Learning reflection through the context of Central Java historical building

F Nursyahidah*, B A Saputro and I U Albab
Faculty of Mathematics and Natural Science Education and Information Technology, Universitas PGRI Semarang, Indonesia

Corresponding author e-mail: faridanursyahidah@upgris.ac.id

Abstract. This study aims to produce a learning trajectory by using the context of Central Java historical building in helping students to understand the concept of one of material in geometry transformation that is reflection. The approach used in this research was Realistic Mathematics Education, in Indonesian version is called by PMRI. Subject of this study was the third grade students of Junior High School 6 Semarang, Central Java, Indonesia. The methodology used was a design research consisting of three phases, namely the preliminary design, the design experiment, and the retrospective analysis. However, this study only shows the results at the design experiment phase, in particular on a pilot experiment. Data collection was done through several techniques, namely: video recordings, photograph, students work result, and students interview during learning process. Student learning activities consist of four activities, namely: observing the video of Central Java historical building, determining, drawing, and finding formula of the shape result of reflection in cartesian coordinate system, determining, drawing, and finding formula of the shape result of reflection by the line which parallel to x-axis and y-axis, and solving problem related to reflection. The results of this study indicate that through a series of activities that have been designed could help to stimulate students understanding of reflection concept by using the context of Central Java historical building.

1. Introduction
One of the important areas in mathematics is Geometry [1] and it is also the oldest parts of mathematics and its sources can be kept track through cultures and society [2]. Reference [3] stated that through sketching, displaying, measuring, and matching, the students evolve spatial perception and find the correlation between geometric shapes. One of the material learned in geometry is transformations that consist of reflection, translation, rotation, and dilatation. Furthermore, according to [4], there are three main rational the importance of learning transformations geometry in mathematics, namely giving chance to students to reflect the significant of concept (e.g. function, symmetry), providing situation which is be able to see mathematics as a knowledge that related to each other, and giving opportunities to students to undertake in doing thinking efforts in high level using some representation skill.

On the other hand, [5] stated that students got problems in perceiving concept and differentiaclize in solving and pinpointing transformations which are translation, reflection, rotation, and the combination of some kinds of transformation. In addition, the difficulties of the students in learning transformation is when they found the transformation problem for the complex shape [6]. Besides, the students also got difficulties in forming transformation prove in algebra and determine the result of transformation of the shape in cartesian coordinate system [7]. Former study also show that, both students and teachers have
problems in comprehending the transformation subject because this is a little more theoretical than the other subjects [8].

According to [9], there are some factors causes the failure of comprehending of students in studying geometry, these are viewing capabilities, geometry language, and ineffectual teaching. In addition, [10] emphasize that if students are taught theoretical concepts excluding signification, this might not evolve their comprehending. In addition, if an idea becomes more complicated for the teacher, they seem to get problem with their own content knowledge [11]. That also often becomes an obstacle to students’ comprehending. Therefore, the importance thing needed before doing learning process in classroom is designing the instruction [12]. But, in fact there are some teachers who still did not design their instruction so that the learning goal cannot be reached optimally [13].

In curriculum 2013, the learning process need to be enjoy, effective, and significant, so that the students should be engaged actively, because they are center of learning. Furthermore, in accordance with the background mentioned, designing of educational material using proper approach and using a suitable context should be required in order to assist students’ comprehending the geometry concept, particularly in reflection in transformation that is learned in the third grade of junior high school students. One of proper approach that can be used is Realistic Mathematics Education (RME) or in Indonesia it is named as PMRI by using folklore as a context. Prior study stated that the utilization of proper context for studying provide a positive impact on learning mathematics that can enhance students' comprehending of mathematical ideas learned [14-20]. In addition, the use of PMRI approach can provide enjoyable and meaningful learning [21-22]. In line with this, there are two principal of Hans Freudenthal’s ideas about RME, namely “mathematics must be connected to reality, and mathematics as a human activity” [23]. So that, the students is not as a passive receivers of ready-made mathematics [24].

PMRI starts from the context in the students’ daily life toward formal mathematics [25-27]. Furthermore, an appropriate context is needed to be applied in PMRI learning process. One of them is local wisdom that has been familiar to the students and it can be modified based on where the school is located [28-29]. In this study, Lawang Sewu was used as a starting point in learning Transformation since some parts of that historical building can represent the material of reflection particularly.

To implement the study, the author used design research method that consist of three stages, namely preliminary design, design of the experiment (pilot experiment and teaching experiment), and retrospective analysis. But, this current research was limited to the pilot experiment phase. From the above discussion, the researchers conduct this study with the aim of developing a hypothetical learning trajectory to support students to comprehend the idea of the reflection in transformation using Central Java historical building.

2. Material and Methods
The methodology used in this research is design research that comprised of three phases, namely preliminary design, teaching experiment (pilot experiment and teaching experiment), and retrospective analysis [30]. This research is limited to pilot experiment phase which was conducted on July-September 2019. The subjects in this research were the third grade students of junior high school (SMPN) 6 Semarang. The purpose of design research is to develop a Hypothetical Learning Trajectory (HLT), which can be developed and polished within the study process. In this research, there is a learning track on the subject of reflection in transformation as a series of students’ works comprised of conjecture and mind tactics that be able to be modified and developed within the teaching experiment. So that the enforcement of the design research comprised of some phases which is a cyclical process of thought experiments and instruction experiment [31]. The data that was compiled in this research were written and audio-video data.

3. Result and Discussion
On the basis of the study that has been conducted, especially in pilot experiment phase, it can be achieved that students' comprehending of the concept of reflection in transformation can be assisted from various
activities designed, namely: observing video of central java historical building, determining, drawing, and finding formula of the shape result of reflection in cartesian coordinate system, determining, drawing, and finding formula of the shape result of reflection by the line which parallel to x-axis and y-axis, and solving problem related to reflection. Moreover, results and discussion of it can be explained as follows.

3.1. Activity 1: observing video of Central Java historical building

In this activity, students were introduced some kinds of transformation by observing video of Central Java historical building as a context. The researcher used that context because the parts of that building can represent the kinds of transformation which was learned. Besides that, it also has been familiar among students in Semarang. The teacher gave question to the students, “who have been there? How many times you visited that place? Explain your answer”, “Do you find any parts of this building that represented transformation?” This questions made students answer the given problem with high enthusiasm. Furthermore, figure 1 presents that activity.

![Figure 1. Students observed video of Central Java historical building](image)

Furthermore, teacher can investigate the activity outcome of observing learning video about Central Java historical building to lead students to reinvent concepts of transformation. By using this context, students were expected to find and also tried to draw some parts of that building that represent some kinds of transformation namely reflection, translation, rotation, and dilatation. The teacher asked to students to discuss some problem on the student’s worksheet with their group. After completed the discussion, they were requested to display the result in front of the class in order to make all students comprehend the idea learned in this activity which is the kinds of transformation. Furthermore, figure 2 shows the result of students work in this activity.

![Figure 2. The student answer on the first activity](image)

Based on the figure 2, it can be seen that the students can determine the parts of the historical building that represent each transformation and draw it. Furthermore, to find out more clearly about the students comprehending, the teacher interviewed the students. From the result of the interview, it can be concluded that students could determine some kinds of transformation including reflection. From the written result and interview it was shown that the purpose of this activity was achieved.
3.2. Activity 2: Determining, drawing, and finding formula of the shape result of reflection in cartesian coordinate system

In the second activity, students were requested to find result of reflection by drawing it and then determine the properties of reflection. After that, the students also were requested to find and sketch the result of reflection on cartesian coordinate system with some kinds of axis which are x-axis, y-axis, the origin (0,0), line $y=x$, and line $y=-x$, then found the formula of each. Furthermore, the result of students answer in this activity can be seen at figure 3 below.

![Figure 3](image)

**Figure 3.** Students work in drawing and determining formula of the shape result of reflection in cartesian coordinate system

Figure 3 indicates student work in students worksheet. It can be regarded that by discussion with their group the students could solve the given problem on students worksheet. From the result of the interview, it can be concluded that students could find, draw, and determine the formula of reflection on cartesian coordinate system with some kinds of axis which are x-axis, y-axis, the origin (0,0), line $y=x$, and line $y=-x$. From the written result and interview it was proven that the purpose of this activity 2 was achieved.

3.3. Activity 3: Determining, drawing, and finding formula of the shape result of reflection by the line which parallel to x-axis and y-axis

In the third activity, students were requested to determine result of reflection by drawing it and then determine the formula of reflection on cartesian coordinate system with some kinds of axis which are parallel to x-axis and parallel to y-axis. Furthermore, the result of students answer in this activity can be shown at figure 4 below.

![Figure 4](image)

**Figure 4.** The student answer in drawing, and finding formula of the shape result of reflection by the line which parallel to x-axis and y-axis

Based on the figure 4, it can be obviously seen that by discussion with their group the students could solve the given problem on student’s worksheet on the third activity. From the result of the interview, it can be concluded that students could find, draw, and determine the formula of reflection on cartesian coordinate system by the line which parallel to x-axis and y-axis. From the written result and interview it was proven that the purpose of this activity 3 was achieved.
3.4. Activity 4: Solving problem related to reflection
In this activity, students were questioned to solve problems related to the reflection. Students were able to solve the issue with the concept learned in previous material. Furthermore, the result of the student’s respond of this activity can be viewed at figure 5 below.

![Figure 5. The student’s answer from given problem](image)

It can be obviously observed from figure 5 that students have comprehended the concept of reflection so they could solve the given problem correctly. The results are consistent with the plan of hypothetical learning trajectory.

From the result of this study, it can be known that by designing material using PMRI approach can stimulate student’s activity and help them understanding the concept learned by finding their own concept by guidance from the teacher. This outcome is in accordance with the outcome of several previous studies [13,14,15,16] stated that applying PMRI in instructional design by using appropriate context can support students understanding the concept learned. By using context of Central Java historical building which the students have been familiar with and it was packaged in interactive video, made the students be more active and enthusiastic in studying process thus they can comprehend the idea of reflection in transformation deeply and more meaningful.

4. Conclusion
The hypothetical learning trajectory resulted in this study composed of four activities, that is: observing the video of Central Java historical building, determining, drawing, and finding formula of the shape result of reflection in cartesian coordinate system, determining, drawing, and finding formula of the shape result of reflection by the line which parallel to x-axis and y-axis, and solving problem related to reflection. The result of this research specify that through a series of activities that have been designed could support to excite the students comprehending of concept of reflection by the use of Central Java historical building context.

Acknowledgments
Researchers expressed acknowledgment to KEMENRISTEKDIKTI-Indonesian Ministry of Research and Technology of Higher Education that has funded research this grants of national competitive research.

References
[1] Ilaslan S 2013 Middle School Mathematics Teachers’ Problems in Teaching Transformational Geometry and Their Suggestions for the Solution of these Problems Thesis (Ankara: Middle East Technical University)
[2] Seloraji P and L K Eu 2017 Malays. Online J. Educ. Technol. 5 (1) 65
[3] Toptas V 2007 İlköğretim matematik dersi (1–5) öğretim programında yer alan 1. sınıf geometri öğrenme alanı öğrenme öğretme sürecinin incelenmesi Thesis (Ankara: Gazi University)
[4] Hollebrands K F 2003 J. Math. Behav. 22 55
[5] Guven B 2012 Aust. J. Educ. Technol. 28 (2) 364
[6] Morris T and Paulsen R 2011 J. Amesa 2
[7] Naidoo J 2010 Strategies Used by Grade 12 Mathematics Learners in Transformation Geometry (Natal: University of Kwazulu)
[8] Harper S R 2002 Enhancing elementary pre-service teachers’ knowledge of geometric transformations Dissertation (Virginia: University of Virginia)

[9] Idris N 2006 Teaching and Learning of Mathematics, Making Sense and Developing Cognitives Ability (Kuala Lumpur, Malaysia: Utusan)

[10] Foster D 2007 Assess. Math. Profic. 53 163

[11] Mashingaidze S 2012 Asian Social Science 8 (15) 197

[12] Putrawangsa S 2018 Desain Pembelajaran: Design Research sebagai Pendekatan Desain Pembelajaran (Mataram: CV. Reka Karya Amerta)

[13] Arif S and Yanawati 2018 Pengantar Desain Pembelajaran (Jambi: Pustaka Ma’arif Press)

[14] Nursyahidah F, Saputro B A and Rubowo M R 2018 J. Phys.: Conf. Ser. 983 012119

[15] Nursyahidah F, Putri R I I and Somakim 2014 Instructional Design of Subtraction using PMRI Approach based on Traditional Game. SEA-DR. (Palembang: Universita Sriwijaya)

[16] Nursyahidah F, Putri R I I and Somakim 2013 IndoMS. J.M.E. 4 (2) 212

[17] Putri R I I & Zulkardi 2018 J. Phys.: Conf. Ser. 1088 012023

[18] Tanujaya B, Prahmana R C and Mumu J 2017 World Trans. Eng. Technol. Educ. 15 (3) 287

[19] Ginting M S, Prahmana R C I, Isa M and Murni 2018 J. Math. Educ. 9 (1) 41

[20] Risdiyanti I, Prahmana R C I and Shahrril M 2019 Elem. Educ. Online 18 (4) 2094

[21] Lestari S A, Saragih S and Hasratuddin 2018 Am. J. Educ. Res. 6 (11) 1473

[22] Mauluddy S S, Surya E and Syahputra E 2017 Int. J. Adv. Res. Innov. Ideas Educ. 3 (2) 2965

[23] Zulkardi 2002 Developing a Learning Environment on Realistic Mathematics Education for Indonesian Student Teachers (Published Thesis) (The Netherlands: PrinPartners IpskampEnschede)

[24] De Lange J 1987 Mathematica, Insight and Meaning (Utrecht : OW & OC, The Netherlands)

[25] Karaca S Y and Özkaya A 2017 Int. J. Curric. Instr. 9 (1) 81-103

[26] Nasution M F, Putri R I and Zulkardi 2018 J. Math. Educ. 9 (1) 69-80

[27] Saleh M, Prahmana R C I, Isa M and Murni 2018 J. Math. Educ. 9 (1) 41-54

[28] Oktiningrum W, Zulkardi and Hartono Y 2016 J. Math. Educ. 7 (1) 1

[29] Jannah & Prahmana 2019 J. Educ. Gift. Young Sci. 7 (2) 299

[30] Gravemeijer K and Cobb P 2006 Design Research from the Learning Design Perspective Educational Design Research ed J V D Akker, K Gravemeijer, S McKenney, and N Nieveen (London: Routledge) pp. 17-51

[31] Gravemeijer K P E 1994 Developing realistic mathematics education (Utrecht: CD-B Press)

[32] Gravemeijer K P E 1994 Developing realistic mathematics education (Utrecht: CD-B Press)