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Developing IT-Based Mathematics Learning TAPPS Model to Improve High School Student's Problem-Solving Skills

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Abstract

Mathematical problem-solving skill is a student skill in order to be able to use mathematical activities to answer questions in mathematics, problems in other sciences and problems in everyday life. Three-dimensional space as a part closely related to everyday life cannot be separated. The objective is to develop IT-Based TAPPS model learning tool to improve student's three-dimensional geometric subject problem-solving skill using IT-Based TAPPS Model. The research method is research and development using *Thiagarajan* paradigm to define, design and develop steps. Three representative classes from MAN 01 Kudus are the samples for the research. The research of learning, motivation, abilities, procedures, teacher and pupil reaction, and problem-solving skill are the variables. The data are collected using validation sheets, tests, questionnaires, observation, and problem solving soft-skill test sheet (all in succession). The research is genuine showing the average scores based on syllabus, lesson plans, student books, student worksheets, and problem solving soft-skill test in the range of 1– 5. The values are 4.5, 4.44, 3.8, 4.38, and 4.38. The learning process is practical learning process. It is signed by the positive responses from both students and teachers. The effect of the students' skills and motivation on problem-solving efficiency is 60.5%. The average score of the test's result for problem-solving skill is 83.78. It is more than the passing grade of 70. The result shows that in average, IT-Based TAPPS Model is more effective to solve problems than ekspository approache. The research is judged to be reliable, efficient and applicable.

Keywords: IT-Based TAPPS Model; Geometry of Three-Dimensional Space; Learning Tools development; Problem Solving Skill; Mathematics

Abstrak

Kemampuan pemecahan masalah matematis adalah suatu keterampilan pada diri peserta didik agar mampu menggunakan kegiatan matematik untuk memecahkan

masalah dalam matematika, masalah dalam ilmu lain dan masalah dalam kehidupan sehari-hari dan ruang dimensi tiga merupakan bagian yang erat kaitannya dengan kehidupan sehari-hari. Penelitian bertujuan mengembangkan perangkat pembelajaran Model TAPPS berbasis IT untuk meningkatkan kemampuan pemecahan masalah pada materi dimensi tiga. Penelitian ini merupakan penelitian pengembangan dengan menggunakan model Thiagarajan, yang terdiri atas tahap pendefinisian, tahap perancangan, dan tahap pengembangan. Penelitian dilakukan di MAN 01 Kudus pada tiga kelas sampel penelitian. Variabel penelitian meliputi perangkat pembelajaran, motivasi, keterampilan proses, respon guru dan siswa, dan kemampuan pemecahan masalah. Teknik pengumpulan data (berturut-turut) menggunakan lembar validasi, tes, angket, observasi, dan lembar TKPM. Hasil penelitian menunjukan rataan nilai silabus, RPP, buku siswa, LKS, dan TKPM berturut-turut dalam rentang 1-5 adalah 4,5; 4,44; 3,8; 4,38 dan 4,38 sehingga perangkat pembelajaran tergolong valid. Respon positif ditunjukkan oleh siswa dan guru terhadap pembelajaran, yang mengindikasikan perangkat pembelajaran praktis. Kemampuan pemecahan masalah meningkat. Motivasi dan keterampilan proses siswa berpengaruh sebesar 60,1% terhadap kemampuan pemecahan masalah siswa. Rataan hasil tes kemampuan pemecahan masalah 83,78 melebihi batas KKM 70, sehingga rataan kemampuan pemecahan masalah yang belajar menggunakan TAPPS berbasis IT lebih baik dari rata-rata kemampuan pemecahan masalah yang menggunakan metode ekspository. Dapat disimpulkan bahwa perangkat pembelajaran valid, praktis, dan efektif dan dapat diterapkan.

Kata Kunci: Geometri pada Dimensi 3; Kemampuan Pemecahan Masalah; Matematika; Model TAPPS berbasis IT; Pengembangan Perangkat Pembelajaran

Introduction

The modern technology development is based on the universal understanding on mathematics, which also plays a significant role in a number of other sciences. Mathematics is abstract, relying on deductive reasoning, and dealing with structured ideas with logically constructed relationships, mathematics is also a tool for thought processes development.

In order to answer the challenge to solve the problems, the world of education, especially mathematics education constantly develops. This is because the rapid progress of science and technology led to increasingly complicated problems that people must deal with currently. Mathematics in education is very crucial for improving students the skills they need to communicate ideas logically, analytically, methodically, critically, artistically, and collaboratively.

Based on the Triennial survey from the Program for International Student Assessment (PISA), Indonesia is at number 74 out of 79 countries. Indonesia has mathematics average score of 379, compared to a global average of 489. The junior high and high school 15 years old students' skill to analyze problems, create arguments, and convey ideas when they propose, conceive, solve, and interpret

mathematical problems (problem solving) in diverse contexts is the focus assessed in PISA. Based on the findings of the PISA study, it can be stated that students in Indonesia have lower problem-solving skill than students in the other 63 countries taking part in the test (PISA, Indonesia Students Performance, 2012).

Based on the above-mentioned problem, it can be concluded that problem solving soft-skill is one of the crucial skills that students need in order to succeed in learning mathematics. By teaching students the way how to solve uncommon situations, struggling to find the answer for every difficulty by connecting current problems with the concepts they have already known, and trying to find the best method to solve a problem, student's problem solving soft-skill can be improved.

Students maybe have trouble in answering an issue because the students are not used to dealing with uncommon questions or the students are not used to tackling the challenges using problem-solving skill. "See, plan, do, and check" are the methods (Polya, 1973) suggested for tackling the issue. Sometimes, students skip problem-solving stage "check" and move on to the final stage. Students are expected to be able to make changes to the solutions at this point by cross-referencing them with other ideas that the students have already understood linked to the difficulties at hand (Jonassen, 2004).

Based on the statements above, it is very important to improve student's problem solving soft-skill. It cannot be denied that in this situation learning process cannot be conducted mediocrely in order to encourage student enthusiasm and to improve learning effectiveness and efficiency. A teacher has to be able to create an environment where students are motivated and engaged in what they are studying. There are numerous options available to make subject presentation more interesting. The Thinking Aloud Pair Problem Solving (TAPPS) learning model is the alternative.

The TAPPS learning paradigm is an evolution from cooperative learning model, mandating cooperative group learning among students. Sharing knowledge, experiences, tasks, and responsibilities is something taught and used to performing by the students. Contact, communication, and sociability activities help each other. Therefore, it is expected that by using the TAPPS learning model student's problem solving soft-skill will be improved.

Being lack of students' capacity to illustrate the real image shape required in a question is one of the reasons why student's problem solving soft-skill is inadequate when facing three-dimensional questions. This is according to interviews with mathematics teachers at school. Look at Figure 1.1 below for an

illustration of how a student's inability to illustrate a problem solution creates a mistake.

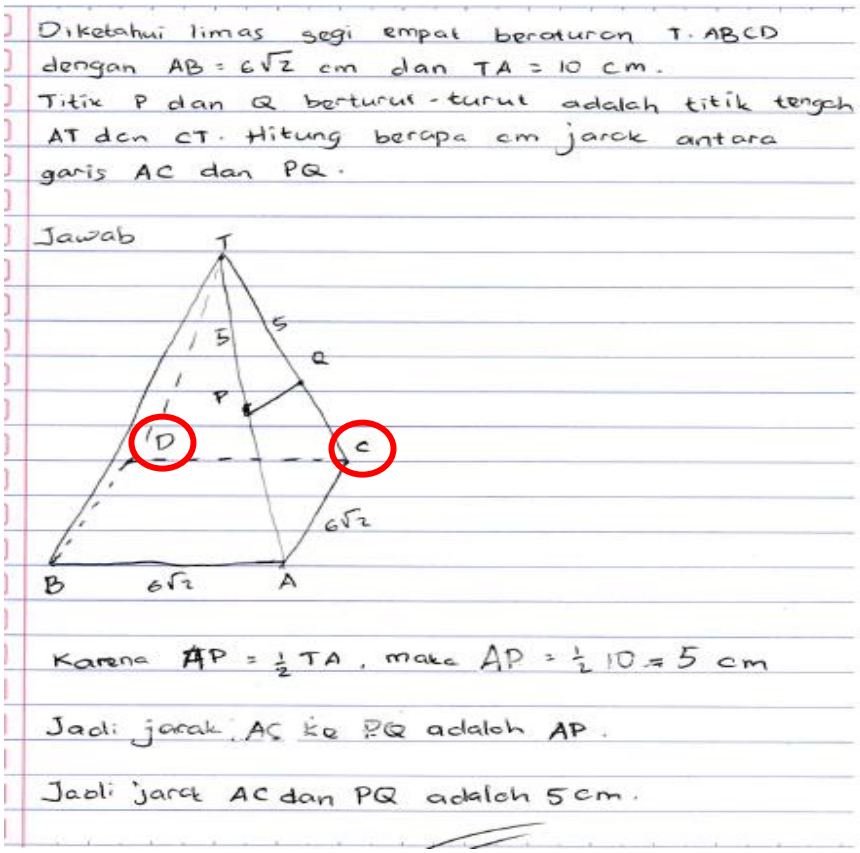

Figure 1. Student's Illustration Capacity

Figure 1 above shows the student's capacity to illustrate the question is still limited. It is shown from the outcomes of the activity that the student still makes mistake in labeling and drawing the picture. In addition, the student interprets the measurement asked in the question incorrectly, so it leads to the incorrect answer. Everyone needs spatial skill in order to solve questions in three-dimensional space. Based on the fact, many questions in three-dimensional space subject cannot be solve and represented in the original shape or structure, the questions can only be seen or represented in two dimensions. Students frequently find difficulties because the questions need imagination and abstraction to transform from three-dimensional objects into two-dimensional form.

The usage of the proper media can help students who may have trouble in illustrating three-dimensional figures. The *Cabri* 3D software, which is created to illustrate spatial structures easier, is one of the media that may be used to improve

spatial skill. *Cabri* 3D's capacity to animate three-dimensional shapes is one of the benefits. *Cabri* 3D has solid foundations and capacity to assist teaching and learning process of spatial geometry (Anthony, 2006). Cabri 3D will be very helpful for learning because it can help students' spatial skill regarding to the meaning of two-dimensional figures in three-dimensional figures and concepts in three-dimensional space by altering the point of view and moving the objects using existing animations.

The learning management strategies implemented by teachers and the students' poor level of subject mastery are inextricably linked. The learning tools utilized in classrooms often serve administrative needs, so student's motivation, activity, and inventiveness in problem-solving are still not given enough attention. To solve the problems above, it is essential to create a reliable IT-based tool on three-dimensional space that will help students to understand the topic by utilizing a learning model that will boost students' enthusiasm to learn mathematics. Based on the stamen above, it is deemed necessary to conduct a research on the creation of IT-based TAPPS model learning tools for three-dimensional space content.

Based on the background of problem, the research formulation of problem are: (1) what are the characteristics of the IT-based TAPPS model of mathematics learning tools to improve student's problem solving soft-skill?, (2) Are the results of developing mathematics learning tools using the IT-based TAPPS model to improve student's problem solving soft-skill valid?, (3) Does the IT-based TAPPS learning tool practically improve problem solving soft-skill?, and (4) Does the learning in general effectively improve problem solving soft-skill?

The objective of the research are to: (1) identify the characteristics of the IT-based TAPPS model mathematical learning tools to improve problem-solving skill, (2) assess the reliability of the mathematics learning tool development outcomes using the IT-based TAPPS model, (3) examine the applicability of mathematics learning tool outcomes using the IT-based TAPPS model, and (4) assess the efficacy of mathematics learning tool outcomes.

Method

The main objective of this research is to develop IT-based TAPPS model learning tools to improve problem-solving skill on three-dimensional geometric subject in class X. This research is classified as research and development (Creswell, 2009). Without a disperse stage, the development model uses a modified Thiagarajan model. Syllabus, Lesson Plans (LP), Student Activities Sheet (SAS), Student Books (SB), and Problem Solving Soft-skill Tests are some the learning resources provided (PSST).

A learning tools validation sheet, lesson plan implementation, observation sheet, students activities observation sheet, students learning motivation questionnaire sheet, students and teachers questionnaire answers, and PSST are the research tool utilized to collect data. The instruments used in this research are observation, questionnaires, and tests.

Based on the findings from learning tools evaluation, descriptive analysis of data collected is conducted. The learning tools created using the criteria of 1.00 Va 1.80 (not good), 1.80 Va 2.60 (not good), 2.60 Va 3.40 (good enough), 3.40 Va 4.20 (good), and 4.20 Va 5.00 are revised and improved using the validator's assessment result (very good). If a document has good classification at minimum assessment criterion, it is considered to be valid. Before the tools, as the research instrument for problem solving soft-skill assessment are used, the tools have to be examined for the validity, reliability, level of difficulty, and distinguishing feature.

The data analysis used for practicality is the examination for data observation on the implementation of lesson plans and questionnaire analysis of students and teachers responses ~~to~~ on learning, with the assessed average score. The evaluation criteria that have been previously prepared by the researcher are utilized to assess the observation sheet on teachers' capacity to manage learning process and as well as students' response questionnaires ~~to~~ on learning.

The effectiveness test analysis is conducted using students' PSST scores examination from the final data. The data are examined through prerequisite tests, including the homogeneity and normality tests (Lilliefors, 1967). The T test and percentage test are used for the test of completeness (Sudjana, 2005). The T test is used for the test of two samples mean difference to compare the averages of tools testing class and traditional learning class. The complex regression test is used to examine the effect. (Sukestiyarno, 2012). N-gain formulation is used for examining the increase and the effectiveness of the treatment (Hake, 1998) and the mean difference test of two classes is also used to compare the value of the increase.

Results

In investigation stage, the researcher has condition specification needed for conducting learning activities at MAN 1 Kudus. Additionally, for the next stage, the researcher conducts preliminary-late analysis, student's characteristics analysis, content analysis, tasks analysis, and learning objectives definition analysis.

The next stage is design stage. In this stage a solution is created to the issues discovered in the first stage. Based on the findings, creating a product is endeavored

especially the learning tools supporting applied learning characteristics and improving student's problem solving soft-skill.

In order to improve student's problem solving soft-skill, the development stage involves creating the syllabus, lesson plans, student's books, worksheets, and PSST that are in accordance with the learning characteristics of the IT-based TAPPS model on three-dimensional space subject for grade X students. Draft I refers to the learning resource created at this point.

The information validity in Draft I is verified by the experts. Five people having expertise in mathematics education are as the validators. Table 1 displays the findings of the overall evaluation found by learning tools validators.

Table 1. Summary of Learning Tools Validation Result

No	Learning Device	Validator					Mean	Criteria	Note
		V1	V2	V3	V4	V5			
1	Syllabus	4,18	4,13	4,50	4,75	5	4,50	SB	Valid
2	Lesson Plans	3,82	3,91	4,45	5	5	4,44	SB	Valid
3	Book	3,64	3,73	4,18	3,73	3,73	3,80	SB	Valid
4	Student Worksheet	3,50	3,88	4,50	5	5	4,38	SB	Valid
5	PSAT	3,63	3,88	4,38	5	5	4,38	SB	Valid

The IT-based TAPPS model, aiming to improve student's problem-solving skill on three-dimensional space subject is used to build learning gadgets general characteristics. The fundamental learning processes are as follows: (1) communicating learning objectives and inspiring students, (2) transferring knowledge, (3) grouping students into study groups, (4) directing study groups, (5) evaluating students, and (6) rewarding students.

The curriculum and lesson plans designed have the characteristics of integrating performance metrics on three-dimensional space subject with problem solving performance indicators. The Student's Book has good quality. It includes of including problem-solving activities in addition to questions examples and conversations. Students are able to improve their problem solving soft-skill by studying and practicing the questions and exercises in the student's book, which are also related to various areas of problem-solving skills and problem solving stages.

Each meeting's learning objectives are reflected in the Student's Activities Sheet (SAS), which also incorporates elements of problem-solving, so that problem solving soft-skill is able to be improved while using presented problems. Students are instructed to use problem solving soft-skill to find solutions based on problems or questions in the SAS. The Problem Solving Soft-Skill Test is the created learning

outcomes test (PSST). This PSST includes the questions concerning about three-dimensional space taught at school, in addition to contextual questions helping students becoming more engaged in and aware of the advantages of problem solving soft-skill they have acquired. So, the PSST determines the measurement of student's problem solving soft-skill performed by the students after receiving learning with learning tools specially built.

Discussion

The observation result for the implemented lesson plan shows that the average score is 3.76 (with a maximum score of 5.00). The score is the excellent criterion. Overall, 81% students respond positively to the survey results on the student response. Additionally, the average score on the teachers' response survey is 3.24 out of 5.00 possibility of good requirement. Therefore, it can be stated that mastering the IT-based TAPPS paradigm is useful.

The outcomes of effectiveness test for the IT-based TAPPS model learning are as follows: (1) the classical problem solving soft-skill completeness with a proportion exceeding 75% and the problem solving soft-skill average score for learning tools test class exceeds the minimum completeness criterion (KKM) of 70; (2) the student's problem solving soft-skill on learning tools test class is more than the controlled class (having average score 78.13); and (3) student's motivation and process skill collectively have a positive effect. Additionally, it is known that student's problem solving soft-skill in learning tools test class has improvement in average. It is more than the student's problem solving soft-skill in controlled class based on the mean difference test.

The class having IT-based TAPPS learning model treatment reaches the learning completeness and exceeds the controlled class. It shows that the knowledge transferred has improved student's skill to solve three-dimensional space problems. This is based on some research findings, including (Jiyanto, 2009), (Maula, 2013), (Naryestha. K. E, 2014), (Pate & Miller, 2004), (Rafiepour & Farsani, 2021) and (Wulandari. A. N, 2013). The researches show the effectiveness of IT-based TAPPS learning model and the possibility of reaching KKM using cooperative learning.

Conclusion

The characteristics of learning tools created based on IT-based TAPPS model are: (1) The indicators that have to be reached are integrated into the curriculum and lesson plans, especially on grade x subjects having relation to three-dimensional space and problem solving soft-skill indicators, (2) The instructional procedures

consist of TAPPS learning activities and IT-based TAPPS model. (3) The Student's Book (SB) includes activities to improve problem solving soft-skill as well as the stages of problem solving, examples of questions and debates, (4) SAS is designed with features of problem solving soft-skill and customized to the learning process and learning objectives for each meeting. and (5) PSST includes questions assessing student's problem solving soft-skill by integrating three-dimensional spatial subject and question indicators.

The instruments for creating syllabus, lesson plan, Student's Books, SAS, and PSST are classified as valid after passing through the procedure of expert validation and outcomes of revision. The very good category produces the average score. Based on the good category average score of lesson plan observation conducted in good category and the average score of questionnaire on students and teachers responses to learning, the result of tools development are classified as practical.

The IT-based TAPPS paradigm for learning has been deemed successful. It is demonstrated by the following facts: (1) student's problem solving soft-skill exceeds the passing grade both individually and collectively; (2) The class of student's problem solving soft-skill with IT-based TAPPS model learning is better than the class having conventional learning; (3) there is an effect between motivation and process skills collectively on student's problem solving soft-skill; and (4) There is an improvement on problem solving soft-skill on the students having IT-based TAPPS learning model and TAPPS learning method.

The suggestions made related to the research's findings are: (1) For time management, the TAPPS learning model should be taken into consideration, especially during group discussions and presentations of discussion outcomes. It is preferable to prepare more thoroughly so that the time ~~is~~ used is more effective and according to the plan; (2) this research is only limited to three-dimensional space subject, so other researchers who will also develop learning tools for problem solving soft-skill should be able to develop other topics in mathematics subjects; and (3) the learning tools of IT-based TAPPS model is only applied in one class ~~in~~ at one school. As a result, other researchers who wish to conduct the next research can increase the research population and sample and observe the effects of the implementation at high, middle, and low level schools.

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