23 (2), 2022, 832-841

Jurnal Pendidikan MIPA

e-ISSN: 2550-1313 | p-ISSN: 2087-9849

http://jurnal.fkip.unila.ac.id/index.php/jpmipa/

Empowering Higher Order Mathematical Thinking Skills with the e-PINTER Model in Blended Learning

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Abstract: This study aims to determine whether the e-PINTER mathematics learning model can improve students' higher-order thinking skills in blended learning settings. The population of this study was all seventh-grade students of Junior High School (SMP) in Purworejo Regency. The research design used a one-group pre-test and post-test design to determine the improvement of higher-order thinking skills. The sampling technique used was stratified cluster random sampling, so that the students of SMP 5 Purworejo, SMP N 11 Purwoprejo, and SMP N 23 Purworejo were obtained as research samples. The data analysis technique used paired t-tests. The results showed that the application of the e-PINTER mathematics learning model could improve students' higher-order thinking skills in blended learning settings. The results of the study have a significant effect on learning mathematics so the empowerment of students' higher-order thinking skills in mathematics should be the center of attention for learning mathematics as a whole.

Keywords: e-PINTER learning model, blended learning, higher-order thinking skills.

Abstrak: *Penelitian ini bertujuan untuk mengetahui apakah model pembelajaran matematika e-PINTER dapat meningkatkan kemampuan berpikir tingkat tinggi siswa pada setting blended learning. Populasi penelitian ini adalah seluruh siswa kelas VII Sekolah Menengah Pertama (SMP) di Kabupaten Purworejo. Desain penelitian menggunakan one group pre-test dan post-test design untuk mengetahui peningkatan kemampuan berpikir tingkat tinggi. Teknik pengambilan sampel yang digunakan adalah stratified cluster random sampling, sehingga diperoleh siswa SMP 5 Purworejo, SMP N 11 Purwprejo, dan SMP N 23 Purworejo sebagai sampel penelitian. Teknik analisis data menggunakan uji-t berpasangan. Hasil penelitian menunjukkan bahwa penerapan model pembelajaran matematika e-PINTER dapat meningkatkan kemampuan berpikir tingkat tinggi siswa pada setting blended learning. Hasil penelitian berpengaruh signifikan terhadap pembelajaran matematika sehingga pemberdayaan kemampuan berpikir tingkat tinggi siswa dalam matematika harus menjadi pusat perhatian pembelajaran matematika secara keseluruhan.*

Kata kunci: *model e-PINTER, blended learning, keterampilan berpikir tingkat tinggi.*

▪ INTRODUCTION

Higher-order thinking (HOT) is the highest level of cognitive processing (Yee, et al, 2015). Developing higher-order thinking skills that require complex cognitive processes is a high priority in learning (Resnick, 1987), especially in mathematics. Several studies on education have stated that higher-order thinking an important indicator and predictor of success, both in academia and in the workplace (Resnick, 1987; Schoenfeld, 1999; Zohar & Dori, 2003). Higher-ordering skills are an important aspect of teaching and learning (Yee et al. 2014). HOTS allows students to overcome the increasing challenges of this information age, but the time to process them is very limited (Phillips, 2004). Judging from the things above, as a result, the application of

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DOI: http://dx.doi.org/10.23960/jpmipa/v23i2.pp832-841
Received: 28 April 2022
Accepted: 03 July 2022
Published: 14 July 2022

the knowledge that students have learned in various problem solving situations in everyday life can cause problems for graduates who are less skilled and less capable of higher-order thinking (Philips, 2004). , Graham & McKenzie, 1995).

The basic skills involved with higher-order thinking include analogical reasoning and logical thinking (Grossen, 1991). Higher-order thinking poses a challenge to analyze or manipulatemanipulatingon into other forms (Mohamed, 2006, Ea et al., 2005). PANAS is seen as concept formation, connecting between concepts, getting the big picture, visualizing problem solving, testing questions, generalizing ideas, critical thinking, practical thinking, and creative thinking (Goethal, 2013). Higher-order cognitive skills include conceptualization, analysis, and evaluation, and involve regular-level reasoning which contains productive thinking, reasoning, and reproduction of previously learned thinking (Papp, et al, 2014). HOT also involves cognitive skills from critical and evaluative thinking, decision making to problem-solving, and transfer of knowledge into other situations (Bramwell-Lalor & Rainford, 2014). Higher-order thinking is put forward on the concept that some forms of learning require greater cognitive processing and indirectly require various forms of learning beyond memorization, fa, cts and, concepts (Cook & Decary, 2019). Higher-order thinking is relational reasoning in which several representations are linked together, through inference, comparison, abstraction, and hierarchy (Frausel, et. Al, 2020). Based on the opinion of the experts above, the definition of higher-order thinking skills in this study is a person's skill to interpret or represent mathematical problems through various mathematical thinking skills.

The case in Indonesia regarding high-level skills shows a worrying condition, especially seen from the rints of the PISA survey. The Indonesian Center for Educational Assessment (2019) states that PISA assesses not only students' ability to restate their knowledge but also how well students can expand their analysis based on their knowledge and apply this knowledge in unusual situations, in inside outside. from school. This subject in the opinion of the researcher can be categorized as high-level thinking because it fulfills the elements of the analysis of the knowledge obtained to be represented in new situations for simplification or generalization. The Indonesian Ministry of Education and Culture (2019) reports that the PISA results show an average math score of 379 with an OECD average score of 487 (www.kemdikbud.go.id). Indonesian PISA respondents represent 3.7 million students in grades 7-12 aged 15 years, representing 85% of the total population aged 15 years and 15 years (www.cepatdata.kemdikbud.go.id).

Another study also stated that students seem to have difficulty in extending their thinking skills to a higher or higher-order when they proceed to secondary school (Bramwell-Lalor & Rainford, 2014). International assessments among secondary school students also show that students lack HOT skills in science (Saido, Siraj, DeWitt, & Al-Amedy, 2018) and mathematics. Fostering students' higher-order thinking skills is considered an important educational goal (Zohar & Dori, 2003). Thus, it can be said that HOT is one of the educational issues that are currently a curriculum challenge in all countries (globally).

Along with the COVID-19 pandemic, the empowerment of higher-order thinking skills is increasingly providing a fairly serious challenge. The impact of the pandemic has resulted in the closure of access to face-to-face education and gradually requires

learning to be held with limited face-to-face meetings. This condition forces all education actors (teachers, students, parents, and the community) to adapt to changes in learning habits that must be adapted to existing conditions. One suitable learning model is to apply blended learning. In practice, Blended Learning is carried out by combining face-to-face with distance learning activities facilitated by internet-based information technology. The material is distributed by the teacher to the Learning Management System (LMS) such as google classroom, Edmodo, or Schoology to be studied independently by students at home (anywhere). Furthermore, material, material enrichment, assignments, problem-solving activities, and discussions are carried out face-to-face.

Theoretically, the implementation of blended learning can optimize students' abilities and learning outcomes. However, the unpreparedness of teachers, students, parents, and the community can present challenges. Therefore, it is necessary to develop a practical learning model used by teachers to be applied in the classroom. In this study, the e-PINTER learning model was applied to see its impact on empowering students' higher-order thinking skills. The e-PINTER Learning Model is named based on its learning syntax abbreviation, namely: Presentation to real life, Investigation, Team activities, Elaboration & Explanation, and Reinforcement. While the terminology "e" is associated with learning that utilizes internet information technology.

A good learning model must of course be adaptive to the demands of the times. In the pandemic era where learning is done online, it presents its own challenges in packaging learning. The e-PINTER mathematics learning model in this study was applied to learning in the pandemic era by implementing the PINTER syntax in an orderly manner. e-PINTER is a mathematical learning model developed from the PINTER model. the difference is that PINTER is applied to conventional face-to-face classes while e-PINTER is applied to blended learning. The PINTER mathematical learning model was developed through the synthesis of cognitive learning theory and relevant research results related to the development of higher order thinking where the name of the model is taken from the learning syntax acronym, the learning syntax of the PINTER model has been specifically designed for the achievement of higher order thinking skills (Kurniawan, et al, 2021)

Optimization of learning activities is carried out using the help of zoom meetings, google meet, or Whatsapp Video Calls via Messenger Room. The learning tools used by the teacher are open ended student worksheet. open-ended student worksheet containing open math problems given to students, both in class and independent learning outside the classroom (home). Under certain conditions, synchronous face-to-face learning can be carried out, either in the form of teleconferences or limited face-to-face meetings in the classroom according to local conditions. The open-ended student worksheet is specifically designed to improve students' thinking skills, both individually and in class discussions (online and offline).

Figure 1. e-PINTER learning model

The concept of learning activities with the PINTER mathematics learning model is carried out with the teacher presenting face-to-face learning (synchronous learning) using zoom meetings, google meet, or Whatsapp Video Calls via Messenger Room. The teacher makes presentations using videos or presentations with Ms. Powerpoint and other applications, teachers also use Learning Activity Sheets to strengthen their understanding of material concepts. The teacher gives assignments by giving or sharing Open-ended student worksheets to students through the Whatsapp Group, Google Classroom, Edmodo, or Schoology applications. Students work on the assignments given and send the results of the work to the teacher through the previously used application. Each student is required to comment on the work submitted by other students so that a discussion process occurs between students. In this discussion activity, the teacher acts as a facilitator and moderator so that the discussion is more focused and does not seem to just blame the work of his friends.

The teacher provides a conclusion by showing a variety of alternative problem solving that may be used to answer the given problem. Various alternative solutions to these problems can be displayed by the teacher in a presentation using Ms. Powerpoint, Windows Journal, Ms. OneNote, and more. The implementation of the e-PINTER mathematics learning model above can theoretically be implemented and applied using various learning application platforms that are already available. However, the teacher also needs to make a kind of virtual screen board that can be scribbled on so that students understand how to solve the problem as if the problem was done on the blackboard in a real class.

Table 1. The sintax of e-PINTER learning models

Syntax	Activity
Presentation to real-world situation	a. Self-study at home b. Students review the material through files distributed by the teacher c. Studying videos related to the context of the material in everyday life d. Students take comprehension notes for class confirmation and elaboration
Investigation	a. Confirmation and elaboration of material understanding with teacher

	facilitation b. Strengthening problem understanding through the provision of open-ended student worksheets c. Conduct guided discoveries with various models of problem-solving strategies, including: concrete-Pictorial-Abstract strategies, Problem Solving, Problem Based Learning, and others d. Spontaneous exploration e. Students make formal generalizations f. Making conclusions through communicating findings to others
Teams Activities	a. Group formation (4 - 5 students) b. Preparation of worksheets containing open problems c. Cooperative learning through brainstorming among group members using the methods: Reason, Reveal, Write, and Share d. Confirmation through class discussion
Elaboration and Explanation	a. Give new problems individually b. Discussion and sharing between students in pairs c. Present the answers in front of the class
Reinforcement	a. Feedback and reflection through Q&A b. Making conclusions c. Making connections with the next material d. Giving assignments through project-based learning independently or in groups at home e. Studying advanced material at home

▪ METHOD

This research is a quasi-experimental research with a one-group pre-test and post-test design and content analysis. One-group pre-test and post-test designs were used to determine whether there was an increase in students' higher-order thinking skills after learning using the e-PINTER mathematics learning model compared to before using the learning model. This improvement was measured using pre-test and post-test. Internal validity in this design is ensured by observing the test procedures. Testing is done by giving different questions on the pre-test and post-test. However, both tests refer to the same indicators for achieving higher-order mathematical thinking. data collection was carried out within 2 months by implementing learning with the e-PINTER model in 6 meetings. The pre-test was given learning from the first meeting and the post-test was carried out at the end of the meeting using different test instruments. The data from the pre-test and post-test were then tested to compare the effects of e-PINTER before and after treatment on the research sample.

The population of this study was all seventh-grade students of SMP in Purworejo Regency. The sampling technique used is stratified cluster random sampling, namely by grouping schools into three categories: high, medium, and low achieving schools. Based on the grouping results, the samples were SMP 5 Purworejo (representing the high school category), SMP 11 Purworejo (representing the medium school category), and SMP 23 Purworejo (representing the low school category). at each grade level in each school were taken randomly to obtain class VII-A at SMP N 5, VII-C at SMP N 11, and grade VII-B at SMP N 23. The average research sample aged 12-14 years consisted of 36 male students and 55 female students, with a total research sample of 91 students.

The instruments used in this study were tests. The test was used in the pre-test and post-test activities to see whether there was an increase in higher-order thinking skills after and before learning with the E-PINTER mathematics learning model. The test consists of 20 multiple choice questions (4 answer choices) and 5 essay questions. Many items are adapted to the availability of an 80 minute test time. The instrument analysis test that has been carried out is in the form of a content validity test through the assessment of 3 experts and a reliability test. The results of the content validity assessment indicate that the research instrument has been declared valid by the three experts. Multiple choice test reliability test on pre-test and post-test using the KR-21 formula, the results obtained r11=0.823 and r11=0.879. Essay test reliability test on pre-test and post-test using the Alpha formula, the results obtained r11=0.924 and r11=0.899.

Analysis of the improvement of higher-order thinking skills using paired sample t-test. The test uses a significance level of = 5% with H0 = There is no increase in higher-order thinking skills before and after learning with the e-PINTER mathematics learning model with Blended Learning settings.

▪ RESULT AND DISSCUSSION

Data was collected on the research sample by applying the e-PINTER mathematics learning model for 6 meetings. During learning, non-routine problems are given in various contexts. It aims to make students familiar with problem-solving activities by using various appropriate problem-solving strategies. In the elaboration step, students can use problem-solving strategies that are considered the easiest in solving new problems. At each meeting, the difficulty of the questions continued to increase. This is intended so that students are always motivated to use the full potential of their thinking abilities. Optimization of thinking skills and other learning measures contribute to the achievement of higher-order mathematical thinking skills. The summary of the results of the pre-test and post-test can be seen in Table 2.

Table 2. Summary pre-test and post-test result

	Higher-order thinking's Score				
	n	$\bar{X}$	***Std-dev***	***Score Max***	***Score Min***
Pre-test	91	40.64	15.71	73	10
Post-test	91	79,65	15.19	93	20

The results of the analysis of the results of the pre-test and post-test with a paired sample t-test with a significance level of = 5%, the result is that tobs = 27.653 > 1.987 = t tab. Thus H0 is rejected. So it can be concluded that the application of the E-PINTER mathematics learning model can improve students' higher-order thinking skills. The summary of the t-test can be seen in Table 3.

Table 2. Summary of the improvement of t-test pre-test and post-test

n	$\bar{D}$	***Std-dev***	t_{obs}	t_{tab}	**decision**
91	25.319	8.734	27,653	1,987	Rejected H_0

This study shows that the E-PINTER learning model can improve higher-order mathematical thinking skills, namely this learning model can be applied in the classroom. The increase in higher-order thinking skills is indicated by the results of statistical tests and the results of observations that have been made during learning. The mean score of pre-test (40.64) and post-test (79.65) also experienced a significant increase. The results of observations also show that students have raised higher-order thinking characteristics which include: linking various concepts, generating analytical thinking, reasoning, critical thinking, creative thinking, and presenting answers in fairly long descriptions.

The results of observation and testing also show the emergence of various non-standard procedures to solve problems, this is one of the keys to the success of the E-PINTER learning model in building higher-order thinking skills. Various learning procedures applied have encouraged students to optimize their cognitive abilities. starting with understanding contextual problems, solving problems by conducting investigations, various ideas in discussion activities, habituation with elaboration activities, until there is an increase so that the learning experience can be recorded in the long term of students.

Learning that leads to the achievement of higher-order thinking skills should be used as a habit. In E-PINTER learning, students who are accustomed to connecting all material concepts so that they can be applied in problem solving have a positive impact on students' better thinking skills. This is in line with the results of research which states that students who are taught how to develop creative insight to solve problems are more suitable for solving more complex problems than those who are not (Rajendran & Idris, 2008).

Students' investigative activities through spontaneous exploration activities and making generalizations encourage students to use their ability to think authentically from within. Investigating Mathematics develops students' mathematical thinking processes and good mental habits (Bastow. et. al. 1984) deepens students' understanding of mathematical content and challenges them to "generate" their mathematics within their universe of knowledge (Ronda, 2005).

Student discussions in small groups and class discussions encourage students to get used to expressing their ideas and opinions, but on the other hand students will also get used to following and giving an assessment of what other students say. Both independent thinking activities and assessing other students' ideas that are carried out together will be able to improve students' thinking skills. Higher-order thinking skills can be improved through activities that require students to do deductive and inductive thinking simultaneously (Zhou. et. al, 2010). Through the practice of deductive and inductive thinking students become accustomed to analyzing, evaluating, and creating arguments by relying on reliable theoretical truths and testing whether theoretical arguments are supported by strong empirical evidence.

Finally, it can be said that learning that leads to higher-order thinking skills is a matter of getting used to. Not only based on students' academic abilities. Students' higher-order thinking abilities are not only determined by academic ability factors but are also influenced by the length of study given by students (Prayitno, Suciati, & Titikusumawati, 2018). Therefore, the teacher must integrate all learning activities towards the achievement of higher-order thinking and outline in the lesson plan. The

results of this study open up opportunities for other researchers to apply the e-PINTER mathematical model to the achievement of other thinking skills, such as mathematical communication, strengthening concept understanding, combinatoric thinking, and others. Other researchers can also apply this model to other materials, besides algebra as chosen in this study.

▪ CONCLUSION

Based on the results of the analysis above, both the analysis of the results of the comparison of pre-test and post-test as well as content analysis of student work, it can be said that students experienced a high level of improvement. thinking skills in mathematics. It is undeniable that the increase in skills is caused by the application of the e-PINTER mathematics learning model. This increase is very visible in the work of students who have been able to solve the questions that have been compiled and can only be solved with advanced thinking skills. The completion procedures used by the students who were observed, both during the learning process and the results of the post-test, showed various solving strategies. This is a sign that higher-order thinking skills have emerged in students.

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