Jakarta: Erlangga)
[3] Waiter N N, Lamontagne C and Chartier S 2011 What does the mean mean? J. of Statistics Education 19 1
[4] Manikandan S 2011 Measures of central tendency: Median and mode J. of Pharmacology and Pharmacotherapeutic 2 214
[5] Kemendikbud 2018 Silabus Matematika SMP Kurikulum 2013 Revisi 2017 (Jakarta: Kementerian Pendidikan dan Kebudayaan RI)
[6] Kemendikbud 2018 Silabus Matematika SD/MI Kurikulum 2013 Revisi 2018 (Jakarta: Kementerian Pendidikan dan Kebudayaan RI)
[7] Kemendikbud 2013 Peraturan Menteri Pendidikan dan Kebudayaan No. 65 Tahun 2013 tentang Standar Proses (Jakarta: Kementerian Pendidikan dan Kebudayaan)
[8] Munirah 2015 Sistem Pendidikan Di Indonesia: antara keinginan dan realita J. Auladuna 2 233
[9] Suroto 2014 Kebijakan pembangunan pendidikan nasional indonesia dan kendala yang dihadapi sebagai upaya perbaikan dalam rangka mempersiapkan warga negara muda yang baik dan cerdas J. Pendidikan Kewarganegaraan 4 495
[10] Primadata A P and Kusumawati D K 2014 Modernisasi pendidikan di Indonesia sebuah perspektif sosiologis terhadap dunia pendidikan di Indonesia J. Analisa Sosiologi 3 25
[11] Suyahman 2015 Pendidikan untuk Semua antara Harapan dan Kenyataan Proc. Nas. Conf on Education (Surakarta: Indonesia) p 274-278
[12] Megawanti P 2012 Meretas permasalahan pendidikan di Indonesia J. Formatif 2 227
[13] NEA (National Education Association) 2012 Preparing 21st Century Students for a Global Society: An Educator’s Guide to the “Four Cs” (United States: National Education Association)
[14] Haithcock F 2010 A Guide to Implementing Lesson Study for District and School Leadership
Teams in Differentiated Accountability Schools 1st Edition (Florida: Florida Department of Education)

[15] Supranoto H 2015 Penerapan lesson study dalam meningkatkan kompetensi pedagogi guru SMA Bina Mulya Gadingrejo tahun pelajaran 2015/2016 J. PROMOSI (Pendidikan Ekonomi UM Metro) 3 218

[16] Sato M 2014 Mereformasi Sekolah Konsep dan Praktik Komunitas Belajar (Tokyo: Pelita-JICATokyo)

[17] Emiliarsa R N 2018 An analysis of teachers’ pedagogical competence in lesson study of MGMP SMP Majalengka J. ELTIN 6 22

[18] Sato M 2012 Dialog dan Kolaborasi di Sekolah Menengah Pertama (Jakarta: Pelita)

[19] Asari S 2017 Sharing and jumping task in collaborative teaching and learning process J. Didaktika 23 184

[20] Wikanta W 2017 Collaborative learning: Pembelajaran inovatif dalam mewujudkan hak-hak belajar siswa J. JpB 5 64

[21] Zulkardi and Putri R I I 2006 Mendesain Sendiri Soal Kontekstual Matematika Proc. Nas. Conf on Mathematics (Semarang: Indonesia)

[22] Zulkardi 2002 Developing A Learning Environmet on Realistics Mathematics Education for Indonesian Student Teacher (Enschede: University of Twente)

[23] Putri R I I 2011 Implementasi alat peraga operasi bilangan bulat bagi guru Sekolah Dasar (SD) se-Kecamatan Ilir Barat I Palembang J. Pendidikan Matematika 5 73

[24] Putri R I I 2015 Professional development of PMRI teachers for introducing social norms J. on Mathematics Education (IndoMS-JME) 6 11

[25] Putri R I I 2012 Developing Learning Trajectory Using Traditional Games In Supporting Students Learning Greatest Common Divisor In Indonesian Primary School Proc. Int. Congress on Mathematics Education (Seoul: Korea)

[26] Rejeki S and Putri R I I 2018 Models to Support Students’ Understanding of Measuring Area of Circles J. Phys.: Conf. Ser. 948 012058

[27] Lestari U P, Putri R I I and Hartono Y 2015 Using set model for learning addition of integers J. on Mathematics Education (IndoMS-JME) 6 16

[28] Sembiring R K 2010 Pendidikan Matematika Realistik Indonesia (PMRI): Perkembangan dan tantangannya J. on Mathematics Education (IndoMS-JME) 1 11

[29] Zulkardi and Putri R I I 2010 Pengembangan blog support untuk membantu siswa dan guru matematika Indonesia belajar pendidikan matematika realistik Indonesia (PMRI) J. Inovasi Perekayasa Pendidikan (JIPP) 2 1

[30] Zulkardi and Putri R I I 2019 New School mathematics curricula, PISA, and PMRI in Indonesia School Mathematics Curricula, Mathematics Education – An Asian Perspective ed Vistro-Yu C P & Toh T L (Singapore: Springer)

[31] Nieveen N, McKenney S, and Van Den Akker J 2006 Educational Design Research: The Value of Variety (London and New York: Routledge Taylor and Francis Group)

[32] Gravemeijer K and Cobb P 2006 Design Research from a Learning Design Perspective in J Van Den Akker, K Gravemeijer, S McKenney, and N. Nieven Educational Design Research (New York: Routledge)

[33] Salma U, Putri R I I and Somakim 2015 Ten-structure as strategy of addition 1-20 by involving spatial structuring ability for first grade students J. International Education Studies 8 16

[34] Sari P, Putri R I I and Kesumawati N 2015 Desain pembelajaran materi pengukuran sudut dengan pendekatan PMRI untuk kelas VI J. Numeracy 2 33

[35] Haryani T M, Putri R I I and Santoso B 2015 Desain pembelajaran dalam memahami konsep luas menggunakan kain motif kotak-kotak di kelas III J. Matematika Kreatif-Inovatif (KREANO) 6 49

[36] Disnawati H D, Hartono Y and Putri R I I 2012 Eksporasi pemahaman siswa dalam pembelajaran bangun datar segi empat di SD menggunakan konteks cak ingkling J.
Pythagoras 7 65

[37] Wahyuni R, Putri R I I and Hartono Y 2015 Volume kubus dan balok melibatkan kemampuan visualisasi spasial di kelas VIII J. Elemen 1 119

[38] Fatiyah N F, Putri R I I and Susanti E 2015 Stadion Gelora Sriwijaya Jakabaring dalam pembelajaran segitiga J. Matematika Kreatif-Inovatif (KREANO) 6 147

[39] Zabeta M, Hartono Y and Putri R I I 2015 Desain pembelajaran materi pecahan menggunakan pendekatan PMRI di kelas VII J. Beta 8 86

[40] Feriana O and Putri R I I 2016 Desain pembelajaran volume kubus dan balok menggunakan filling dan packing di kelas V J. Kependidikan 46 149

[41] Ramury F, Hartono Y and Putri R I I 2015 Pembelajaran pecahan senilai dengan bermain lego J. Didaktik Matematika 2 1

[42] Putri R I I and Zulkardi 2018 Higher-order Thinking Skill Problem on Data Representation in Primary School: A case study J. Phys.: Conf. Ser. 948 012056