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#2600 Summary

SUMMARY REVIEW EDITING

Submission

Authors	Maryati Maryati, Rully Charitas Indra Prahmana
Title	DESIGNING LEARNING ROTATION USING THE CONTEXT OF BAMBOO WOVEN MOTIF
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Dear Abdul Baist,
Editor in Chief of Prima: Jurnal Pendidikan Matematika

We hope this submission finds you well.

We as the research collaboration team are writing the manuscript entitled "Designing Learning Rotation using The Context of Bamboo Woven Motif" for consideration for publication in the Prima: Jurnal Pendidikan Matematika. This manuscript was written using the Prima: Jurnal Pendidikan Matematika Manuscript Template mentioned on the website.

This paper explores student learning trajectories in learning rotation, which develop from informal to formal level through the Indonesian Realistic Mathematics Education (IRME) approach. Furthermore, researchers used a design research method which was divided into 3 stages, namely preliminary design, design experiments, and retrospective analysis. This study describes how the bamboo woven motif contributes significantly to ninth-grade students in understanding the concept of rotation. The results of the design experiments show that the context of the woven bamboo motif can stimulate students to understand their knowledge of the concept of rotation. All strategies and models that students find, describe, and discuss that show how students' construction or contributions can be used to help their initial understanding of the concept of rotation.

This paper also describes our original work and is not under consideration by any other journal. All authors approved the manuscript and this submission. The two co-authors do not have any conflict of interest regarding this manuscript. This document was reported as the result of the research we conducted as one of the requirements of our responsibility as a researcher in our university. Furthermore, This year, we didn't get funding for our research publication so that I would like to waive all article processing charges, if our paper is accepted. Lastly, we do hope that this article can be published in this journal so that we can contribute our research results to your journal.

Thank you for receiving our manuscript and considering it for review. We do really appreciate your time and look forward to seeing your response.

Best Wishes,
Rully Charitas Indra Prahmana

Abstract Views	238

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Title and Abstract

Title: DESIGNING LEARNING ROTATION USING THE CONTEXT OF BAMBOO WOVEN MOTIF

Abstract

An essential part of learning transformation geometry is rotation. Before learning more about other parts of the transformation geometry topic, such as translation, dilation, and reflection, firstly, students are required to understand well about rotation. However, several students have not been able to understand this subject properly due to the stages of learning in the rotation has not been appropriately arranged. Thus, this study aims to design a student learning trajectory in learning rotation, which develop from informal to formal level through the Indonesian Realistic Mathematics Education (IRME) approach. Furthermore, researchers used a design research method divided into three stages, namely preliminary design, design experiments, and retrospective analysis. This study describes how the bamboo woven motif contributes significantly to 31 ninth-grade students understanding the rotation concept. As a result, the woven bamboo motif's context can stimulate students' understanding of rotation. It is proven based on the strategies and models of students during their learning process which contributes to their fundamental knowledge of rotation.

Indexing

Keywords: Bamboo woven motif; Indonesian Realistic Mathematics Education; Rotation; Design Research

Language: en

Supporting Agencies

Agencies: —

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Blind Review Artikel yang di submit pada tanggal 3 Mei 2020, dengan judul awal,

“Design Learning Rotation Using the Context of Bamboo Woven Motif”

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DESIGN LEARNING ROTATION USING THE CONTEXT OF BAMBOO WOVEN MOTIF

Abstrak

Salah satu bagian penting dari pembelajaran transformasi geometri adalah pembelajaran rotasi. Sebelum mempelajari lebih jauh terkait topik transformasi geometri, siswa dituntut untuk memahami dengan baik materi rotasi. Namun, banyak siswa belum mampu memahami materi ini dengan baik yang disebabkan oleh tahapan pembelajaran pada materi rotasi belum tersusun dengan baik. Sehingga, penelitian ini bertujuan untuk menghasilkan lintasan belajar siswa dalam pembelajaran rotasi, yang berkembang dari bentuk informal ke bentuk formal melalui pendekatan Pendidikan Matematika Realistik Indonesia (PMRI). Selanjutnya, peneliti menggunakan metode penelitian design research yang dibagi menjadi 3 tahapan, yaitu desain pendahuluan, percobaan desain, dan analisis retrospektif. Penelitian ini mendeskripsikan bagaimana motif Anyaman Bambu memberikan kontribusi nyata pada siswa kelas IX dalam memahami konsep rotasi. Hasil dari percobaan desain menunjukkan bahwa konteks motif Anyaman Bambu dapat merangsang siswa untuk memahami pengetahuan mereka tentang konsep rotasi. Seluruh strategi dan model yang siswa temukan, gambarkan, serta diskusikan yang menunjukkan bagaimana konstruksi atau kontribusi siswa dapat digunakan untuk membantu pemahaman awal mereka tentang konsep rotasi.

Kata Kunci: Motif Anyaman bambu, Pendidikan Matematika Realistik Indonesia, Rotasi, Design Research

Abstract

An essential part of learning geometry transformation is rotation. Before learning more about the topic of geometry transformation, students are required to understand well about rotation. However, several students have not been able to understand this subject properly due to the stages of learning in the material rotation has not been arranged properly. Thus, this study aims to design student learning trajectories in learning rotation, which develop from informal to formal level through the Indonesian Realistic Mathematics Education (IRME) approach. Furthermore, researchers used a design research method which was divided into 3 stages, namely preliminary design, design experiments, and retrospective analysis. This study describes how the bamboo woven motif contributes significantly to ninth-grade students in understanding the concept of rotation. The results of the design experiments show that the context of the woven bamboo motif can stimulate students to understand their knowledge of the concept of rotation. All strategies and models that students find, describe, and discuss that show how students' construction or contributions can be used to help their initial understanding of the concept of rotation.

Keywords: Bamboo Woven Motif, Indonesian Realistic Mathematics Education, Rotation, Design Research

INTRODUCTION

Rotation is a transformation that moves points by rotating these points θ to a central point of rotation (Maryati & Prahmana, 2019). Furthermore, Risdiyanti & Prahmana (2018) show that learning about geometry transformation especially rotation can be used to design learning using the local contexts such as culture or other things that are easily found in students' daily activities. On the other hand, students can understand mathematical concepts easily, fun, close to daily activities, and affordable to students' imagination (Zulkardi, 2013;

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Adams & Cook, 2017; Clarke & Roche, 2018). Thus, it would be made it easier for students to be able to solve the problems encountered in students' daily lives.

The Program for International Student Assessment (PISA) results analyzed by Stacey (2011) shows that Indonesian students still have difficulty in formulating problems in daily life into mathematical models. One example is interpreting the context of real situations into mathematical models, understanding mathematical structures, including order, relationships, and patterns (Edo, Hartono, & Putri, 2013; Revina & Leung, 2019). One contributing factor is the process of learning mathematics which tends to use practical formulas and has not connected mathematical concepts with students' daily activities (Naidoo, 2012; Arisetyawan, Suryadi, Herman, & Rahmat, 2014). Therefore, meaningful learning activities are needed so that students can master the concepts and traits of rotation easily and fun.

One of the learning approaches that can connect the learning subject with daily life is the Indonesian Realistic Mathematics Education (IRME) (Sembiring, Hadi, & Dolk, 2008). The IRME is an adaptation of Realistic Mathematics Education (RME) and has been developed in accordance with the context, cultural values, or local wisdom in Indonesia (Lestariningsih, Putri, & Darmawijoyo, 2015). The IRME places more emphasis on the processes that occur during the learning process so that they are not only concerned with the final results (Sembiring et al., 2008). Thus, IRME could be used as a solution in a learning approach that wants to connect a mathematical material with daily student activities.

IRME is one of the learning approaches that will lead students to understand mathematical concepts by constructing themselves through prior knowledge related to daily life (Revina & Leung, 2019; Risdiyanti & Prahmana, 2020). Furthermore, by discovering the concept by themselves, the students' learning process will become more meaningful. In addition, one of the developments in IRME was carried out with research aimed at improving classroom learning practices through an interactive analysis of hypothetical learning trajectory of what would happen in the classroom and its implementation, the research was design research (Cobb & Gravemeijer, 2006).

As an innovation in learning mathematics and as an implementation of the 2013 curriculum which is oriented to the relationship of mathematics to the conditions of reality and culture of students, researchers designing learning rotation using the context of the woven bamboo motif through the IRME approach. This context was chosen because it is close to students and easily found in students' daily lives. Through this design, it is expected to be an innovation in learning mathematics that can facilitate students in understanding the concept of rotation and be able to solve everyday problems related to the concept and further concept in transformation geometry, such as translation and dilatation.

RESEARCH METHOD

The research method used in this study is design research, which is an appropriate way to answer research questions and achieve research objectives starting with preliminary design, design experiments, and retrospective analysis (Cobb & Gravemeijer, 2006; Prahmana, 2017). The subjects in this study were IXA grade students of SMP Negeri 1 Tepus consisting of 31 students. Data collection techniques used in this study include video recording, documentation, written data, and observation. Data analysis conducted in this study was to compare the observations during the learning process with the Hypothetical Learning Trajectory that had been designed at the preliminary design stage.

RESULTS AND DISCUSSION

The results obtained in this study in the form of learning trajectories in learning rotation using the context of the bamboo woven motif through the PMRI approach. The following is an explanation of the learning process of rotation material in class IXA

The Early Learning Phase

Learning begins with giving assignments in groups (4-5 people per group), namely working on the Student Worksheet (SW) entitle "Activity 2". Describing the activities in this learning process begins with the teacher instructing all students to gather with their respective groups. Next, the teacher gives assignments to each group to work on the SW entitle "Activity 2" about the concept of rotation.

The Informal Phase

At this stage, students do activities based on the steps or instructions on the SW entitle "Activity 2" which starts from preparing the woven and ornamentation. After all students are ready with their weaving and ornaments, the teacher instructs each group to record the initial coordinates and the final coordinates after they are rotated according to the instructions in the worksheet. In Figure 1, students are seen rotating the ornaments according to the instructions in SW "Activity 2" to get a starting point and end point.

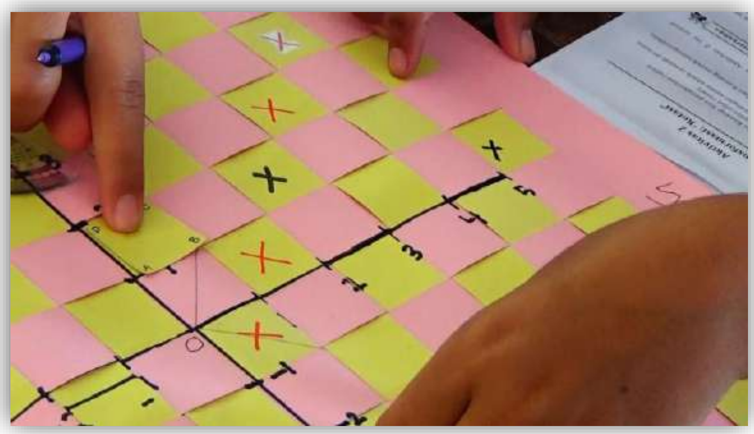


Figure 1. Students rotate the ornaments and calculate the coordinates (Informal)

The Phase of Model Of

At this stage, students write the coordinate points that have been obtained at an informal stage in a table as shown in Figure 2.

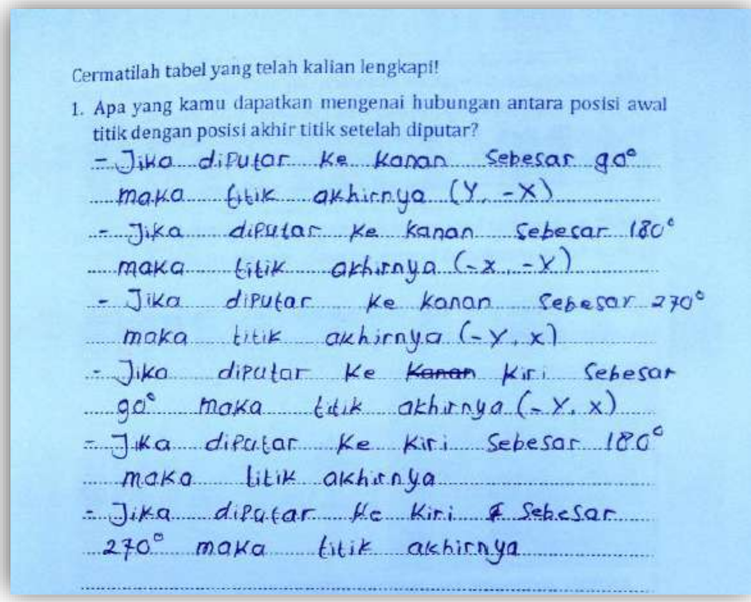
Soal Nomor	Nama Titik	Posisi Awal Titik	Perputaran			Posisi Akhir Titik
			Arah	Besar Sudut	Titik Pusat	
2	A	(1, 1)	Kanan	90°	(0, 0)	(1, -1)
	B	(2, 1)	Kanan	90°	(0, 0)	(1, -2)
	C	(2, 2)	Kanan	90°	(0, 0)	(2, -2)
	D	(1, 2)	Kanan	90°	(0, 0)	(2, -1)
3	A	(1, 1)	Kanan	180°	(0, 0)	(-1, -1)
	B	(2, 1)	Kanan	180°	(0, 0)	(-2, -1)
	C	(2, 2)	Kanan	180°	(0, 0)	(-2, -2)
	D	(1, 2)	Kanan	180°	(0, 0)	(-1, -2)
4	A	(1, 1)	Kanan	270°	(0, 0)	(-1, 1)
	B	(2, 1)	Kanan	270°	(0, 0)	(-1, 2)
	C	(2, 2)	Kanan	270°	(0, 0)	(-2, 2)

Soal Nomor	Nama Titik	Posisi Awal Titik	Perputaran			Posisi Akhir Titik
			Arah	Besar Sudut	Titik Pusat	
	D	(1, 2)	Kanan	270°	(0, 0)	(-2, 1)
5	A	(1, 1)	Kiri	90°	(0, 0)	(-1, 1)
	B	(2, 1)	Kiri	90°	(0, 0)	(-1, 2)
	C	(2, 2)	Kiri	90°	(0, 0)	(-2, 2)
	D	(1, 2)	Kiri	90°	(0, 0)	(-2, 1)
6	A	(1, 1)	Kiri	180°	(0, 0)	(-1, -1)
	B	(2, 1)	Kiri	180°	(0, 0)	(-2, -1)
	C	(2, 2)	Kiri	180°	(0, 0)	(-2, -2)
	D	(1, 2)	Kiri	180°	(0, 0)	(-1, -2)
7	A	(1, 1)	Kiri	270°	(0, 0)	(1, -1)
	B	(2, 1)	Kiri	270°	(0, 0)	(1, -2)
	C	(2, 2)	Kiri	270°	(0, 0)	(2, -2)
	D	(1, 2)	Kiri	270°	(0, 0)	(2, -1)

Figure 2. Student work results record the starting point and end point of the rotation results in a table (Model of)

The Phase of Model For

At this stage, students analyze the change from starting point to end point and make interpretations related to the concept of rotation with their own language as shown in Figure 3.



Cermatilah tabel yang telah kalian lengkapi!

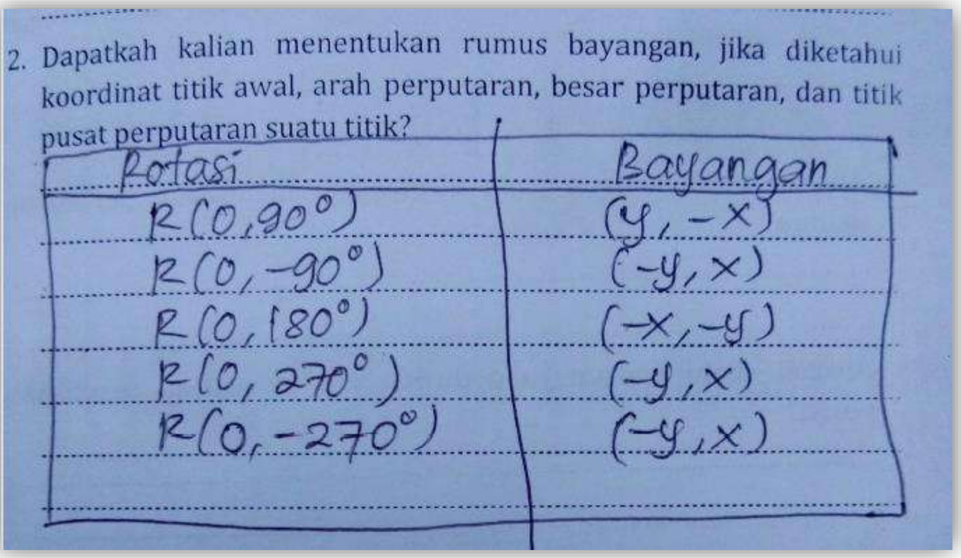
1. Apa yang kamu dapatkan mengenai hubungan antara posisi awal titik dengan posisi akhir titik setelah diputar?

- Jika diputar ke kanan sebesar 90° maka titik akhirnya (Y, -X)
- Jika diputar ke kanan sebesar 180° maka titik akhirnya (-x, -Y)
- Jika diputar ke kanan sebesar 270° maka titik akhirnya (-Y, x)
- Jika diputar ke ~~Kanan~~ kiri sebesar 90° maka titik akhirnya (-Y, x)
- Jika diputar ke kiri sebesar 180° maka titik akhirnya
- Jika diputar ke kiri sebesar 270° maka titik akhirnya

Figure 3. Students write the results of their interpretation related to the concept of rotation in the worksheet (Model for)

Formal Phase

At this stage, students make mathematical modeling in the form of a rotation formula according to their respective understanding. The results of students' mathematical modeling can be seen in Figure 4.



2. Dapatkah kalian menentukan rumus bayangan, jika diketahui koordinat titik awal, arah perputaran, besar perputaran, dan titik pusat perputaran suatu titik?

Rotasi	Bayangan
R(0,90°)	(y, -x)
R(0,-90°)	(-y, x)
R(0,180°)	(-x, -y)
R(0,270°)	(-y, x)
R(0,-270°)	(-y, x)

Figure 4. Student mathematical modeling results related to the rotation formula (formal)

To classify the results of student answers listed in the worksheet, a class discussion is needed. Therefore, the teacher invites each group to present their work. Students are seen presenting the concept of rotation as shown in Figure 5.

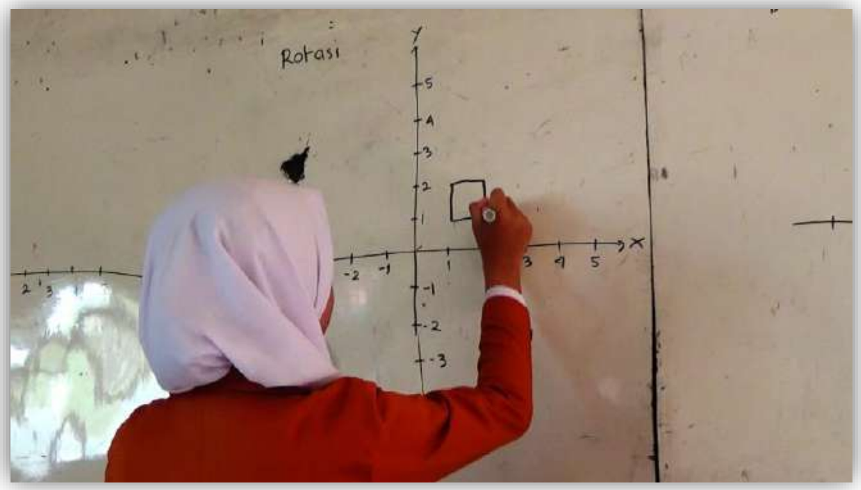


Figure 5. Students present about rotation

During the discussion process, it seemed that the participants in the discussion were very enthusiastic about expressing their opinions and ideas on the work done by each group's worksheet. It is caused by the position of the ornamental starting point that is different from each discussion group, so that the position of the ornamental endpoint will also be different. Furthermore, the teacher guides students to have 5 common perception of the concept of rotation. Firstly, if the starting point is rotated 90 degrees to the right with a center point (0.0), then the end point will be the opposite, but the back is negative. Secondly, if the starting point is rotated 90 degrees to the left with the center point (0,0), then the end point will be the opposite, but the front is negative. Thirdly, if the starting point is rotated 180 degrees to the right and to the left with center point (0,0), then the end point will be the same that is to be all negative. Fourthly, if the starting point is rotated as far as 270 degrees to the right with the center point (0,0), then the end point will be the opposite, but the front negative. Lastly, if the starting point is rotated 270 degrees to the left with the center point (0,0), then the end point will be the opposite, but the back is negative.

In addition, some researchers have also made mathematics learning design using IRME approaches and cultural contexts, such as learning number pattern using “Barathayudha” war stories (Risdiyanti & Prahmana, 2020), rotational learning designs using kawung batik motifs (Risdiyanti & Prahmana, 2018), the design of transformation learning using Sidoarjo written batik motifs (Lestariningsih & Mulyono, 2017), and learning number operation using Indonesian traditional game "Tepuk Bergambar" (Prahmana, Zulkardi, & Hartono, 2012). Therefore, the role taken from the results of this study is to enrich to the study of mathematics learning design that is rotational learning design using the context of the woven bamboo motif.

CONCLUSION

Learning trajectories that can support the concept of rotation from informal to formal level include the activity of recording the starting and ending points of ornamentation on the webbing field, analyzing and interpreting the change of the starting point into an end point using their own language, and writing the rotation formula. The results of the design experiments show that the context of the woven bamboo motif can stimulate students to understand their knowledge of the concept of rotation. All the strategies and models that students find, illustrate, and discuss show how the construction or contribution of students can be used to help their initial understanding of the concept of rotation.

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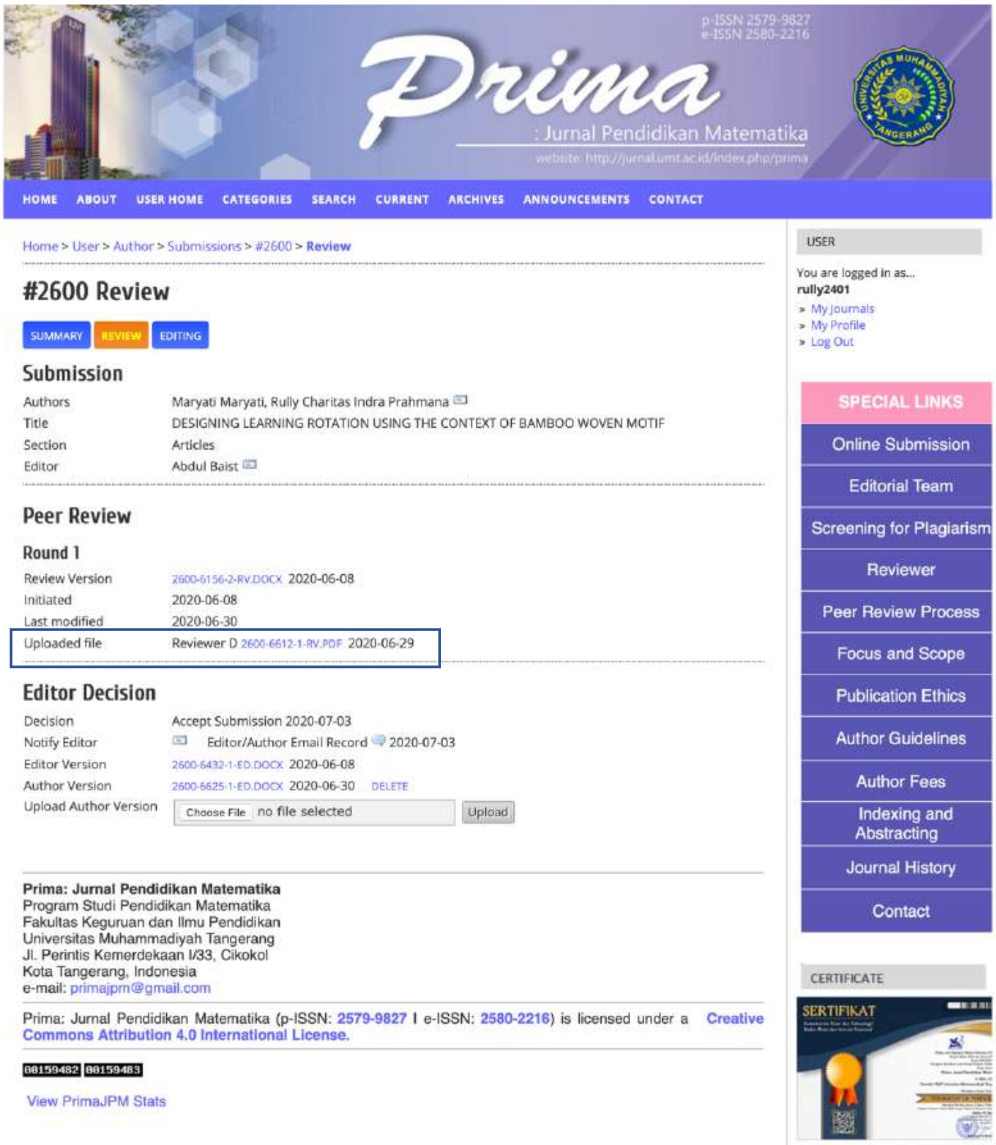

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CERTIFICATE

SERTIFIKAT

Hasil review oleh seorang reviewer dengan memberikan catatan perbaikan pada artikel nya secara langsung.

[Paper ID: 2600]

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DESIGN LEARNING ROTATION USING THE CONTEXT OF BAMBOO WOVEN MOTIF

No. Article: 2600-6155-1

Abstract

An essential part of learning geometry transformation is rotation. Before learning more about the topic of geometry transformation, students are required to understand well about rotation. However, several students have not been able to understand this subject properly due to the stages of learning in the material rotation has not been arranged properly. Thus, this study aims to design student learning trajectories in learning rotation, which develop from informal to formal level through the Indonesian Realistic Mathematics Education (IRME) approach. Furthermore, researchers used a design research method which was divided into 3 stages, namely preliminary design, design experiments, and retrospective analysis. This study describes how the bamboo woven motif contributes significantly to ninth-grade students in understanding the concept of rotation. The results of the design experiments show that the context of the woven bamboo motif can stimulate students to understand their knowledge of the concept of rotation. All strategies and models that students find, describe, and discuss that show how students' construction or contributions can be used to help their initial understanding of the concept of rotation.

Keywords: Bamboo Woven Motif, Indonesian Realistic Mathematics Education, Rotation, Design Research

Abstrak

Salah satu bagian penting dari pembelajaran transformasi geometri adalah pembelajaran rotasi. Sebelum mempelajari lebih jauh terkait topik transformasi geometri, siswa dituntut untuk memahami dengan baik materi rotasi. Namun, banyak siswa belum mampu memahami materi ini dengan baik yang disebabkan oleh tahapan pembelajaran pada materi rotasi belum tersusun dengan baik. Sehingga, penelitian ini bertujuan untuk menghasilkan lintasan belajar siswa dalam pembelajaran rotasi, yang berkembang dari bentuk informal ke bentuk formal melalui pendekatan Pendidikan Matematika Realistik Indonesia (PMRI). Selanjutnya, peneliti menggunakan metode penelitian design research yang dibagi menjadi 3 tahapan, yaitu desain pendahuluan, percobaan desain, dan analisis retrospektif. Penelitian ini mendeskripsikan bagaimana motif Anyaman Bambu memberikan kontribusi nyata pada siswa kelas IX dalam memahami konsep rotasi. Hasil dari percobaan desain menunjukkan bahwa konteks motif Anyaman Bambu dapat merangsang siswa untuk memahami pengetahuan mereka tentang konsep rotasi. Seluruh strategi dan model yang siswa temukan, gambarkan, serta diskusikan yang menunjukkan bagaimana konstruksi atau kontribusi siswa dapat digunakan untuk membantu pemahaman awal mereka tentang konsep rotasi.

Kata Kunci: Motif Anyaman bambu, Pendidikan Matematika Realistik Indonesia, Rotasi, Design Research

INTRODUCTION

Rotation is a transformation that moves points by rotating these points θ to a central point of rotation (Maryati & Prahmana, 2019). Furthermore, Risdiyanti & Prahmana (2018) show that learning about geometry transformation especially rotation can be used to design learning using the local contexts such as culture or other things that are easily found in students' daily activities. On the other hand, students can understand mathematical concepts easily, fun, close to daily activities, and affordable to students' imagination (Zulkardi, 2013; Adams & Cook, 2017; Clarke & Roche, 2018). Thus, it would be made it easier for students to be able to solve the problems encountered in students' daily lives.

Submited: 3 May 2020; Revised: XXXX; Accepted: XXXX

Comment [AJ1]: THE DESIGN OF…
Comment [AJ2]: Transformational Geometry
Comment [AJ3]: See a previous suggestion.
Comment [AJ4]: Please rewrite this background, so it is more coherence.
Comment [AJ5]: How many are there learning trajectories?
Comment [AJ6]: How many students were involved in this study?
Comment [AJ7]: Penelitian Desain?
Comment [AJ8]: Please state clearly the aims of the current study in this section.
Also, please add relevant theoretical framework for analyzing and interpreting results.
Comment [AJ9]: A circular definition. Please rewrite it precisely.
Comment [AJ10]: Life?

The Program for International Student Assessment (PISA) results analyzed by Stacey (2011) shows that Indonesian students still have difficulty in formulating problems in daily life into mathematical models. One example is interpreting the context of real situations into mathematical models, understanding mathematical structures, including order, relationships, and patterns (Edo, Hartono, & Putri, 2013; Revina & Leung, 2019). One contributing factor is the process of learning mathematics which tends to use practical formulas and has not connected mathematical concepts with students' daily activities (Naidoo, 2012; Arisetyawan, Suryadi, Herman, & Rahmat, 2014). Therefore, meaningful learning activities are needed so that students can master the concepts and traits of rotation easily and fun.

One of the learning approaches that can connect the learning subject with daily life is the Indonesian Realistic Mathematics Education (IRME) (Sembiring, Hadi, & Dolk, 2008). The IRME is an adaptation of Realistic Mathematics Education (RME) and has been developed in accordance with the context, cultural values, or local wisdom in Indonesia (Lestariningsih, Putri, & Darmawijoyo, 2015). The IRME places more emphasis on the processes that occur during the learning process so that they are not only concerned with the final results (Sembiring et al., 2008). Thus, IRME could be used as a solution in a learning approach that wants to connect a mathematical material with daily student activities.

IRME is one of the learning approaches that will lead students to understand mathematical concepts by constructing themselves through prior knowledge related to daily life (Revina & Leung, 2019; Risdiyanti & Prahmana, 2020). Furthermore, by discovering the concept by themselves, the students' learning process will become more meaningful. In addition, one of the developments in IRME was carried out with research aimed at improving classroom learning practices through an interactive analysis of hypothetical learning trajectory of what would happen in the classroom and its implementation, the research was design research (Cobb & Gravemeijer, 2006).

As an innovation in learning mathematics and as an implementation of the 2013 curriculum which is oriented to the relationship of mathematics to the conditions of reality and culture of students, researchers designing learning rotation using the context of the woven bamboo motif through the IRME approach. This context was chosen because it is close to students and easily found in students' daily lives. Through this design, it is expected to be an innovation in learning mathematics that can facilitate students in understanding the concept of rotation and be able to solve everyday problems related to the concept and further concept in transformation geometry, such as translation and dilatation.

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Also, please add relevant references.

RESEARCH METHOD

The research method used in this study is design research, which is an appropriate way to answer research questions and achieve research objectives starting with preliminary design, design experiments, and retrospective analysis (Cobb & Gravemeijer, 2006; Prahmana, 2017). The subjects in this study were IXA grade students of SMP Negeri 1 Tepus consisting of 31 students. Data collection techniques used in this study include video recording, documentation, written data, and observation. Data analysis conducted in this study was to compare the observations during the learning process with the Hypothetical Learning Trajectory that had been designed at the preliminary design stage.

Comment [AJ12]: Plase elaborate more on the following points:
- Please describe activities in the preliminiary design phase
- Please describe activities in the design experiment phase;
- Please describe activities in the retrospective analysis.

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RESULTS AND DISCUSSION

The results obtained in this study in the form of learning trajectories in learning rotation using the context of the bamboo woven motif through the PMRI approach. The following is an explanation of the learning process of rotation material in class IXA

The Early Learning Phase

Learning begins with giving assignments in groups (4-5 people per group), namely working on the Student Worksheet (SW) entitled "Activity 2". Describing the activities in this learning process begins with the teacher instructing all students to gather with their respective groups. Next, the teacher gives assignments to each group to work on the SW entitle "Activity 2" about the concept of rotation.

Comment [AJ14]: Please provide the 'Activity 2" in this manuscript, so readers can understand your explanation. Otherwise, readers will not understand this text.

The Informal Phase

At this stage, students do activities based on the steps or instructions on the SW entitle "Activity 2" which starts from preparing the woven and ornamentation. After all students are ready with their weaving and ornaments, the teacher instructs each group to record the initial coordinates and the final coordinates after they are rotated according to the instructions in the worksheet. In Figure 1, students are seen rotating the ornaments according to the instructions in SW "Activity 2" to get a starting point and end point.

Comment [AJ15]: Plase see the previous comment.

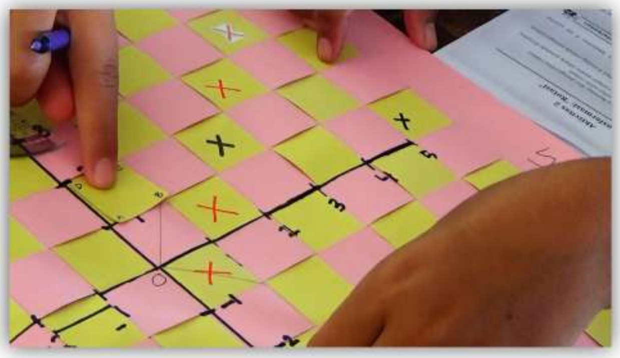


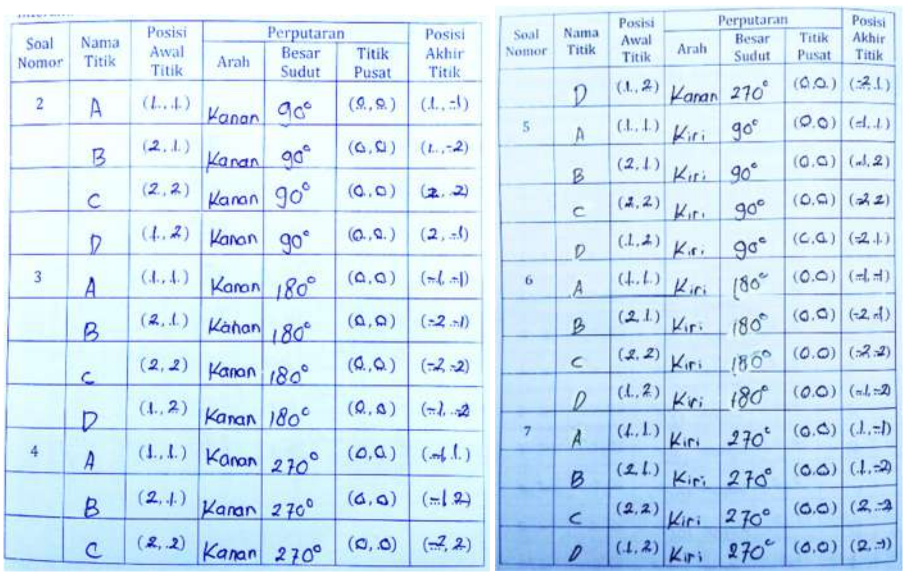
Figure 1. Students rotate the ornaments and calculate the coordinates (Informal)

Comment [AJ16]: This part is difficult to understand because the SW is not available here.

The Phase of Model Of

Comment [AJ17]: This part is difficult/impossible to understand; the SW activity 2 is not available here.

At this stage, students write the coordinate points that have been obtained at an informal stage in a table as shown in Figure 2.



Soal Nomor	Nama Titik	Posisi Awal Titik	Perputaran			Posisi Akhir Titik
			Arah	Besar Sudut	Titik Pusat	
2	A	(1, 1)	Kanan	90°	(0, 0)	(1, -1)
	B	(2, 1)	Kanan	90°	(0, 0)	(1, -2)
	C	(2, 2)	Kanan	90°	(0, 0)	(2, -2)
	D	(1, 2)	Kanan	90°	(0, 0)	(2, -1)
3	A	(1, 1)	Kanan	180°	(0, 0)	(-1, -1)
	B	(2, 1)	Kanan	180°	(0, 0)	(-2, -1)
	C	(2, 2)	Kanan	180°	(0, 0)	(-2, -2)
	D	(1, 2)	Kanan	180°	(0, 0)	(-1, -2)
4	A	(1, 1)	Kanan	270°	(0, 0)	(-1, 1)
	B	(2, 1)	Kanan	270°	(0, 0)	(-1, 2)
	C	(2, 2)	Kanan	270°	(0, 0)	(-2, 2)

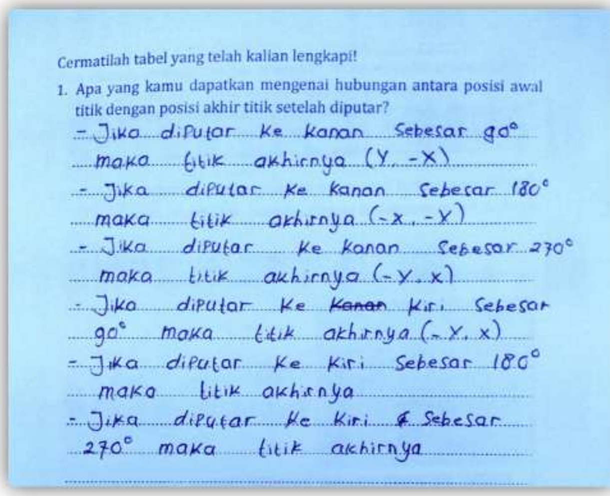
Soal Nomor	Nama Titik	Posisi Awal Titik	Perputaran			Posisi Akhir Titik
			Arah	Besar Sudut	Titik Pusat	
	D	(1, 2)	Kanan	270°	(0, 0)	(-2, 1)
5	A	(1, 1)	Kiri	90°	(0, 0)	(-1, 1)
	B	(2, 1)	Kiri	90°	(0, 0)	(-1, 2)
	C	(2, 2)	Kiri	90°	(0, 0)	(-2, 2)
	D	(1, 2)	Kiri	90°	(0, 0)	(-2, 1)
6	A	(1, 1)	Kiri	180°	(0, 0)	(-1, -1)
	B	(2, 1)	Kiri	180°	(0, 0)	(-2, -1)
	C	(2, 2)	Kiri	180°	(0, 0)	(-2, -2)
	D	(1, 2)	Kiri	180°	(0, 0)	(-1, -2)
7	A	(1, 1)	Kiri	270°	(0, 0)	(1, -1)
	B	(2, 1)	Kiri	270°	(0, 0)	(1, -2)
	C	(2, 2)	Kiri	270°	(0, 0)	(2, -2)
	D	(1, 2)	Kiri	270°	(0, 0)	(2, -1)

Figure 2. Student work results record the starting point and end point of the rotation results in a table (Model of)

Comment [AJ18]: Please translate the text into English.

The Phase of Model For

At this stage, students analyze the change from starting point to end point and make interpretations related to the concept of rotation with their own language as shown in Figure 3.


Cermatilah tabel yang telah kalian lengkapi!

1. Apa yang kamu dapatkan mengenai hubungan antara posisi awal titik dengan posisi akhir titik setelah diputar?

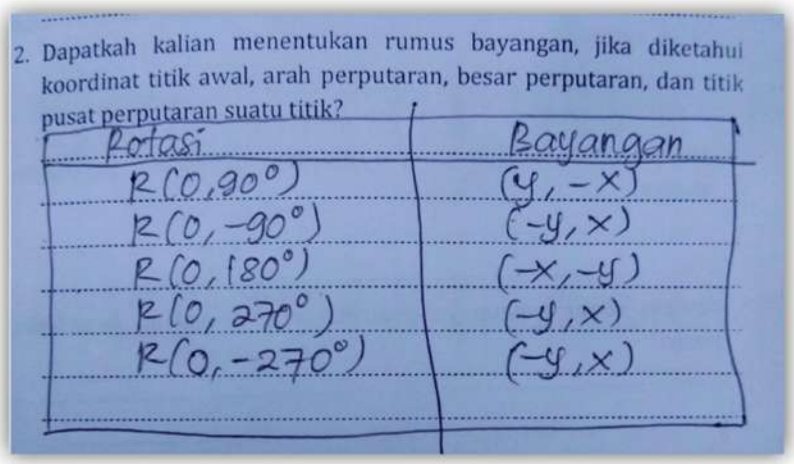
- Jika diputar ke kanan sebesar 90° maka titik akhirnya (Y, -X)
- Jika diputar ke kanan sebesar 180° maka titik akhirnya (-x, -Y)
- Jika diputar ke kanan sebesar 270° maka titik akhirnya (-Y, x)
- Jiko diputar ke ~~Kanan~~ kiri sebesar 90° maka titik akhirnya (-Y, x)
- Jika diputar ke kiri sebesar 180° maka titik akhirnya
- Jika diputar ke kiri ~~∉~~ sebesar 270° maka titik akhirnya

Figure 3. Students write the results of their interpretation related to the concept of rotation in the worksheet (Model for)

Comment [AJ19]: Please translate the text of student written work into English.

Formal Phase

At this stage, students make mathematical modeling in the form of a rotation formula according to their respective understanding. The results of students' mathematical modeling can be seen in Figure 4.


2. Dapatkah kalian menentukan rumus bayangan, jika diketahui koordinat titik awal, arah perputaran, besar perputaran, dan titik pusat perputaran suatu titik?

Rotasi	Bayangan
R(0, 90°)	(y, -x)
R(0, -90°)	(-y, x)
R(0, 180°)	(-x, -y)
R(0, 270°)	(-y, x)
R(0, -270°)	(-y, x)

Figure 4. Student mathematical modeling results related to the rotation formula (formal)

To classify the results of student answers listed in the worksheet, a class discussion is needed. Therefore, the teacher invites each group to present their work. Students are seen presenting the concept of rotation as shown in Figure 5.

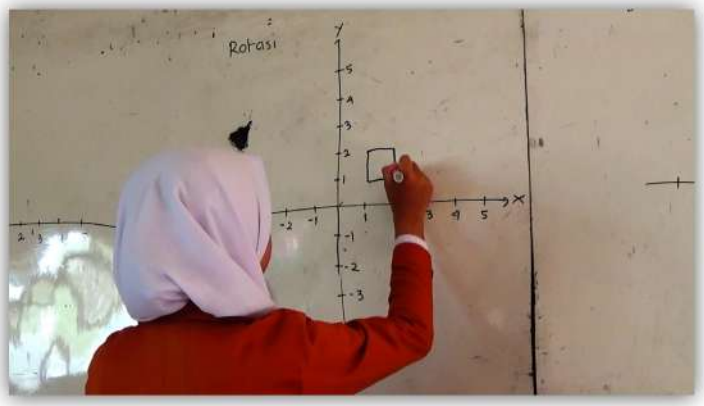


Figure 5. Students present about rotation

Comment [AJ20]: This figure/picture is not clear. Which rotation did the student present?

During the discussion process, it seemed that the participants in the discussion were very enthusiastic about expressing their opinions and ideas on the work done by each group's worksheet. It is caused by the position of the ornamental starting point that is different from each discussion group, so that the position of the ornamental endpoint will also be different. Furthermore, the teacher guides students to have 5 common perception of the concept of rotation. Firstly, if the starting point is rotated 90 degrees to the right with a center point (0.0), then the end point will be the opposite, but the back is negative. Secondly, if the starting point is rotated 90 degrees to the left with the center point (0,0), then the end point will be the opposite, but the front is negative. Thirdly, if the starting point is rotated 180 degrees to the right and to the left with center point (0,0), then the end point will be the same that is to be all negative. Fourthly, if the starting point is rotated as far as 270 degrees to the right with the center point (0,0), then the end point will be the opposite, but the front negative. Lastly, if the starting point is rotated 270 degrees to the left with the center point (0,0), then the end point will be the opposite, but the back is negative.

In addition, some researchers have also made mathematics learning design using IRME approaches and cultural contexts, such as learning number pattern using “Barathayudha” war stories (Risdiyanti & Prahmana, 2020), rotational learning designs using kawung batik motifs (Risdiyanti & Prahmana, 2018), the design of transformation learning using Sidoarjo written batik motifs (Lestariningsih & Mulyono, 2017), and learning number operation using Indonesian traditional game "Tepuk Bergambar" (Prahmana, Zulkardi, & Hartono, 2012). Therefore, the role taken from the results of this study is to enrich to the study of mathematics learning design that is rotational learning design using the context of the woven bamboo motif.

Comment [AJ21]: These part should be in the literature review/Introduction.

In the discussion part, you should compare and contrast your results with other relevant studies.

CONCLUSION

Learning trajectories that can support the concept of rotation from informal to formal level include the activity of recording the starting and ending points of ornamentation on the webbing field, analyzing and interpreting the change of the starting point into an end point using their own language, and writing the rotation formula. The results of the design experiments show that the context of the woven bamboo motif can stimulate students to understand their knowledge of the concept of rotation. All the strategies and models that students find, illustrate, and discuss show how the construction or contribution of students can be used to help their initial understanding of the concept of rotation.

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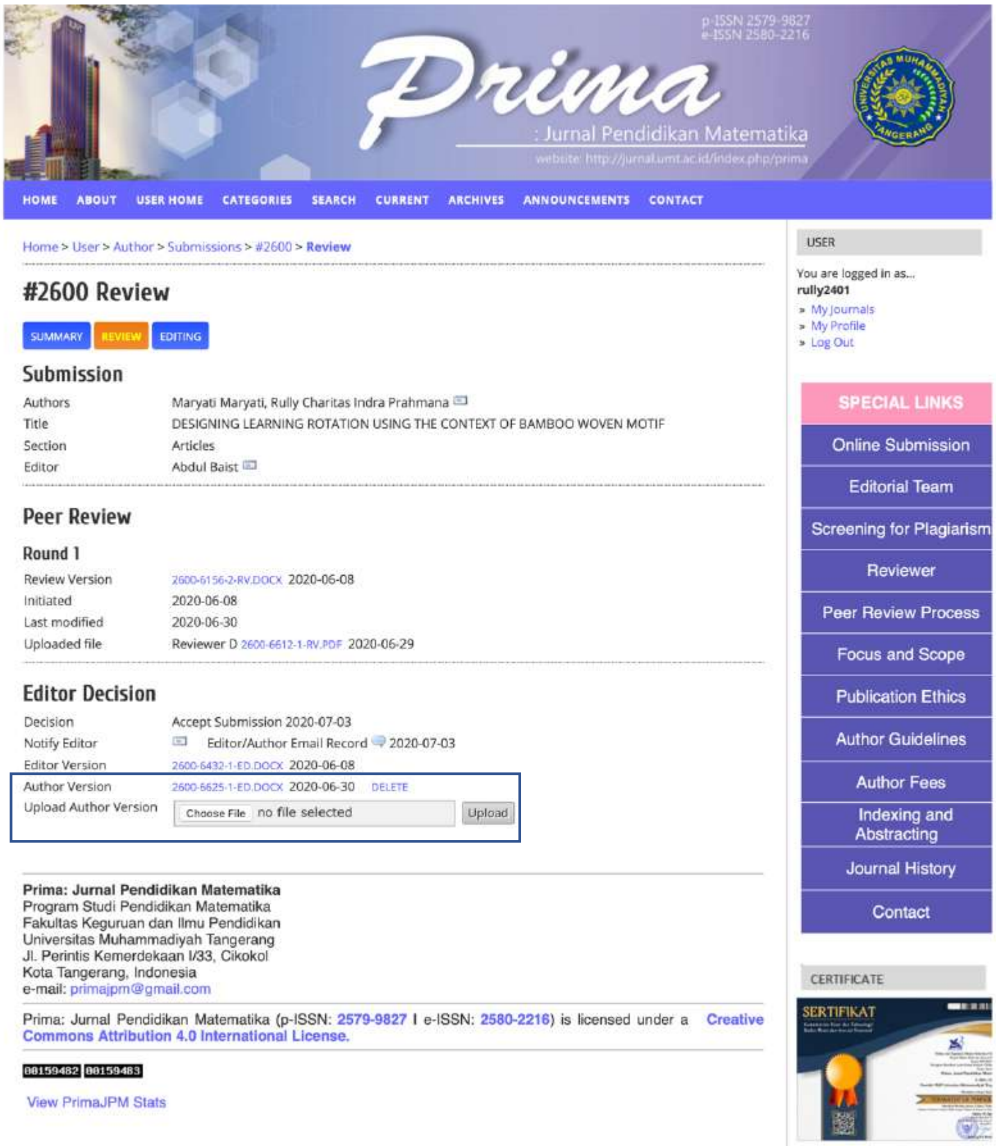
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#2600 Review

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Section	Articles
Editor	Abdul Baist

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CERTIFICATE

SERTIFIKAT

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THE DESIGN OF LEARNING ROTATION USING THE CONTEXT OF BAMBOO WOVEN MOTIF

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Abstract
An essential part of learning transformation geometry is rotation. Before learning more about other parts of the transformation geometry topic, such as translation, dilation, and reflection, firstly, students are required to understand well about rotation. However, several students have not been able to understand this subject properly due to the stages of learning in the rotation has not been appropriately arranged. Thus, this study aims to design a student learning trajectory in learning rotation, which develop from informal to formal level through the Indonesian Realistic Mathematics Education (IRME) approach. Furthermore, researchers used a design research method divided into three stages, namely preliminary design, design experiments, and retrospective analysis. This study describes how the bamboo woven motif contributes significantly to 31 ninth-grade students understanding the rotation concept. The results of the design experiments show that the context of the woven bamboo motif can stimulate students to understand their knowledge of rotation. All strategies and models that students find to describe and discuss show how students' construction or contributions can be used to help their initial understanding of rotation.

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Abstrak
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Kata Kunci: Motif Anyaman bambu, Pendidikan Matematika Realistik Indonesia, Rotasi, Design Research

INTRODUCTION

Rotation is a circular motion that moves points by rotating these points θ to a central point of rotation (Maryati & Prahmana, 2019). Furthermore, Risdiyanti & Prahmana (2018) show that learning about transformation geometry especially rotation can be used to design learning using the local contexts such as culture or other things that are easily found in students' daily activities. On the other hand, students can understand mathematical concepts easily, fun, close to daily activities, and affordable to students' imagination (Zulkardi, 2013; Adams &

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Cook, 2017; Clarke & Roche, 2018). Thus, it would be made it easier for students to be able to solve the problems encountered in students' daily life.

The Program for International Student Assessment (PISA) results analyzed by Stacey (2011) shows that Indonesian students still have difficulty in formulating problems in daily life into mathematical models. One example is interpreting the context of real situations into mathematical models, understanding mathematical structures, including order, relationships, and patterns (Edo, Hartono, & Putri, 2013; Revina & Leung, 2019). One contributing factor is the process of learning mathematics which tends to use practical formulas and has not connected mathematical concepts with students' daily activities (Naidoo, 2012; Arisetyawan, Suryadi, Herman, & Rahmat, 2014). Therefore, meaningful learning activities are needed so that students can master the concepts and traits of rotation easily and fun.

One of the learning approaches that can connect the learning subject with daily life is the Indonesian Realistic Mathematics Education (IRME) (Sembiring, Hadi, & Dolk, 2008). The IRME is an adaptation of Realistic Mathematics Education (RME) and has been developed in accordance with the context, cultural values, or local wisdom in Indonesia (Lestariningsih, Putri, & Darmawijoyo, 2015). The IRME places more emphasis on the processes that occur during the learning process so that they are not only concerned with the final results (Sembiring et al., 2008). Thus, IRME could be used as a solution in a learning approach that wants to connect a mathematical material with daily student activities.

IRME is one of the learning approaches that will lead students to understand mathematical concepts by constructing themselves through prior knowledge related to daily life (Revina & Leung, 2019; Risdiyanti & Prahmana, 2020). Furthermore, by discovering the concept by themselves, the students' learning process will become more meaningful. In addition, one of the developments in IRME was carried out with research aimed at improving classroom learning practices through an interactive analysis of hypothetical learning trajectory of what would happen in the classroom and its implementation, the research was design research (Cobb & Gravemeijer, 2006).

As an innovation in learning mathematics and as an implementation of the 2013 curriculum which is oriented to the relationship of mathematics to the conditions of reality and culture of students, researchers designing learning rotation using the context of the woven bamboo motif through the IRME approach. This context was chosen because it is close to students and easily found in students' daily lives. Through this design, it is expected to be an innovation in learning mathematics that can facilitate students in understanding the concept of rotation and be able to solve everyday problems related to the concept and further concept in transformation geometry, such as translation, dilatation, and reflection.

RESEARCH METHOD

This study's research method is design research, which is an appropriate way to answer research questions and achieve research objectives, starting with a preliminary design, design experiments, and retrospective analysis (Cobb & Gravemeijer, 2006; Prahmana, 2017). In the preliminary design, the researcher implements the initial idea of using the context of the bamboo woven motif in learning rotation by studying the literature. After reviewing the previous research, curriculum in Indonesia, and mathematics textbook, the researcher does observations at SMP N 1 Tepus to see the students' initial abilities used as the basis for designing the prototype rotation learning trajectory. In the design experiments phase, researchers tested the learning trajectory that has been developed at the preliminary design stage. Lastly, after the design experiments stage, data obtained from learning activities in class are analyzed. The results are used to plan activities or to develop designs for subsequent learning activities. At this stage, data analysis conducted in this study was to compare the observations during the learning process with the Hypothetical Learning Trajectory that had been designed at the preliminary design stage.

The subjects in this study were IXA grade students of SMP Negeri 1 Tepus consisting of 31 students. Data collection techniques used in this study include video recording, documentation, written data, and observation. In this research, the design of learning rotation utilizing the context of the Bamboo woven motif is compared with actual student learning. Therefore, to what extent the design process and implementation of this rotation learning design would be explored in this research.

RESULTS AND DISCUSSION

The results obtained in this study in the form of learning trajectories in learning rotation using the context of the bamboo woven motif through the PMRI approach. The following is an explanation of the learning process of rotation material in class IXA

The Early Learning Phase

Learning begins with giving assignments in groups (4-5 people per group), namely working on the Student Worksheet (SW) entitled "Activity 2". This activity aims to bring up the language or understanding of students about the concept of rotation. Describing the activities in this learning process begins with the teacher instructing all students to gather with their respective groups. Next, the teacher gives assignments to each group to work on the SW entitle "Activity 2" about the concept of rotation. Activities in the SW start from preparing the Anyaman and ornaments as shown in Figure 1.

Figure 1. Students make the ornaments using *manila* paper

The Informal Phase

At this stage, students do activities based on the steps or instructions on the SW entitle "Activity 2" which starts from preparing the woven and ornamentation. After all students are ready with their weaving and ornaments, the teacher instructs each group to record the initial coordinates and the final coordinates after they are rotated according to the instructions in the worksheet. In Figure 2, students are seen rotating the ornaments according to the instructions in SW "Activity 2" to get a starting point and end point.

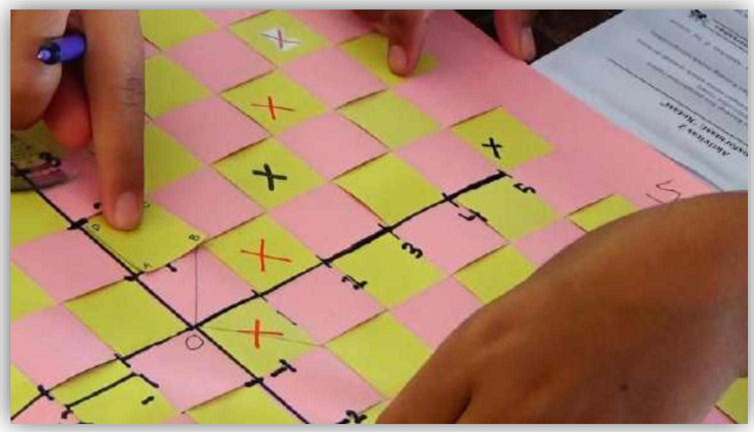
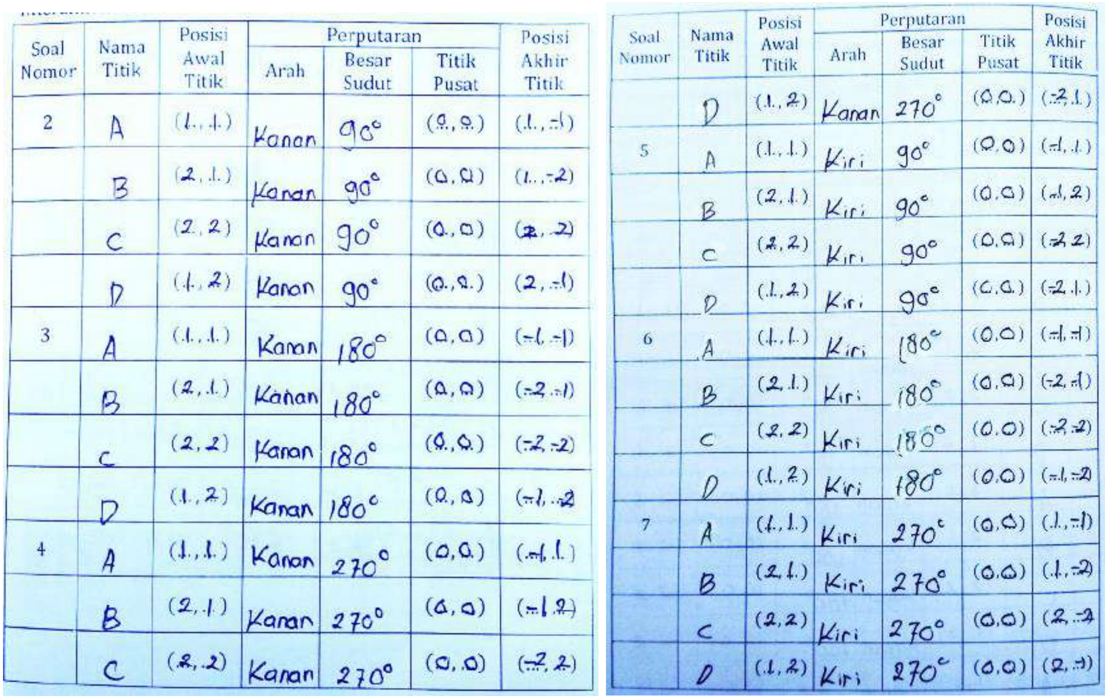


Figure 2. Students rotate the ornaments and calculate the coordinates (Informal)

The Phase of Model of

At this stage, students write the coordinate points that have been obtained at an informal stage in a table as shown in Figure 3.

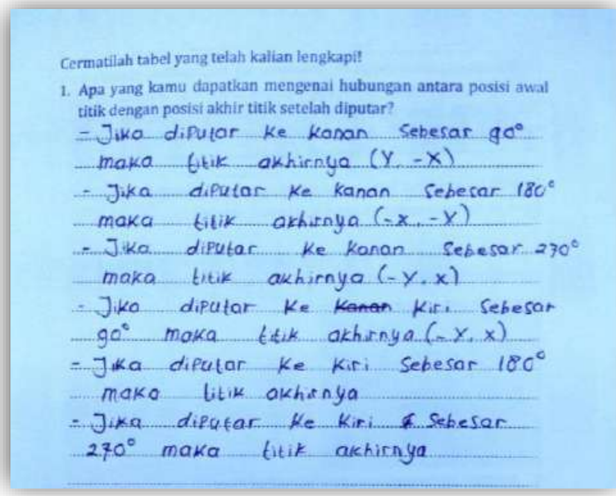


Soal Nomor	Nama Titik	Posisi Awal Titik	Perputaran			Posisi Akhir Titik
			Arah	Besar Sudut	Titik Pusat	
2	A	(1, 1)	Kanan	90°	(0, 0)	(1, -1)
	B	(2, 1)	Kanan	90°	(0, 0)	(1, -2)
	C	(2, 2)	Kanan	90°	(0, 0)	(2, -2)
	D	(1, 2)	Kanan	90°	(0, 0)	(2, -1)
3	A	(1, 1)	Kanan	180°	(0, 0)	(-1, -1)
	B	(2, 1)	Kanan	180°	(0, 0)	(-2, -1)
	C	(2, 2)	Kanan	180°	(0, 0)	(-2, -2)
	D	(1, 2)	Kanan	180°	(0, 0)	(-1, -2)
4	A	(1, 1)	Kanan	270°	(0, 0)	(-1, 1)
	B	(2, 1)	Kanan	270°	(0, 0)	(-1, 2)
	C	(2, 2)	Kanan	270°	(0, 0)	(-2, 2)
	D	(1, 2)	Kanan	270°	(0, 0)	(-2, 1)
5	A	(1, 1)	Kiri	90°	(0, 0)	(-1, 1)
	B	(2, 1)	Kiri	90°	(0, 0)	(-1, 2)
	C	(2, 2)	Kiri	90°	(0, 0)	(-2, 2)
	D	(1, 2)	Kiri	90°	(0, 0)	(-2, 1)
6	A	(1, 1)	Kiri	180°	(0, 0)	(-1, -1)
	B	(2, 1)	Kiri	180°	(0, 0)	(-2, -1)
	C	(2, 2)	Kiri	180°	(0, 0)	(-2, -2)
	D	(1, 2)	Kiri	180°	(0, 0)	(-1, -2)
7	A	(1, 1)	Kiri	270°	(0, 0)	(1, -1)
	B	(2, 1)	Kiri	270°	(0, 0)	(1, -2)
	C	(2, 2)	Kiri	270°	(0, 0)	(2, -2)
	D	(1, 2)	Kiri	270°	(0, 0)	(2, -1)

Figure 3. Student work results record the starting point and end point of the rotation results in a table (Model of)

The Phase of Model For

At this stage, students analyze the change from starting point to end point and make interpretations related to the concept of rotation with their own language as shown in Figure 4.



Cermatilah tabel yang telah kalian lengkapi!

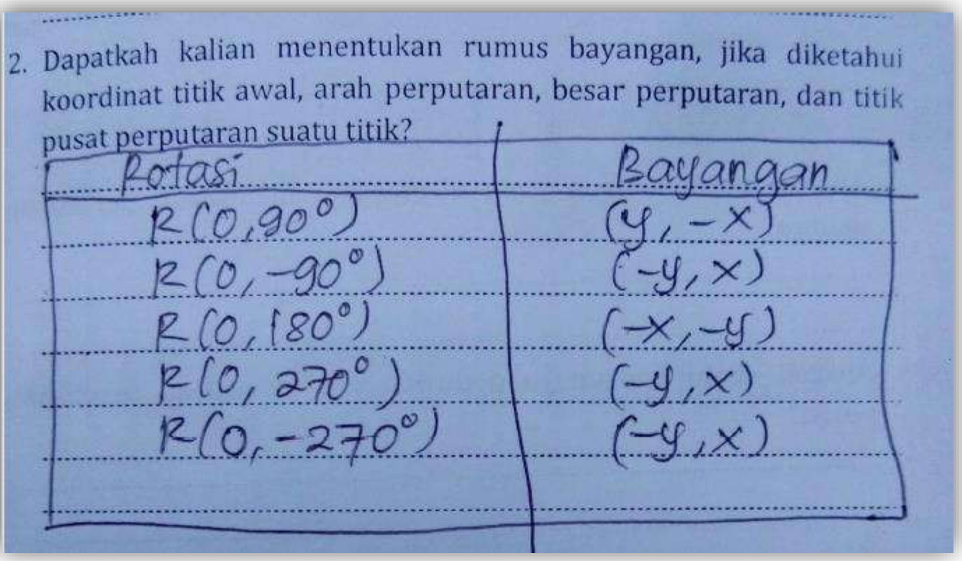
1. Apa yang kamu dapatkan mengenai hubungan antara posisi awal titik dengan posisi akhir titik setelah diputar?

- Jika diputar ke kanan sebesar 90° maka titik akhirnya (Y, -X)
- Jika diputar ke kanan sebesar 180° maka titik akhirnya (-x, -Y)
- Jika diputar ke kanan sebesar 270° maka titik akhirnya (-Y, x)
- Jika diputar ke ~~kanan~~ kiri sebesar 90° maka titik akhirnya (-Y, x)
- Jika diputar ke kiri sebesar 180° maka titik akhirnya
- Jika diputar ke kiri sebesar 270° maka titik akhirnya

Figure 4. Students write the results of their interpretation related to the concept of rotation in the worksheet (Model for)

Formal Phase

At this stage, students make mathematical modeling in the form of a rotation formula according to their respective understanding. The results of students' mathematical modeling can be seen in Figure 5.


2. Dapatkah kalian menentukan rumus bayangan, jika diketahui koordinat titik awal, arah perputaran, besar perputaran, dan titik pusat perputaran suatu titik?

Rotasi	Bayangan
R(0,90°)	(y, −x)
R(0, −90°)	(−y, x)
R(0, 180°)	(−x, −y)
R(0, 270°)	(−y, x)
R(0, −270°)	(−y, x)

Figure 5. Student mathematical modeling results related to the rotation formula (formal)

To classify the results of student answers listed in the worksheet, a class discussion is needed. Therefore, the teacher invites each group to present their work. Students are seen presenting the concept of rotation as shown in Figure 6.

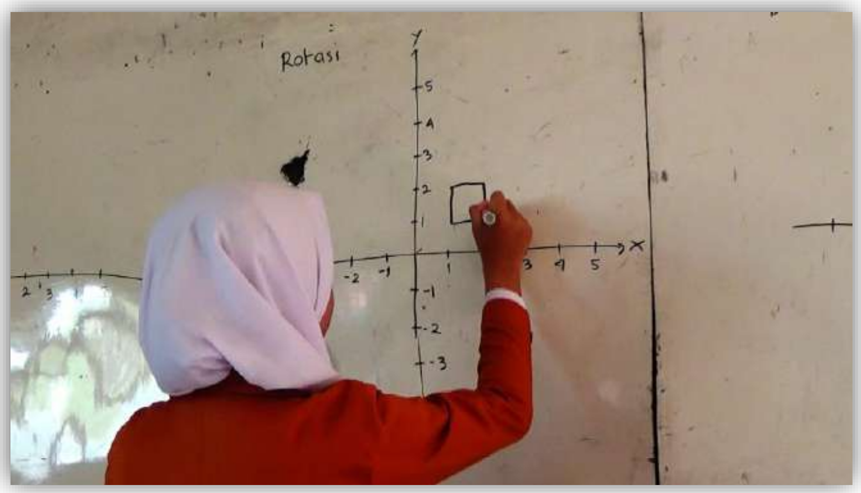


Figure 6. Students present about rotation

During the discussion process, it seemed that the participants in the discussion were very enthusiastic about expressing their opinions and ideas on the work done by each group's worksheet. It is caused by the position of the ornamental starting point that is different from each discussion group, so that the position of the ornamental endpoint will also be different. Furthermore, the teacher guides students to have 5 common perception of the concept of rotation. Firstly, if the starting point is rotated 90 degrees to the right with a center point (0.0), then the end point will be the opposite, but the back is negative. Secondly, if the starting point is rotated 90 degrees to the left with the center point (0,0), then the end point will be the opposite, but the front is negative. Thirdly, if the starting point is rotated 180 degrees to the right and to the left with center point (0,0), then the end point will be the same that is to be all negative. Fourthly, if the starting point is rotated as far as 270 degrees to the right with the center point (0,0), then the end point will be the opposite, but the front negative. Lastly, if the starting point is rotated 270 degrees to the left with the center point (0,0), then the end point will be the opposite, but the back is negative.

In addition, some researchers have also made mathematics learning design using IRME approaches and cultural contexts, such as learning number pattern using “Barathayudha” war stories (Risdiyanti & Prahmana, 2020), rotational learning designs using kawung batik motifs (Risdiyanti & Prahmana, 2018), the design of transformation learning using Sidoarjo written batik motifs (Lestariningsih & Mulyono, 2017), and learning number operation using Indonesian traditional game “Tepuk Bergambar” (Prahmana, Zulkardi, & Hartono, 2012). Therefore, the role taken from the results of this study is to enrich to the study of mathematics learning design that is rotational learning design using the context of the woven bamboo motif.

CONCLUSION

Learning trajectories that can support the concept of rotation from informal to formal level include the activity of recording the starting and ending points of ornamentation on the webbing field, analyzing and interpreting the change of the starting point into an end point using their own language, and writing the rotation formula. The results of the design experiments show that the context of the woven bamboo motif can stimulate students to understand their knowledge of the concept of rotation. All the strategies and models that students find, illustrate, and discuss show how the construction or contribution of students can be used to help their initial understanding of the concept of rotation.

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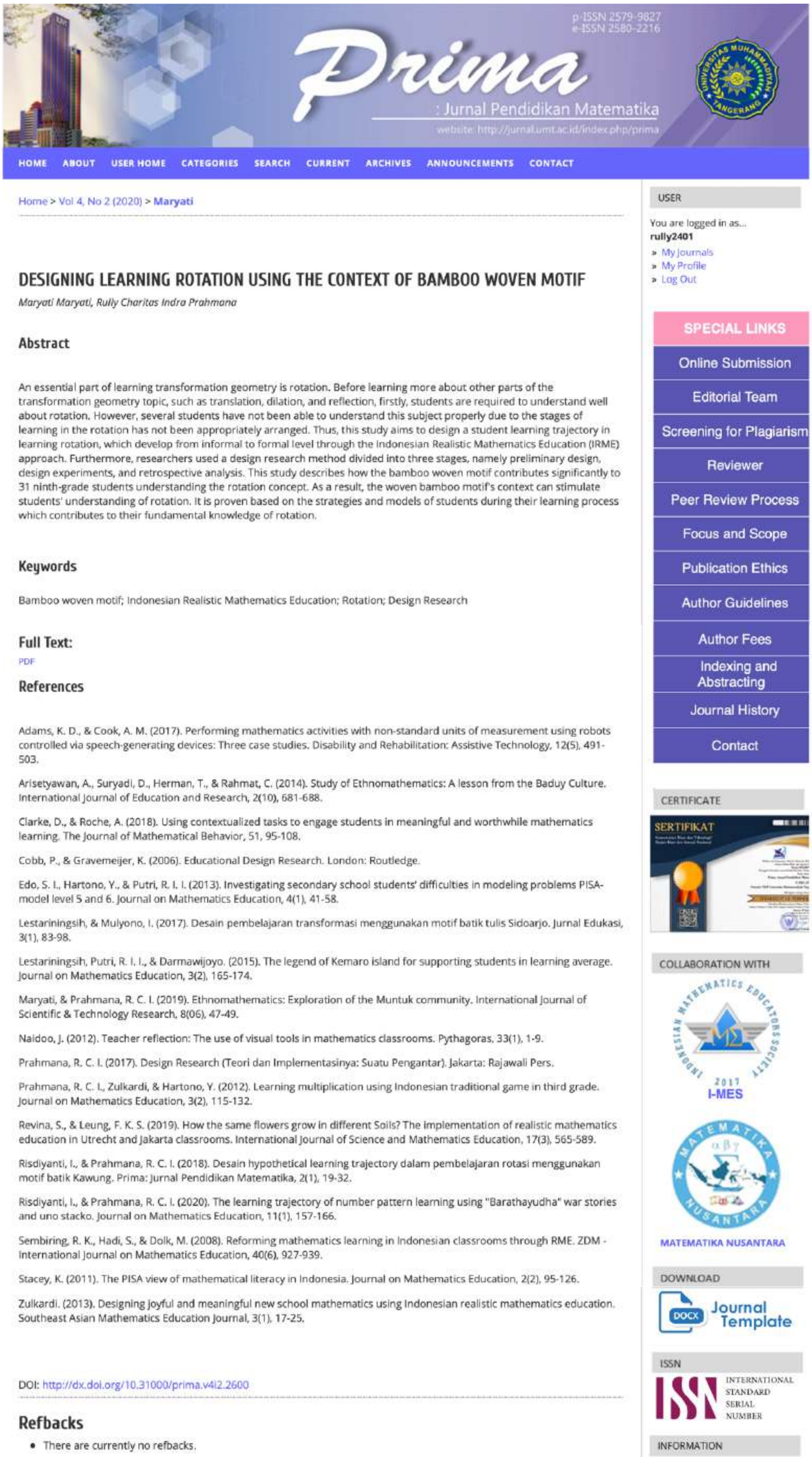

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DESIGNING LEARNING ROTATION USING THE CONTEXT OF BAMBOO WOVEN MOTIF

Maryati Maryati, Rully Charitas Indra Prahmana

Abstract

An essential part of learning transformation geometry is rotation. Before learning more about other parts of the transformation geometry topic, such as translation, dilation, and reflection, firstly, students are required to understand well about rotation. However, several students have not been able to understand this subject properly due to the stages of learning in the rotation has not been appropriately arranged. Thus, this study aims to design a student learning trajectory in learning rotation, which develop from informal to formal level through the Indonesian Realistic Mathematics Education (IRME) approach. Furthermore, researchers used a design research method divided into three stages, namely preliminary design, design experiments, and retrospective analysis. This study describes how the bamboo woven motif contributes significantly to 31 ninth-grade students understanding the rotation concept. As a result, the woven bamboo motif's context can stimulate students' understanding of rotation. It is proven based on the strategies and models of students during their learning process which contributes to their fundamental knowledge of rotation.

Keywords

Bamboo woven motif; Indonesian Realistic Mathematics Education; Rotation; Design Research

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DESIGNING LEARNING ROTATION USING THE CONTEXT OF BAMBOO WOVEN MOTIF

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Abstract

An essential part of learning transformation geometry is rotation. Before learning more about other parts of the transformation geometry topic, such as translation, dilation, and reflection, firstly, students are required to understand well about rotation. However, several students have not been able to understand this subject properly due to the stages of learning in the rotation has not been appropriately arranged. Thus, this study aims to design a student learning trajectory in learning rotation, which develop from informal to formal level through the Indonesian Realistic Mathematics Education (IRME) approach. Furthermore, researchers used a design research method divided into three stages, namely preliminary design, design experiments, and retrospective analysis. This study describes how the bamboo woven motif contributes significantly to 31 ninth-grade students understanding the rotation concept. As a result, the woven bamboo motif's context can stimulate students' understanding of rotation. It is proven based on the strategies and models of students during their learning process which contributes to their fundamental knowledge of rotation.

Keywords: Bamboo woven motif, Indonesian Realistic Mathematics Education, Rotation, Design Research

Abstrak

Salah satu bagian penting dari pembelajaran transformasi geometri adalah pembelajaran rotasi. Sebelum mempelajari lebih jauh terkait bagian-bagian lain dari topik transformasi geometri, seperti translasi, dilatasi, dan refleksi, siswa dituntut untuk memahami dengan baik materi rotasi terlebih dahulu. Namun, banyak siswa belum mampu memahami materi ini dengan baik yang disebabkan oleh tahapan-tahapan dalam pembelajaran pada materi rotasi belum tersusun dengan baik. Sehingga, penelitian ini bertujuan untuk menghasilkan sebuah lintasan belajar siswa dalam pembelajaran rotasi, yang berkembang dari bentuk informal ke bentuk formal melalui pendekatan Pendidikan Matematika Realistik Indonesia (PMRI). Selanjutnya, peneliti menggunakan penelitian desain (*design research*) yang dibagi menjadi 3 tahapan, yaitu desain pendahuluan, percobaan desain, dan analisis retrospektif. Penelitian ini mendeskripsikan bagaimana motif Anyaman Bambu memberikan kontribusi nyata untuk 31 siswa kelas IX dalam memahami konsep rotasi. Hasilnya, konteks motif anyaman bambu dapat merangsang pemahaman siswa tentang rotasi. Ini terbukti berdasarkan pada strategi dan model siswa selama proses pembelajaran mereka yang berkontribusi pada pengetahuan dasar mereka tentang rotasi.

Kata Kunci: Motif anyaman bambu, Pendidikan Matematika Realistik Indonesia, Rotasi, Design Research

INTRODUCTION

Rotation is a circular motion that moves points by rotating these points θ to a central point of rotation (Maryati & Prahmana, 2019). Furthermore, Risdiyanti & Prahmana (2018) show that learning about transformation geometry, especially rotation, can be used to design learning using the local contexts such as culture or other things that are easily found in students' daily activities. On the other hand, students can understand mathematical concepts easily, fun, close to daily activities, and affordable to students' imagination (Zulkardi, 2013; Adams & Cook, 2017; Clarke & Roche, 2018). Thus, it would be made it easier for students to be able to solve the problems encountered in students' daily life.

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The Program for International Student Assessment (PISA) results analyzed by Stacey (2011) shows that Indonesian students still have difficulty in formulating problems in daily life into mathematical models. One example is interpreting the context of real situations into mathematical models, understanding mathematical structures, including order, relationships, and patterns (Edo, Hartono, & Putri, 2013; Revina & Leung, 2019). One contributing factor is the process of learning mathematics, which tends to use practical formulas and has not connected mathematical concepts with students' daily activities (Naidoo, 2012; Arisetyawan, Suryadi, Herman, & Rahmat, 2014). Therefore, meaningful learning activities are needed so that students can master the concepts and traits of rotation easily and fun.

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The subjects in this study were IXA grade students of SMP Negeri 1 Tepus consisting of 31 students. Data collection techniques used in this study include video recording, documentation, written data, and observation. In this research, the design of learning rotation utilizing the context of the Bamboo woven motif is compared with actual student learning. Therefore, to what extent the design process and implementation of this rotation learning design would be explored in this research.

RESULTS AND DISCUSSION

The results obtained in this study in the form of learning trajectories in learning rotation using the context of the bamboo woven motif through the PMRI approach. The following is an explanation of the learning process of rotation material in class IXA

The Early Learning Phase

Learning begins with giving assignments in groups (4-5 people per group), namely working on the Student Worksheet (SW) entitled "Activity 2". This activity aims to bring up the language or understanding of students about the concept of rotation. Describing the activities in this learning process begins with the teacher instructing all students to gather with their respective groups. Next, the teacher gives assignments to each group to work on the SW entitle "Activity 2" about the concept of rotation. Activities in the SW start from preparing the *Anyaman* and ornaments, as shown in Figure 1.

Figure 1. Students make the ornaments using *manila* paper

The Informal Phase

At this stage, students do activities based on the steps or instructions on the SW entitle "Activity 2" which starts from preparing the woven and ornamentation. After all, students are ready with their weaving and ornaments, and the teacher instructs each group to record the initial coordinates and the final coordinates after they are rotated according to the instructions in the worksheet. In Figure 2, students are seen rotating the ornaments according to the instructions in SW "Activity 2" to get a starting point and endpoint.

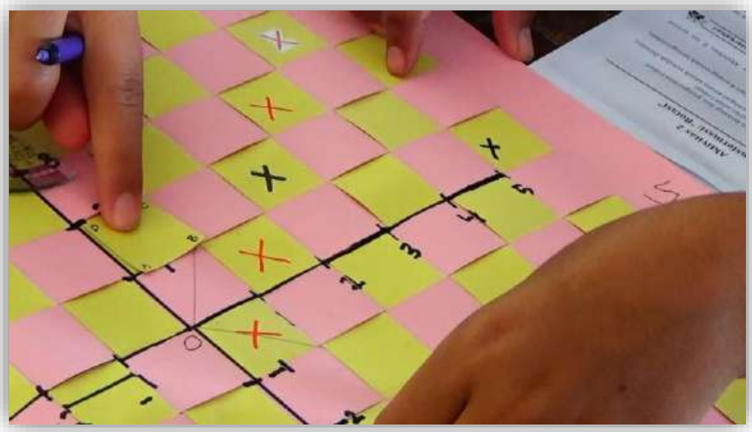
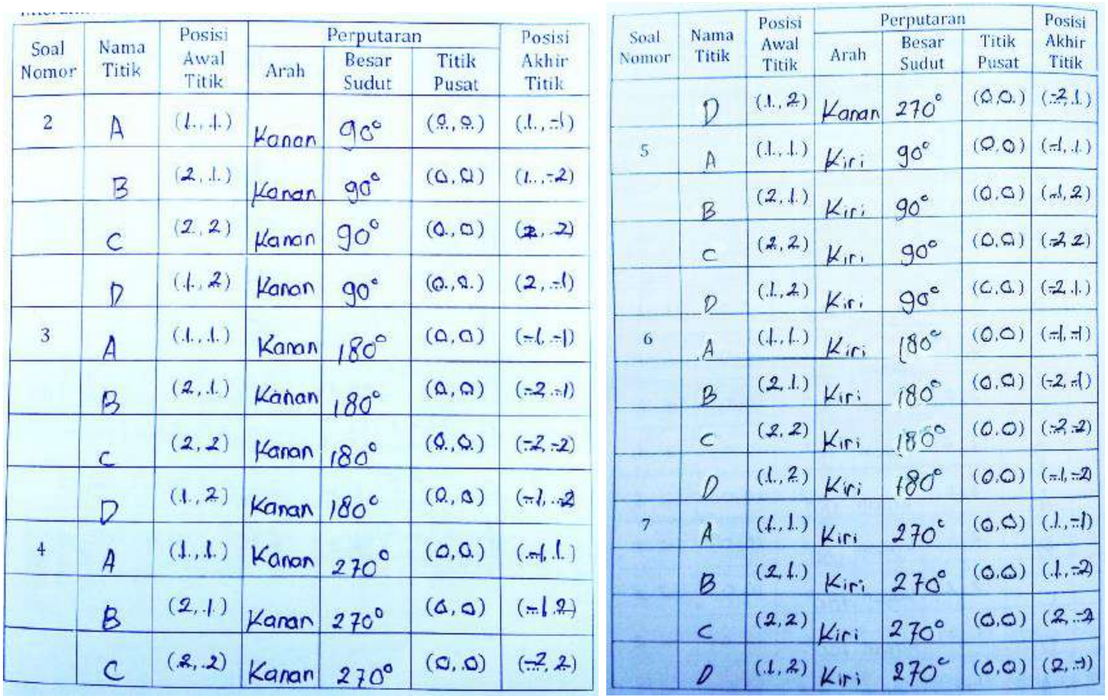


Figure 2. Students rotate the ornaments and calculate the coordinates (Informal)

The Phase of Model Of

At this stage, students write the coordinate points that have been obtained at an informal stage in a table, as shown in Figure 3.



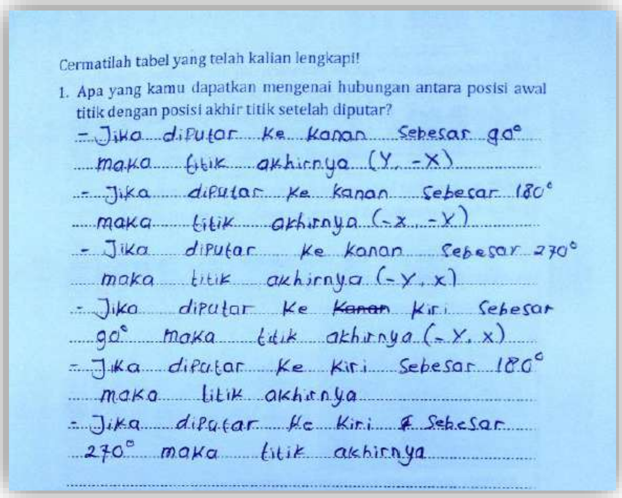
Soal Nomor	Nama Titik	Posisi Awal Titik	Perputaran Arah	Perputaran Besar Sudut	Perputaran Titik Pusat	Posisi Akhir Titik
2	A	(1,1)	Kanan	90°	(0,0)	(1,-1)
	B	(2,1)	Kanan	90°	(0,0)	(1,-2)
	C	(2,2)	Kanan	90°	(0,0)	(2,-2)
	D	(1,2)	Kanan	90°	(0,0)	(2,-1)
3	A	(1,1)	Kanan	180°	(0,0)	(-1,-1)
	B	(2,1)	Kanan	180°	(0,0)	(-2,-1)
	C	(2,2)	Kanan	180°	(0,0)	(-2,-2)
	D	(1,2)	Kanan	180°	(0,0)	(-1,-2)
4	A	(1,1)	Kanan	270°	(0,0)	(-1,1)
	B	(2,1)	Kanan	270°	(0,0)	(-1,2)
	C	(2,2)	Kanan	270°	(0,0)	(-2,2)

Soal Nomor	Nama Titik	Posisi Awal Titik	Perputaran Arah	Perputaran Besar Sudut	Perputaran Titik Pusat	Posisi Akhir Titik
	D	(1,2)	Kanan	270°	(0,0)	(-2,1)
5	A	(1,1)	Kiri	90°	(0,0)	(-1,1)
	B	(2,1)	Kiri	90°	(0,0)	(-1,2)
	C	(2,2)	Kiri	90°	(0,0)	(-2,2)
	D	(1,2)	Kiri	90°	(0,0)	(-2,1)
6	A	(1,1)	Kiri	180°	(0,0)	(-1,-1)
	B	(2,1)	Kiri	180°	(0,0)	(-2,-1)
	C	(2,2)	Kiri	180°	(0,0)	(-2,-2)
	D	(1,2)	Kiri	180°	(0,0)	(-1,-2)
7	A	(1,1)	Kiri	270°	(0,0)	(1,-1)
	B	(2,1)	Kiri	270°	(0,0)	(1,-2)
	C	(2,2)	Kiri	270°	(0,0)	(2,-2)
	D	(1,2)	Kiri	270°	(0,0)	(2,-1)

Figure 3. Student work results record the starting point and endpoint of the rotation results in a table (Model of)

The Phase of Model For

At this stage, students analyze the change from a starting point to an endpoint and make interpretations related to the concept of rotation with their own language, as shown in Figure 4.



Cermatilah tabel yang telah kalian lengkapi!

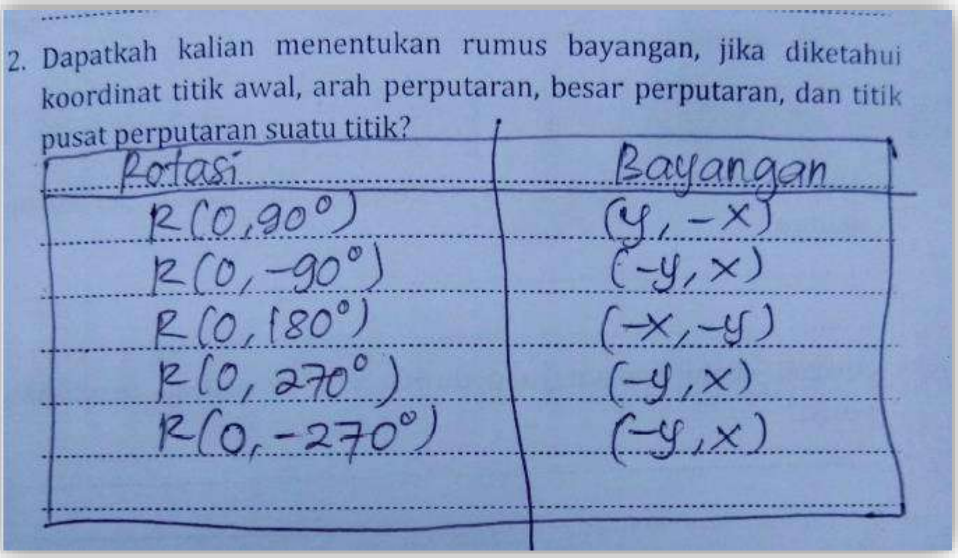
1. Apa yang kamu dapatkan mengenai hubungan antara posisi awal titik dengan posisi akhir titik setelah diputar?

- Jika diputar ke kanan sebesar 90° maka titik akhirnya (Y, -X)
- Jika diputar ke kanan sebesar 180° maka titik akhirnya (-x, -Y)
- Jika diputar ke kanan sebesar 270° maka titik akhirnya (-Y, x)
- Jika diputar ke ~~kanan~~ kiri sebesar 90° maka titik akhirnya (-Y, x)
- Jika diputar ke kiri sebesar 180° maka titik akhirnya
- Jika diputar ke kiri sebesar 270° maka titik akhirnya

Figure 4. Students write the results of their interpretation related to the concept of rotation in the worksheet (Model for)

Formal Phase

At this stage, students make mathematical modeling in the form of a rotation formula according to their respective understanding. The results of students' mathematical modeling can be seen in Figure 5.


2. Dapatkah kalian menentukan rumus bayangan, jika diketahui koordinat titik awal, arah perputaran, besar perputaran, dan titik pusat perputaran suatu titik?

Rotasi	Bayangan
R(0, 90°)	(y, −x)
R(0, −90°)	(−y, x)
R(0, 180°)	(−x, −y)
R(0, 270°)	(−y, x)
R(0, −270°)	(−y, x)

Figure 5. Student mathematical modeling results related to the rotation formula (formal)

A class discussion is needed to classify the results of student answers listed in the worksheet. Therefore, the teacher invites each group to present their work. Students are seen presenting the concept of rotation, as shown in Figure 6.

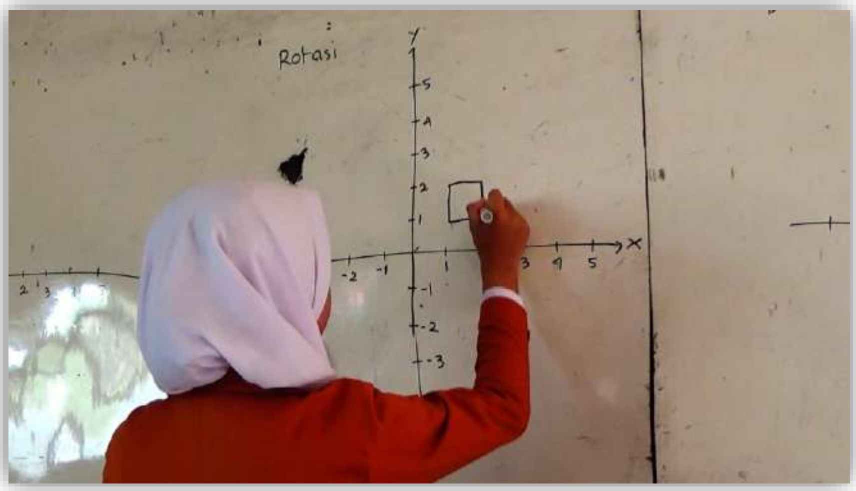


Figure 6. Students present about rotation

During the discussion process, it seemed that the participants in the discussion were very enthusiastic about expressing their opinions and ideas on the work done by each group's worksheet. It is caused by the position of the ornamental starting point that is different from each discussion group so that the position of the ornamental endpoint will also be different. Furthermore, the teacher guides students to have five common perceptions of the concept of rotation. Firstly, if the starting point is rotated 90 degrees to the right with a center point (0.0), then the endpoint will be the opposite, but the back is negative. Secondly, if the starting point is rotated 90 degrees to the left with the center point (0,0), then the endpoint will be the opposite, but the front is negative. Thirdly, if the starting point is rotated 180 degrees to the right and to the left with the center point (0,0), then the endpoint will be the same that is to be all negative. Fourthly, if the starting point is rotated as far as 270 degrees to the right with the center point (0,0), then the endpoint will be the opposite, but the front negative. Lastly, if the starting point is rotated 270 degrees to the left with the center point (0,0), then the endpoint will be the opposite, but the back is negative.

In addition, some researchers have also made mathematics learning design using IRME approaches and cultural contexts, such as learning number pattern using “Barathayudha” war stories (Risdiyanti & Prahmana, 2020), rotational learning designs using kawung batik motifs (Risdiyanti & Prahmana, 2018), the design of transformation learning using Sidoarjo written batik motifs (Lestariningsih & Mulyono, 2017), and learning number operation using traditional Indonesian game “Tepuk Bergambar” (Prahmana, Zulkardi, & Hartono, 2012). Therefore, the role taken from the results of this study is to enrich the study of mathematics learning design that is a rotational learning design using the context of the woven bamboo motif.

CONCLUSION

Learning trajectories that can support the concept of rotation from informal to formal level include the activity of recording the starting and ending points of ornamentation on the webbing field, analyzing and interpreting the change of the starting point into an endpoint using their own language, and writing the rotation formula. The context of the woven bamboo motif can stimulate students’ concept of rotation.

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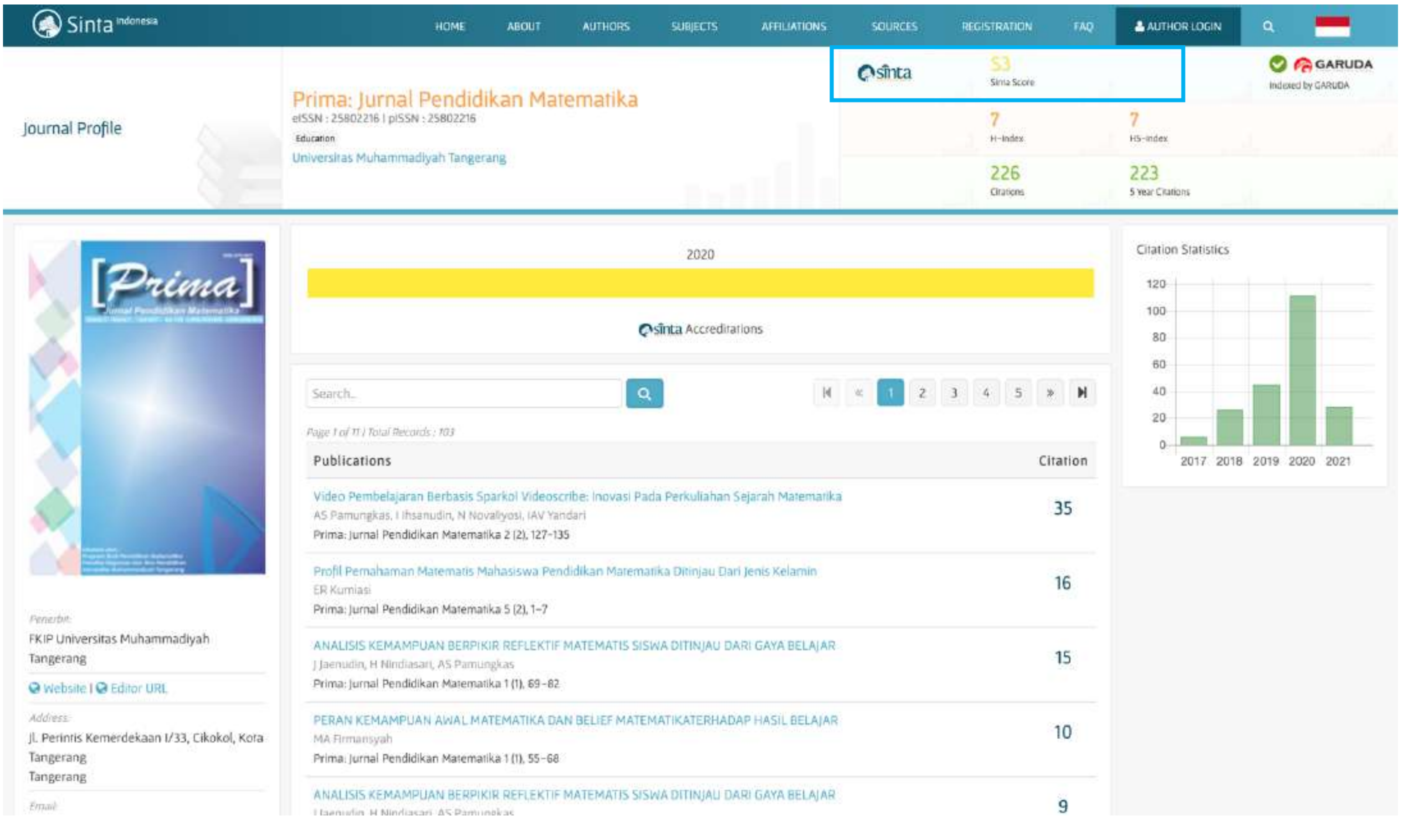

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