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USING FORMULATOR TARSIA TO CREATE COLLABORATIVE ACTIVITIES IN MATHEMATICS CLASSROOM

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Abstract. The purpose of this study was to establish if students could engage on collaborative activities which were supported by Formulator Tarsia. This study was specially concerned with the engagement of 8th grade students in learning mathematics. Data were collected through direct observations, open questionnaires, and dialogue with some students. The result showed that students engaged with puzzle and domino activities really well and there was some good dialogue between them about checking the answers and the puzzle piece positions. Students said that they had really enjoyed the activities and they worked very well together in small group. Solving mathematics puzzle and domino created by Formulator Tarsia were fun activities that can generate dialogue, reactivate prior knowledge, and can encourage higher order thinking.
Keywords: Formulator Tarsia; Collaborative Activities; Students' Engagement

A. INTRODUCTION

Topic about teaching and learning mathematical concepts effectively often dominates conversation when discussing about issues surrounding mathematics education. Teachers have been trying to apply many methods that offer alternative ways to construct students' engagement and motivation in learning mathematics. Motivation refers to the ways in which students choose to behave, their self-confidence in their ability, their ability to overcome obstacles and challenges, and their capacity to recover from academic setbacks (Martin, 2003). Students' motivation determines whether or not they will engage in a particular learning activity (Martin, 2006). Engagement has been defined as a multifaceted construct which operates at three levels: cognitive, affective, and behavioral (Fredrick's, Blumenfeld & Paris, 2004). According to Attard (2012), cognitive engagement involves the idea of investment, recognition of the value of learning and a willingness to go beyond the minimum requirements. Affective engagement includes students' reactions to school, teachers, peers and academics, influencing their willingness to become involved in school work. Behavioral engagement encompasses the idea of active participation and involvement in academic and social activities.

In the first phase of this research, three junior high school students were asked about what activities that they could engage really well in mathematics classroom. They said that they could engage really well in the activities that include physical activity, active learning situations involving concrete materials, and games. They also said that conventional method which includes explanation, examples, and exercise often demotivated them. Active learning situations have become an important focus in this time. Collaborative learning is an important element of active learning theory and practice. According to Ford (2013), collaborative learning is an approach to teaching and learning that involves groups of students working together to complete a task, solve a problem or create a product. Studies have found that

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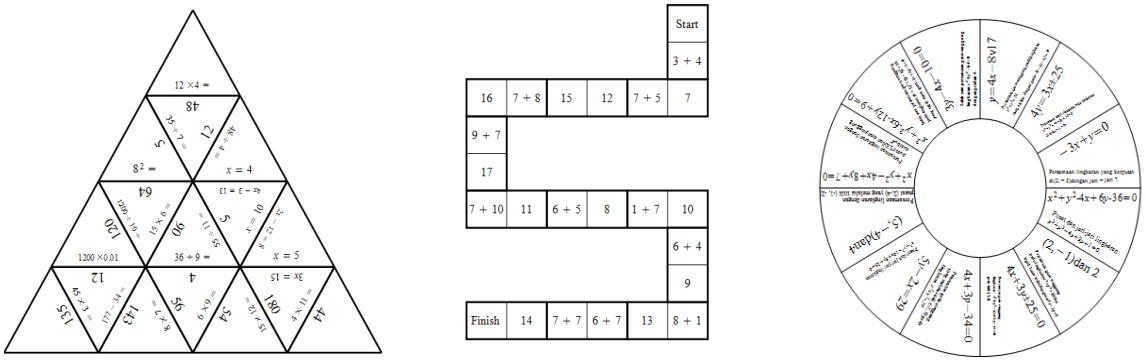
working together on a problem and considering each other's ideas led to increased conceptual understanding and problem solving skills (Tao, 2003, cited in Ford, 2013, p.2)

Promoting real collaboration is hard to do well. Activities are more effective when they encourage critical, constructive discussion, rather than argumentation or uncritical acceptance (Mercer, 2000). Shared goals and group accountability are important (Askew & William, 1995). In a collaborative activity, teachers must provide complex task to be solved by students. If the task is too simple, students can do it alone easily. Complex task require a situation in which attaining the goal, completing the task, being successful, and getting a good grade require that the team work together and share knowledge (Johnson, Johnson & Holobec, 2008). Collaborative activities can be incorporated into normal lesson periods in a variety of ways, such as solving domino and jigsaw puzzle containing mathematics problems. Currently, teachers can easily create domino and jigsaw puzzle using software called Formulator Tarsia.

Formulator Tarsia includes the powerful equation editor for building mathematics expressions for the activities. It became a powerful tool for learning activities since it supports the activity templates. An advanced feature of text placement along the side of the shape makes this tool irreplaceable software for fast activity creation. It enables easy support of teachers and gives them new perspectives to development of their teaching activity. Formulator Tarsia is a free license software and easy to use. With this software, teacher will easily be able to create, print out, save and exchange customized jigsaws, domino activities and a variety of rectangular card sort activities. The activities created using this software can be presented in printable form, ready to cut out (Hermitech Laboratory, 2003). Samples of puzzle and domino activities can be seen in the following graphic.



Graphic A.1. Sample of puzzle and domino activities (Supriyo & Qomaria, 2017)

In this study, 8th grade students solved mathematics domino and puzzle created by Formulator Tarsia. They did that activities in a small group consist of 4-5 students. Every group has been asked to record the time they need to complete each collaborative activity. Through domino and puzzle activities, students had opportunities to develop leadership, decision-making, trust-building, communication, and conflict-management skills. There have been limited studies concerned on collaborative activities using Formulator Tarsia. Therefore, this study intends to establish if students could engage on collaborative activities which were supported by Formulator Tarsia. Researcher focus on the cognitive, affective, and behavioral engagement of 8th grade students in learning mathematics.

B. MATERIAL & METHODS

There were twenty six 8th grade students participated in this study. Students were divided into 6 groups consisting of 4 - 5 students. They did three collaborative activities: domino, standard hexagon jigsaw puzzle, and extended rhombus jigsaw puzzle. To boost their motivation, students were asked to record the time they need to complete each collaborative activity. In order to know that Formulator Tarsia can be used to create collaborative activities,

researcher examined three types of students' engagement in this activities, namely cognitive, affective, and behavioral engagement. Behavioral engagement included observable student actions or participation while at classroom and was investigated through a student's positive conduct, effort, and participation Behavioral engagement measured through direct observations. To measure it, observers used Likert-type scale. Each item was completed using 1 – 5 frequency scale (5: very frequently, 4: frequently, 3: occasionally, 2: rarely, 1: never). Cognitive and affective engagement was internal, less readily observable forms of engagement that require students' own reports for accurate measurement. So, in order to measure cognitive and affective engagement, researcher used open questionnaires and dialogue with some students. To examine affective engagement, students were asked about their feelings toward collaborative activities and their peers. Questions about cognitive engagement included student's perceptions and beliefs associated to learning activities.

C. RESULT & DISCUSSION

Students' behavioral engagement in collaborative activities using domino, standard hexagon jigsaw puzzle, and extended rhombus jigsaw puzzle was recorded. The table below shows the result of the direct observations.

Table C.1. Result of Students' Behavioral Engagement Observation

Observation Item	Average Score
Listen to the rules of each activity	4,54
Eye contact is focused on the activities	4,58
Make appropriate facial expression, gestures, and posture shifts (i.e. smiling, nodding in agreement, leaning forward)	4,73
Discuss relates to class material	4,65
Give idea and opinion to the group discussion	4,38
Show persistence to solve problems	4,62

The result above revealed that students engaged with puzzle and domino activities really well. Most of students frequently listened to the rules of each activity given by teachers. They followed the rules very well. When students did collaboration activities, they looked enthusiastic. They focused on solving problems in each activity. However, some students were distracted by an off-task conversation and sometimes observed other group (s). Each member of the group actively provided ideas for completing domino and puzzle activities. Discussion not only deals with solutions to questions but also discussed about the exact position of the puzzle pieces. Sometimes, they joked together, laughed, encouraged each other to solve problems quickly. Each student showed his/ her persistence in completing the tasks. There was no passive student. All members actively made effort to solve domino and puzzle as quick as possible.

Observers also noted that each group has different strategies in collaboration activities using domino and puzzles. Some groups solved problems on each piece of the puzzle together. The other group divided the task in which each member was responsible for particular pieces of puzzle. If their strategy did not work, they persisted in trying different strategy until they got the best strategy for their group. Choosing the best strategy for their group was an experience to improve their decision-making skill. Students also developed leadership and trust-building through this activity. Although there was no instruction about team leader, naturally in each group appeared student who takes a role as leader. In these activities, students shared intellectual experience that they learn, do, and experience more together than they would alone.

Students' affective engagement measured through open questionnaire and dialogue. Questionnaire and dialogue asked about students' feelings toward collaborative activities and their peers. The result of the open questionnaire and dialogue can be seen in the table below.

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Table C.2. Result of Students' Affective Engagement Measurement

Dimension	Students' Responses
Interest	I felt excited when we learn mathematics in small group.
	I found learning mathematics enjoyable.
	I was very interested to know how to solve mathematics Problems.
	Learning mathematics through domino and puzzle gave me pleasure.
Achievement Orientation	I felt happy when I can finish mathematics tasks.
	I was satisfied when I get good results after making an effort.
	The efforts in solving mathematics domino and puzzle were worthwhile.
Peers Orientation	I gained better understanding when learning with friends.
	Group work stimulated our creativity.
	I became close with my friends in the same group.
	I communicated with all member of my group really well

Students' cognitive engagement measured through open questionnaire and dialogue. Questionnaire and dialogue asked about student's perceptions and beliefs associated to learning activities. The result of the open questionnaire and dialogue can be seen in the table below.

Table C.3. Result of Sudents' Cognitive Engagement Measurement

Dimension	Students' Responses
Self-Regulation	I often try to relate what I am studying to other things I know about.
	I frequently try to decide what I am supposed to learn rather than just read mathematics material
	I often check my task to make sure it's done correctly when I finish it
Motivation	Through these activities, I believed that I can improve my ability in solving mathematics problems.
	I did my best in order to solve domino and puzzle problems.
	These collaborative activities boosted my learning motivation.
Deep strategy	I would think about what I have already learnt and try to get a new understanding of what I know.
	I would use my spare time to study the topics we have discussed.

The students' responses to affective and cognitive engagement have been extremely positive. Students expressed interest in learning mathematics through domino, standard hexagon puzzle, and extended rhombus jigsaw puzzle. They were attracted by various methods of solving problems and the beauty of geometrical shape using in puzzle activities. The activities encouraged discussion and active learning. Most students have been positive with the increasing participation in discussion. Some of them found some of the activities difficult, but this challenged them. Most of students have gained confidence in articulating ideas. Kong, Wong, & Lam (2003) provided relationship between student's behavioral, affective, and cognitive engagement. Students' behavioral engagement is closely related to their cognitive and affective engagements. Their extent of attentiveness, diligence, and the time they spent on homework is closely related to their cognitive engagement.

There are likely a variety of practices that teachers can implement to support students engagement. Lent (2014) has suggested that teachers should create opportunities for active

rather than passive learning, create relevance in assignments and topics, and value and use collaborative learning methods. In this study, collaborative activities were designed using Formulator Tarsia. Result showed that students engaged with those activities very well. It means that domino and puzzle activities could be considered to be good practices in mathematics classroom. The activities were students centered, use experience and prior knowledge as a basis for solving problems, and have a high level of student engagement. According to Protheroe (2007), in an effective mathematics classroom, an observer should find that students are actively engaged in doing mathematics, solving challenging problems, making interdisciplinary connections, sharing mathematical ideas, using multiple representations to communicate mathematical ideas, and using manipulatives and other tools.

Domino and puzzle activities applied in this study in accordance with the principles of collaborative learning orientation. Swan (2006) stated that a collaborative activity in which learners are challenged and arrive at understanding through discussion. There was some good dialogue between students about checking the answers and the puzzle piece positions. Students with widely differing levels of mathematical ability could work actively and productively on the activities. Activities designed by researcher used rich collaborative task. The tasks used in collaborative activity should be accessible, extendable, encourage decision making, promote discussion, and encourage creativity (Ahmed, 1987, cited in Swan, 2006)

In order to create rich collaborative task easily, teachers should develop confidence in using technology and a positive attitude towards it. They need to be able to integrate ICT within the goals and objectives for mathematics teaching (Cheal, Geer, White, 2012). Formulator Tarsia is one of mathematics software to create a wide range of puzzle and domino activities easily. Teacher does not need to spend time cutting up the puzzle as the software automatically shuffle up the pieces of the puzzle, thus allowing the teacher to simply print and cut out and hand it to the students to compose. Tarsia jigsaw puzzle activities can be used for many mathematical topics and all students' ability levels. They promote discussion and group work, and provide an awesome alternative to doing questions out of a textbook.

D. CONCLUSION

This study determined that domino and jigsaw puzzle designed by Formulator Tarsia could be used to create collaborative activities in mathematics classroom. In these activities, students showed very good behavioral, affective, and cognitive engagement. They persisted in completing the tasks, developed decision-making skill, leadership and trust-building. Students also expressed interest in learning mathematics through these collaborative activities. Most of students have gained confidence in articulating ideas. Activities created by Formulator Tarsia could be considered to be good collaborative practices in mathematics classroom.

This study was conducted with only 26 students and 3 types of Tarsia activities. By increasing the sample size of both students and Tarsia activities would improve data accuracy. It would be advised that any future research regarding Tarsia activities in mathematics collaborative learning can be conducted more frequent covering not only students' behavioral, affective, and cognitive engagement.

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