Al-Jabar: Jurnal Pendidikan Matematika
Volume 11, Number 1, 2020, Pages 121 – 132
http://ejournal.radenintan.ac.id/index.php/al-jabar/index

Problem based learning with a scientific approach with character in mathematics learning

Ahmat Wakit[1], R. Hadapiningradja Kusumodestoni[1]
[1] Universitas Islam Nahdlatul Ulama Jepara, Indonesia
✉ ahmatwakit@unisnu.ac.id

Article Information
Submitted May 17, 2020
Revised May 20, 2020
Accepted June 17, 2020

Keywords
Mathematical Problem Solving Skills; Problem Based Learning; Scientific.

Abstract
The studied aims to determined the characteristics of the development of learned devices with the problem-based learned model with a scientific approached which container the character in math subject. The research method used is a development research. Development is carried out with the preparation of valid, practical and effective tools. The learned tools developed were syllabus, (RPP) Learning Implementation Plans, (LKS) Student Worksheets, Student Books, and TKPM (Problem Solving Ability Tests). After the learned device valid then tested, the experiment was carried out by observed the learned process, process skills, students' character, at the end of the learned process did by TKPM and filled in the student response questionnaire. Data were analyzed to determined the practicality and effectiveness of the used of learned devices. The results showed: (1) the average score of the learned device validation results was 4.37 in the very good category so the devices developed were valid; (2) the application of practical learned tools because the average score of the teacher's ability to manage to learned is 3.98 in the good category and the average score of 4.36 student respons is in the very good category; (3) the application of effective learned devices because TKPM has achieved classical completed, the average TKPM experimental class better than the control class, the proportion of completed TKPM students experiment better than control class students, there is a positive influence was students' process and attitude skills towards TKPM, there is an increase in mathematical problem-solved abilities.

INTRODUCTION

The high and low quality of education can't be separate from the quality of learning that is design and manage by teacher. The teacher plays an important role in building the character of students so teachers need to develop learning methods containing characters in various fields, one of which is learning mathematics. One of the goals of mathematics learning is students have problem-solving.

According to (Häkkinen et al., 2017) education must focus more on certain skills area such a problem-solving skills, collaborative skills, and others. Problem-solving skills are need in everyday life to overcome existing problems. Therefore, teach is need that can spur students' ability in solving mathematical problems. There are various ways to improve problem solving skills, especially in the learning of mathematics such as the use of appropriate methods. According to Ulandari et al., (2019) and Huda & Suyitno (2017) learning by using Problem Base Learning can improve the ability to solve mathematical problems anAd the ability to recognize student experience. This is in line with the results of the study (Surya et al., 2017) that is increasing the mathematical problem solving ability of students taught with contextual learning models is higher than students who are taught with expository learning. The process of learning activities with PBL can also have a positive effect on student performance (Ahamad

How to cite Wakit, A., & Kusumodestoni, R. H. (2020). Problem Based Learning with a Scientific Approach with Character in Mathematics Learning. *Al-Jabar: Jurnal Pendidikan Matematika*, *11*(1), 121-132.
E-ISSN 2540-7562
Published by Mathematics Education Department, UIN Raden Intan Lampung.

et al., 2018). Learning could be success only seen from the results of learning, but also seen from the process during the learning process. The students' process skills are also very important in the learning process, the focus of this study is on scientific process skills which are observing, asking, doing, reasoning or associating, and communicating (making conclusions, presenting) (Cristea, 2016). Activities which developed in a scientific approach can trigger the emergence and creation of various learning experiences get by students by involving all five senses, physical, and psychological students so as to help develop the various potentials they have (Ihsan, 2014). Scientific approach have characteristics such as fact-base learning material, teacher explanations, student responses, and teacher and student interactions free from instant prejudice, subjective thinking, or reasoning that deviates from the flow of logical thinking; encourage and inspire students to think critically, analytically, and correctly in identifying, understanding, solving problems, and applying learning material (Rhosalia, 2017).

The results of the initial tests show the problem-solving ability of junior high school students in Jepara is still low. The low problem-solving ability shows by the results of the problem-solving ability test conducted by researchers in the initial research with the average value of problem-solving ability of VII grade students in triangular and quadrilateral material is 58.67 less than KKM, that is 70. The low problem-solving ability of students because to some mistakes, such as unable to understand the problem and not be able to design the problem.

The results of the students complete in the initial research indicate that 1) students can't understand the problem so the student can't plan and solve problems correctly; 2) students have difficult in planning problem solving so students are unable to solve problems correctly; 3) Student's mistake because the students unable to apply the four stages of problem-solving. The first stage is understand the problem, students do not careful in understand the problem and then they don't understand what is known and what is the question. The second stage is planning completion, students can't be gather information and apply mathematical concepts. The third stage resolves the problem, students can't solve the problem because they are not understand what is be done. The fourth stage is double check, the uncorrect answer which done by the student so they are not know that the answers are right or wrong.

The appropriate learning model also influences students' have understanding and ability to solve existing problems. The teacher can motivate students to attract them in learning mathematics by link the material learning with problems in everyday life. According to (Ramadhani, 2018) in improving students' abilities in solving mathematical problems and self-confidence in the learning process require the application of learning models that are able to involve students in the learning process. (Sipayung & Anzelina, 2019) in carry out learning the teacher has be able to analyze students 'problem solving skills in each activity, it aims to find out how the development of students' mathematical problem solving abilities. (Karatas & Baki, 2013) explain the problem-base learning can significan improve students' understand and problem-solving ability. According to (Abdullah et al., 2010) groups of students who take part in learning with PBL can solve problem solving use Polya's problem solving procedur effective. Problem-based learning (PBL) is very appropriate in overcome existing problems. The main activity in this model is to solve problems through a series of group activities base on everyday problems so the student can have actively involve in learning. According to (Davidson & Major, 2014) problem-base learning has a positive impact on student activities and collaboration. PBL is an instructional learn-center approach that empowers student to conduct research, integrates

theory and practice, and applies knowledge and skills to develop a viable solution to a defined problem (Savary, 2006).

The main focus of this learning model is student activity, learning activities will be maximize with an appropriate approach that is scientific approach. The steps in the scientific approach are to observe, ask, collect information, associate, and form networks / communicate. (Servant-Miklos, 2019) add that if the teacher wants to use PBL, then he has pay special attention to the phase of discussion and the use of various problems. This statement is in accordance with the results of research from (Ari & Katrancı, 2014) which states that PBL can have use because it increases students' thinking ability and can help students in improving problem-solving skills, but the preparation and practice of this method take time. (Hendriana et al., 2018) also add the use of problem-base learning models can increase student activity in the learning process.

The success of learning also accompany by the availability of quality learning tools. The unavailability of learning tools based on the problem-base learning model with a scientific approach with character is also the factor that makes students unable to explain their knowledge to find a solution to the problem. Learning by increase class activities can stimulate student activities and build student character. (Irfan, 2016) explains the learning of mathematics can have doing by encouraging students to reflect and award so has to instill and strengthen students' motivation, appreciation of mathematics, student contributions in learning, interests, belief, self-confidence and perseverance. According to (A. Kamaruddin, 2012), character education have been carried out with high commitment and continuous improvement of the behavior carrying out. The character basic value have been integrate in the learning of Mathematics and Natural Sciences (Hudha et al., 2014). The success or failure of character learning in Indonesia lies in the quality of support from the participation of teachers, parents and technological infrastructure to support student learning. (Sukestiyarno et al., 2019). Therefore, it is necessary to develop learning tools that are in line with curriculum requirements and consider the needs of teachers and students so that they can improve mathematical problem-solving abilities. One thing that can integrate character education in mathematics learning so as to produce changes in student character behavior is the teacher can choose the right learning strategy in choosing focus items that are program with the characteristics of the mathematical material have being taught, and able to bring students to utilize technology correctly and physically socializing with the environment (Sukestiyarno et al., 2019). Previous study discuss how to improve problem solving abilities. Both with the development of learning methods, teaching tools and others. This research is a research development of teaching devices with problem base have learning methods with a scientific approach that contains elements of character. The focus of research is on improving problem solving skills and also improving scientific process skills.

From the problems above, the researcher offers a solution has by developing a learning tool based on the problem-base learning model with a scientific approach that have character-charging hopefully to improve students' problem-solving abilities and character. The purpose of this study was to determine the characteristics of the development of learning models based on problem-base learning with a scientific approach with character, resulting in valid, practical and effective learning tools.

METHODS

The research method used a development research model that was described by Borg & Gall modified into 4 main stage, namely (1) preliminary study phase, (2) planning stage, (3) tested and validation stage, and (4) dissemination stage. The steps for development are carried out in stage and coherently, explained in Figure 1.

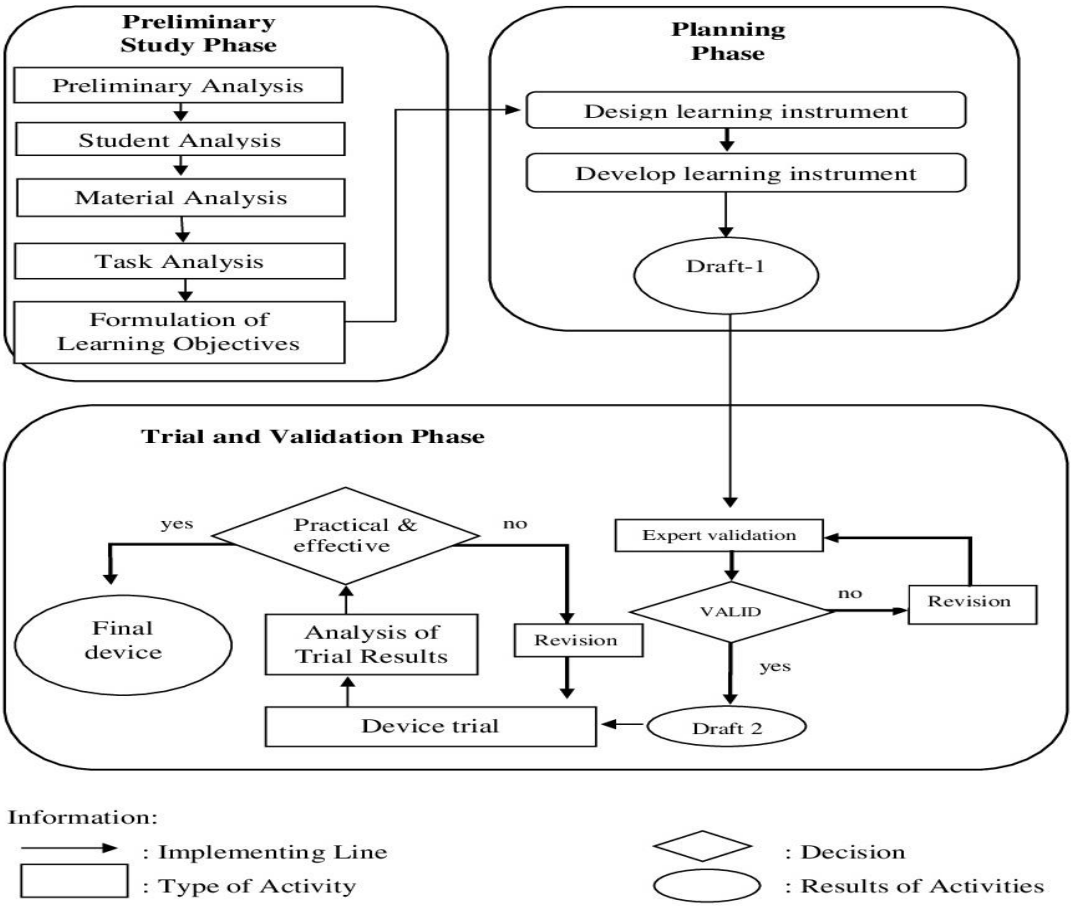

Figure 1. Figure of Steps for Developing Learning Tools for Problem Based Learning Models with Scientific Approaches

The research was conducted MTs PB Roudlotul Mubtadiin Balekambang Jepara Indonesia for the first year. The subject is studied were student of grade VII F, VII G, and VII H. The product developed was a triangular mathematics learn devices was included: (a) Syllabus, (b) Learn Implementation Plans (RPP), (c) Student Books, (d) Student Worksheets (LKS), and (e) Problem-Solving Ability Test (TKPM). The device was prepared then tested by validator, namely 3 mathematic lecture and 2 mathematic teacher. The device was valid if each device was "Good" or "Very Good" category. Table 1 shows the criteria for evaluated the validity of the device developed.

Table 1. Validity Assessment Criteria

Value	Category
$1,0 < x \leq 1,8$	Not Good
$1,8 < x \leq 2,6$	Poor
$2,6 < x \leq 3,4$	Good Enough
$3,4 < x \leq 4,2$	Good
$4,2 < x \leq 5,0$	Very Good

Description: x = Average total score

The next step after the device was declared valid is a field trial. This field trial used to determined the practical and effectiveness of device have been developed. Learn device said to be practical if they meet two criteria, namely (1) the use of learn device where the category of "good" or "very good" and (2) the response of student to learn in the category of "good" or "very good". The application of learn device said to be effective if: (1) more than 75% of experimental class student get test score ≥ 70, (2) student problem-solving abilities of experimental class were better from control class, (3) proportion of complete of problem-solving abilities of class students Experiments were better from control class student, (4) the influence of process skill and student response to mathematical problem solve skill, (5) an increase in student problem solving ability. Each test result is containe in Figure 2.

Data retrieval instrumen were the studied : (a) learn device validation sheet, (b) device usage observation sheet, (c) student process skill sheet, (d) student respons questionnaire, (e) student character sheets and TKPM questions.

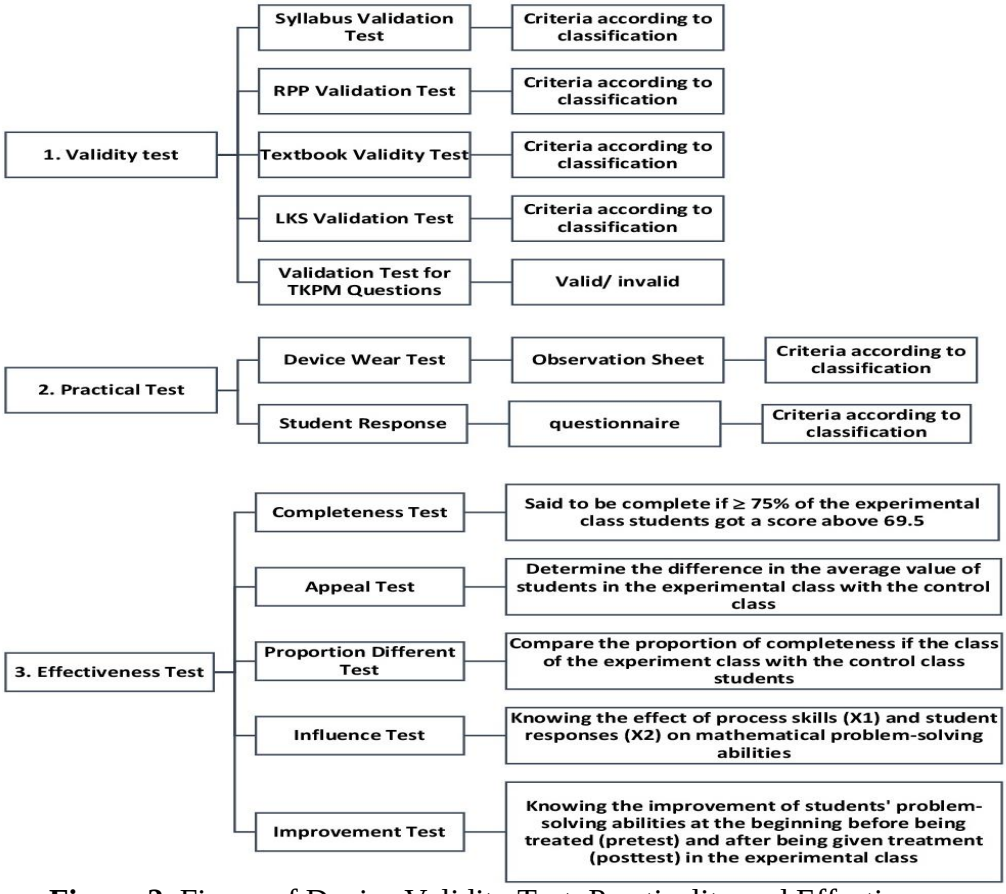

Figure 2. Figure of Device Validity Test, Practicality and Effectiveness

The method employed in this research was a descriptive-qualitative method to describe the object of research based on the data of students' creative thinking skills in solving higher-order thinking skill (HOTS) questions. This research was conducted on the students of Mathematics Education Study Program at the Tarbiyah and Teacher Training Faculty of IAIN Langsa. The subjects were 28 third semester students. The subjects were selected using non-probability sampling technique, specifically the purposive sampling and snowball sampling. The researchers determined a particular informant following the objectives and the needs of the research. The selection of the subjects was based on the consideration that the samples taken were emphasized on the quality of their understanding and the high mathematical skill in the calculus course. The data collecting techniques used were tests and interviews. There were 4 description questions characterized by HOTS based on indicators of creative thinking skill. The interviews were focused on the questions that have been given in the tests. Before the tests were given, they were validated for their validity, reliability, level of difficulty, and discriminating index. Then, the data were reduced using triangulation techniques which were the combination of tests, interviews, and field notes.

RESULTS AND DISCUSSION

The result of studied were to get valid learn skill, practical and effective learned. There are four steps in the development of learn tool in studied: preliminary studied, plan, field trial and validation, and dissemination. The preliminary studied phase aimed to determined the material needed in learn and to knew the condition in the field. Activity carried out include final preliminary analysis, student analysis, task analysis, material analysis, analysis of learn question and formulation of learn objective.

The planning stage, the activity carried out were designed and compiled learn tool that are in accordance with the mathematic learn problem-base learn model with a scientific approach. The tools compiled were learn device which include syllabi, lesson plan, student books, LKS, and test problem-solve ability. The tool prepared were adjusted to the systematic learn tools were applied in Indonesia. After the tools prepared, the Draft 1 device is obtained (see Figure 1).

The next step was trial and validation stage, the developed device was validated by 5 experts which include 3 lectures and 2 teachers. There were some improvement that needed to be done, especially in student book and question. Improvement in student book was located too small font size, non-standard font shape and added practice question. Improvement to the problem lied in sentence that will be difficult for student to understand, the order of sentence needed to be fixed. As for the syllabus, RPP and LKS were very serious and needed to be fixed. After being repaired and all validators gave value, the learn tool for Draft 2 obtained (see Figure 1). The result of the validator's assessment of each developed device described in Table 2.

Table 2. Recapitulation of Learning Device Validation Results

Instrument	Validator Assessment					Average	Criteria
	I	II	III	IV	V		
Syllabus	4.94	3.83	4.39	4.33	4.44	4.39	Very Good
RPP	4.95	3.77	4.32	4.14	4.18	4.27	Very Good
Student Book	4.93	4.40	4.30	4.20	4.33	4.43	Very Good
LKS	5.00	4.39	4.22	4.11	4.28	4.40	Very Good
TKPM	Valid	Valid	Valid	Valid	Valid	Valid	Valid

At the stage of validation of the learn tool developed, the results of the validation of the equipment of each item showed a very good value, mean was the device developed in the studied were in the valid category, and has been used in conducted learn. The score of each item in Table 2.

The next activity was limited device test. That was, the device that has been validated used to learn in a smaller class to find out the practicality of the device been developed. As a limited trial class, class VII G. was chosen. The teacher carried out the learn and observed used the observated sheet used. The aim was to find out how far the suitability of learn with the learn plan was made. The score of the wearability of the device or the ability of the teacher to manage learn 3.98 is in a good category. After the learn processed student were given a questionnaire to finded out the student response to the developed device. The average score of 4.36 student responses was very good category. The learn tool showed developed partical.

After knew the device was developed practical, then tested with a large scale, in this case, called the experimental class. The experimental class referred to in studied were the class taught by the problem-based learn model with a scientific approach. In addition to the experimental class, the studied also needed a control class as a comparative class, the control class was taught by the expository method, namely the lecture method. During the learn process, observations were carried out on the student activity processed.

The resultbof observations of students' processed skill, observations of student character, and test result of student problem-solved ability obtained will be analyzed and used to determined the effectiveness of the application of developed learn tools. The result of the analysis showed: 1) the problem-solve ability taught used the problem-based learn model with a scientific approach achieves classical completed, which is $\geq$ 75% of students got a score of $\geq$ 70; 2) the problem-solve ability of students who are taught used the problem-based learn model with a more scientific approach (experimental class) was better students taught with the expository method (control class); 3) the proportion of completed of the problem-solve ability of the experimental class students was better the completed of the problem-solve skills of the control class students; 4) the influence of students 'processed and character skills on students' problem-solve abilities is 52.5%; 5) there is an increase in students' problem-solve ability. Based on the description, it could be concluded that the application of mathematical learn tools were a problem-based learn model with an effective scientific approach. Another finding the process of student achievement increased significantly from the first meeting until the final meeting.

The problem-solve ability of students increased after follow the learn with the problem-based learn model with a scientific approach. Students can apply every step in solve Polya's problem in a coherent way of answered questions. Before follow the learn with problem-based learning model with a scientific approach students tend to answered questions directly so that they often experience error in identifyed problems or in their calculations. The results of this studied indicate the learn model of problem-based learning with a scientific approach can improve student learn outcome was the case problem-solved ability, this is in line with the results of (Putra & Suparman, 2020) that the Problem-Based Learn (PBL) learning model can be used to improve students' problem solved ability. (Winarti et al., 2019) also added that Problem Based Learning used performance assessment can improve students' problem solved ability were solved problems in the educational statistics coursed. Increased students' problem-solved ability because students can take steps/stages of solved Polya's problem namely understanding problems, planning solutions, solving problems and checking again. These four steps support improving students' problem-solving abilities in the triangular material.

The results of the analysis of students 'answer sheets at pretest and posttest showed that there was a development of students' problem-solving abilities. The stage of understanding the problem were an important stage in solving a problem, if students cannot understand the problem, students cannot solve the problem correctly. At this stage, the ability to understood students' problems increase, almost all of the trial class students were correct in understood a given problem. This stage of planned the complation of the core stage in solved the problem, at this stage was the biggest score of the other stages. The ability of students to plan complation increase but the increase still not optimal because in planned the complation of the students required to understood the problem first and gather information/material that can support in solved the problem. Students Difficult in understood problem and plan solutions were caused by several factors included, students who are not accustomed to solved problems in word problems, and learn does not develop problem solved (Nurkaeti, 2018) and (Daulay & Ruhaimah, 2019).

The phase of solved the problem was the main stage in solved the problem, if the stage was not do properly according to the plan of completion then a problem will not be resolved. In this case the ability of students to solve problems increase, although there could students who got a low score at the stage, due to planning to solved problem that less precise. The final step in solved the problem was to check the return and draw conclusions. The ability of students at this stage increase, it could be said that on average students can review and draw conclusions from existing problems.

The stages was completed the problem also described in the answer sheet in the LKS. The developed worksheet contains problem-solved question and answer sheets with problem-solved stages. Each student meets fills out the answer sheet provided according to the Polya stage, this caused students to get used to solved problems with their problem-solved steps.

Observations during the processed of the trial learned device activities used to obtain information about the sixth choice processed skills after participating in learn activity used the problem-based learn model with a scientific approach. The development of student processed skills were indicated by an increase in the five indicators of student processed skills. The results of the observation of the development of each processed skill indicator described in Figure 3.

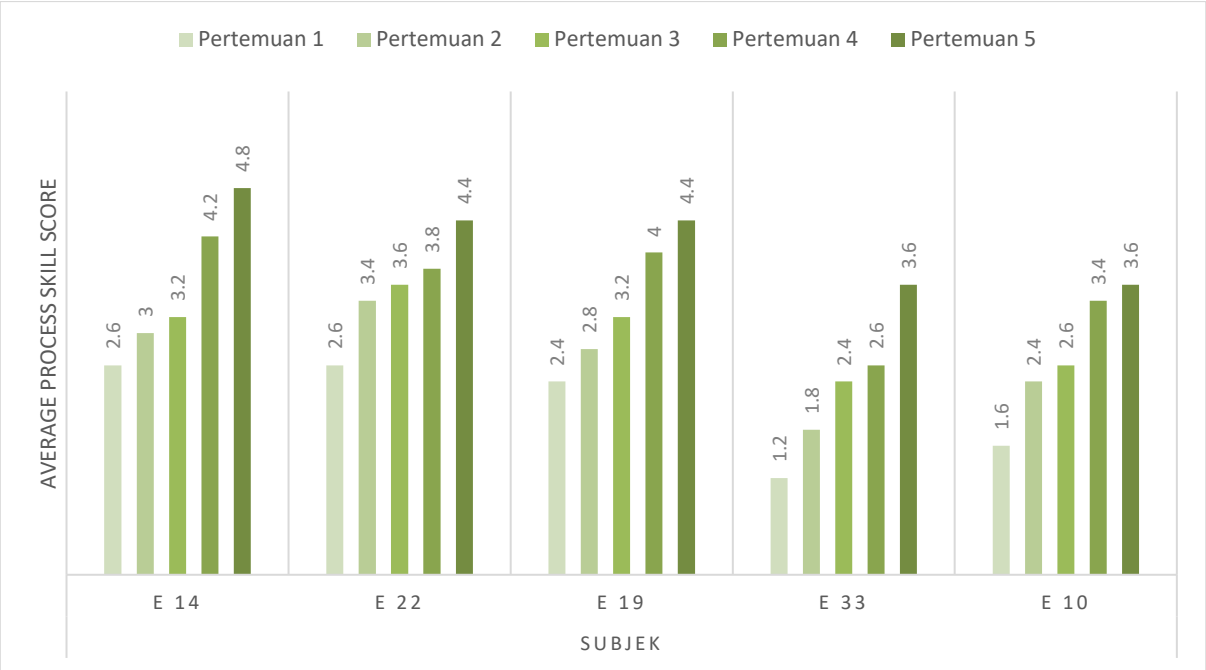

Figure 3. Figure of Scientific Process Skill Improvement

The improvement of students' processed skills was very clear seen from the five students selected (shown in Figure 3). All research subjects experienced an increase in scientific processed skills in each learned. E14 subjects have high processed skills from the five subjects, at meetings 1 through 5 experienced a significant increase, this is reasonable because E14 subjects included students with high ability. The E10 subject is a student with low ability, but after followed the learned with the method, the scientific processed skills of the E10 subject have increased. Subjects E22, E19 and E33 also matched the same thing, the score of each meeting increased, although the scored of each subject was different but when observed the scientific processed skills of students increased significantly. The increase occurs as a result of the learn processed of someone. The processed in question was an activity carried out by individuals in achieving learn goals with a scientific approach. Achieving the learn objectived could be expressed as learn outcomes. Based on the description above, it showed that this study produced a mathematical learn tool model of problem-based learn with a valid scientific approach and also the application of practical and effective learn tools.

CONCLUSIONS

Conclusions was be generalized finding according to research problems, can also be a recommendation for the next step; 1) development of mathematical learned devices model of problem-based learn with a valid scientific approach because each learn device shows very good category; 2) application of problem-based learn model learn tools with a practical scientific approach because the use of learned device was a good category and the response of students is very good category; 3) the used of learned tools for problem based learn models with a scientific approach contain character can improved students' processed skills in the classroom; 4) the problem solved ability of students who taught used the problem based learn model with a scientific approach contain characters (experimental class) better than students taught by the expository method (control class); 5) the influence of learn processed skill and students on

students' problem solved skills by 52.5%; 6) the used of learn tools for problem based learn models with a scientific approach containing characters can improved the ability to solved mathematical problems.

The researcher suggests to further research that: 1) in improved the ability to solved mathematical problems and the processed skills of students in the classroom can use the problem base learn model that contains the elements of character with notes needed to adjust teach device used with the conditions of students in the class; 2) the teacher role is very important in the successed of this model of learn because the teacher is a facilitator.

AUTHOR CONTRIBUTIONS STATEMENT

AW developed the instrument and provided ideas for related research. AS helped complete research and compile articles.

REFERENCES

A. Kamaruddin, S. (2012). Character education and students social behavior. *Journal of Education and Learning (EduLearn)*, *6*(4), 223.

Abdullah, N. I., Tarmizi, R. A., & Abu, R. (2010). The effects of problem based learning on mathematics performance and affective attributes in learning statistics at form four secondary level. *Procedia - Social and Behavioral Sciences*, *8*(5), 370–376.

Ahamad, S. N. S. H., Li, H. C., Shahrill, M., & Prahmana, R. C. I. (2018). Implementation of problem-based learning in geometry lessons. *Journal of Physics: Conference Series*, *943*(1).

Ari, A. A., & Katrancı, Y. (2014). The opinions of primary mathematics student-teachers on problem-based learning method. *Procedia - Social and Behavioral Sciences*, *116*(5), 1826–1831.

Cristea, A. (2016). No 主観的健康感を中心とした在宅高齢者における 健康関連指標に関する共分散構造分析title. *Revista Brasileira de Ergonomia*, *9*(2), 10.

Daulay, K. R., & Ruhaimah, I. (2019). Polya theory to improve problem-solving skills. *Journal of Physics: Conference Series*, *1188*(1).

Davidson, N., & Major, C. H. (2014). Boundary crossings: Cooperative learning, collaborative learning, and problem-based learning. *Journal on Excellence in College Teaching*, *25*(3&4), 7–55.

Häkkinen, P., Järvelä, S., Mäkitalo-Siegl, K., Ahonen, A., Näykki, P., & Valtonen, T. (2017). Preparing teacher-students for twenty-first-century learning practices (PREP 21): A framework for enhancing collaborative problem-solving and strategic learning skills. *Teachers and Teaching: Theory and Practice*, *23*(1), 25–41.

Hendriana, H., Johanto, T., & Sumarmo, U. (2018). The role of problem-based learning to improve students' mathematical problem-solving ability and self confidence. *Journal on Mathematics Education*, *9*(2), 291–299.

Huda, W. N., & Suyitno, H. (2017). Analysis of mathematical problem solving abilities in terms of students' motivation and learning styles. *Journal of Primary Education*, *6*(3), 209–217.

Hudha, A. M., Ekowati, D. W., & Husamah. (2014). Character education model in mathematics and natural sciences learning at Muhammadiyah Junior High School. *International Journal of Education, Learning & Development*, *2*(4), 33–47. Retrieved from www.eajournals.org

Ihsan, rudi susilana dan heli. (2014). Pendekatan saintifik dalam implementasi kurikulum 2013 berdasarkan kajian teori psikologi belajar. *Edutech*, *1*(2), 13.

Irfan, M. (2016). Role of learning mathematics in the character building. *International Conference On Education*, (Education in the 21th Century), 599–604.

Karatas, I., & Baki, A. (2013). The effect of learning environments based on problem solving on students' achievements of problem solving. *International Electronic Journal of Elementary Education*, *5*(3), 249–267.

Nurkaeti, N. (2018). Polya's strategy: An analysis of mathematical problem solving difficulty in 5th grade elementary school. *EduHumaniora | Jurnal Pendidikan Dasar Kampus Cibiru*, *10*(2), 140.

Putra, L. I. A., & Suparman. (2020). Design of student worksheet according to PBL learning model to improve problem-solving skills. *International Journal of Scientific and Technology Research*, *9*(3), 4967–4973.

Ramadhani, R. (2018). The enhancement of mathematical problem solving ability and self-confidence of students through problem based learning. *Jurnal Riset Pendidikan Matematika*, *5*(1), 127.

Rhosalia, L. A. (2017). Pendekatan saintifik (scientific approach) dalam pembelajaran tematik terpadu kurikulum 2013 versi 2016. *JTIEE (Journal of Teaching in Elementary Education)*, *1*(1), 59.

Savary, J. . (2006). Overview of problem-based learning : Devinition and distinction interdisciplinary. *Journal Problem-Based Learning*, *1*(1), 9–20. Retrieved from

Servant-Miklos, V. F. C. (2019). The harvard connection: How the case method spawned problem-based learning at Mcmaster University. *Health Professions Education*, *5*(3), 163–171.

Sipayung, T. N., & Anzelina, D. (2019). An analysis of students problem solving skills using a realistic mathematics approach on integers materials. *Journal of Physics: Conference Series*, *1211*(1).

Sukestiyarno, Y. L., Cahyono, A. N., & Pradnya, I. N. (2019). Integrating character education in mathematics learning in Indonesia and Denmark. *Journal of Physics: Conference Series*, *1321*(3).

Surya, E., Putri, F. A., & Mukhtar. (2017). Improving mathematical problem-solving ability and self-confidence of high school students through contextual learning model. *Journal on Mathematics Education*, *8*(1), 85–94.

Ulandari, L., Amry, Z., & Saragih, S. (2019). Development of learning materials based on realistic mathematics education approach to improve students' mathematical problem solving ability and self-efficacy. *International Electronic Journal of Mathematics Education*, *14*(2), 331–340.

Winarti, E. R., Waluya, S. B., Rochmad, & Kartono. (2019). The impact of problem based learning using performance assessment on student's mathematical problem solving ability. *Journal of Physics: Conference Series*, *1321*(3).