

An Instructional Design to Improve Students' Higher Order Thinking Skills in Linear Programming

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Abstract. The purpose of this study is to provide an instructional design for improving students' Higher Order Thinking Skills (HOTS) in linear programming. The method used in writing this article is the literature review method consisting of books and articles. The results showed that the development of an instructional design through the Model Eliciting Activities (MEAs) approach was effective in increasing student HOTS in mathematics learning. MEAs guide students to mathematically model based on context or real problems, break them down into separate parts, then understand the relationships between these parts, and interpret the results of student construction.

Keyword: Higher Order Thinking Skills (HOTS), Linear Programming, Model Eliciting Activities (MEAs).

Abstrak. Tujuan dari penelitian ini adalah memberikan desain pembelajaran untuk meningkatkan Higher Order Thinking Skills (HOTS) siswa dalam program linier. Metode yang digunakan dalam penulisan artikel ini adalah metode literature review yang terdiri dari buku dan artikel. Hasil penelitian menunjukkan bahwa pengembangan desain pembelajaran melalui pendekatan Model Eliciting Activities (MEAs) efektif dalam meningkatkan HOTS siswa pada program linier dengan kegiatan pembelajaran yang menitikberatkan pada aktivitas siswa untuk memecahkan masalah pada dunia nyata dengan menggunakan prosedur matematika ketika membuat model matematika. MEAs membimbing siswa untuk membuat model matematis berdasarkan konteks atau masalah nyata, memecahnya menjadi bagian-bagian yang terpisah, kemudian memahami hubungan antara bagian-bagian tersebut, dan menginterpretasikan hasil konstruksi siswa.

Kata Kunci: Higher Order Thinking Skills (HOTS), Program Linear, Model Eliciting Activities (MEAs).

INTRODUCTION

Improving the quality of education in Indonesia is one of the fundamental demands and is always being rolled out in the field of education. Knowledge, skills, and attitudes, as well as mastery of Information and Communication Technology (ICT), are all part of education in the twenty-first century. Education in 21st century is more about directing students to take an active role in learning, learning is student center, so the teacher is a learning facilitator. The Government continues to develop and expects students to achieve various competencies by implementing Higher Order Thinking Skills (HOTS).

According to Dinni (2018) Higher Level When students are engaged with what they know in a way that allows them to modify it, they are able to transform or create the information they have and produce something new. It can be said that Higher Order Thinking can be done when a person tries to associate new information in memory that has been stored and linked by rearranging and developing information in order to find solutions to difficult problems to solve. In learning mathematics, creativity, communication, problem-solving, and mathematical thinking are just a few of the Higher Order Thinking skills (Tambunan, 2018).

Higher order thinking requires a person to apply new information or knowledge that he has acquired and manipulate information to reach possible answers in new situations. In line with this, Hanik et al. (2020) also said that

HOTS is oriented towards critical and creative thinking skills. This ability is one of the abilities that students must have in the skill dimension. The integration of critical and creative thinking follows the policy direction of the Ministry of Education and Culture in 2018, HOTS has been integrated in addition to Strengthening Character Education.

A linear program is a way of achieving the optimal result (such as maximum profit or lowest cost) by utilizing a mathematical model to complete it. Students must demonstrate basic competency in linear program subjects by being able to answer contextual problems relating to linear programs. Students' ability to tackle difficulties from everyday life, such as linear program problems, is rather low. This suggests that students are having trouble applying mathematical concepts to real-world challenges. The results of research Ogan & George (2015) states that students have difficulty in constructing the mathematical meaning of symbols in linear programs.

The ability to solve difficulties has become increasingly important as the era has progressed. Because problems in linear programs are relevant to daily life, it is critical to developing a learning strategy that may improve students' problem-solving abilities while also engaging them in the learning process. One of the learning models that develop critical thinking is the Model Eliciting Activities (MEAs) approach. The Model-Eliciting Activities (MEAs) approach to mathematics learning is an alternative approach to improve students' critical and creative mathematical thinking skills so that

they continue to be well trained (Istianah, 2013).

MEAs are one of the suggested mathematics instructional strategies for teachers (Irvine et al., 2016). Learning uses the MEAs approach based on the context in life so that it becomes a mathematical model that is used as a solution to its solution. MEAs guide students to mathematically model based on context or real problems, break them down into separate parts, then understand the relationships between these sections, and interpret the results of student construction. Based on the results of research, Handajani et al. (2018) suggest the use of MEAs in a linear program because students feel not bored, can be actively involved and work together and students are more daring to express their thoughts.

METHOD

The literature review method was used to write this paper. The literature used is made up of books and articles about the topic at hand. The writing of this article began by searching for international and national articles through Science Direct and Google Scholar. The topics that are the focus of the search are Higher Order Thinking Skills (HOTS), an instructional design, and Model Eliciting Activities (MEAs). This article also uses sources from books that support the study of this article by complementing the information from existing articles.

RESULT AND DISCUSSION

Higher order thinking skills are closely related to skills thinking in accordance with the cognitive, affective, and psychomotor domains that become a unity in the learning and teaching process (Ariyana et al., 2018). In the cognitive, according to Atikah et al. (2018) high-order thinking skills are the ability to connect, manipulate and transform existing knowledge and experiences to think critically and creatively in an effort to make decisions and solve problems in new situations. As discussed in the learning oriented for higher order thinking skills, the description of aspects of higher order thinking skills as follows:

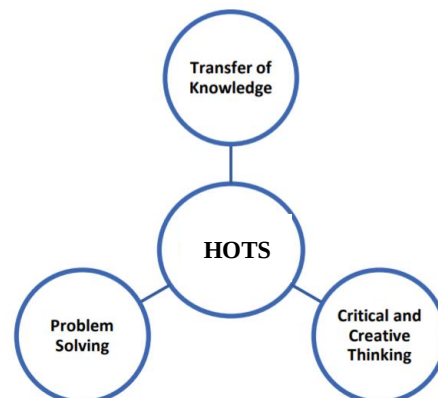


Figure 1. Aspects of higher order thinking skills (Ariyana et al., 2018, p.5)

Based on the picture above, it can be seen that in higher order thinking skills, students are expected not only to have problem-solving abilities, but in practice students also need to have abilities to think critically and creatively. If students have the ability to think creatively and critically, then students will be able to develop themselves in making decisions, assessing and solving problems appropriately. Higher order thinking skills as problem solving are needed in the

learning process, because learning designed with a high-level skill-oriented learning approach cannot be separated from problem solving, a combination of cognitive skills and creativity skills.

The measurement of higher order thinking skills of students can be seen by increasing it to be used as a benchmark for teachers in choosing a problem, if a problem is a good quality and be able to run well, there will also be a balance with the achievement of learning objectives and good learning achievement as well as significant changes for students. For the necessary to have a taxonomy or grouping of things based on a certain hierarchy (level) so that it can be used to measure the skill level of students in this case using Bloom's taxonomy.

HOTS include critical, logical, reflective, metacognitive, and creative thinking (Dinni, 2018). These skills are also used to underline high-level processes according to Bloom's taxonomic ladder. The thinking skills according to Bloom's Taxonomy, knowledge and comprehension are included in the LOT category, while those included in HOT are analysis, synthesis, and evaluation thinking skills, while applications are often in both categories (Thompson, 2008). Based on this statement, it can be concluded that the stages of thinking, Knowledge (C1), and understanding (C2) are included in the LOT category, while the stages of thinking analysis (C4), synthesis (C5), and evaluation (C6) are included in the HOT category. Meanwhile the application thinking stage (C3) falls between the two categories. HOTS are treated

similarly in revised Bloom's Taxonomy by Anderson and Krathwohl. They classifies HOTS, as well as the sublevels in Analyze (differentiating, organizing, attributing), Evaluate (checking, critiquing), and Create (generating, planning, producing) (Irvine et al., 2016).

Many learning systems are based on creative and critical thinking in the learning process by paying attention to students' HOTS. To improve students' Higher-Level Thinking Ability and help students to construct the knowledge they get, the teacher is required to choose an appropriate learning strategy. The choice of learning strategy is one of the important things that must be understood by every teacher because learning is an interaction not only between students but also between students and teachers. The strategy used can be determined by the teacher himself, by paying attention to the material to be delivered on the lesson that day, also seeing the state of the classroom environment and whether using these learning strategies is appropriate if applied to students.

According to Saido et al. (2013) in improving students' higher order thinking skills, a strategy is needed, namely through problem solving activities. MEAs approach is a learning strategy that focuses on student actions in order to get solutions to real-world problems through the use of mathematical techniques to create a mathematical model. Based on the results of their research, Akhmad & Masriyah (2014) reported that the Model Eliciting Activities (MEAs) approach met the criteria of effectiveness when teachers

managed learning, in learning activities, and student responses, as well as learning outcomes.

MEAs are cooperative activities in which students tackle highly realistic and authentic mathematics problems (Coxbill et al., 2013). They are attempting to develop a mathematical model that is both generalizable and reusable. A mathematical condition must be deciphered by students.

According to Chamberlin, MEAs implemented in several steps. The first is the teacher reads articles or news in real life for students. Then, the teacher creates a mathematical question. Next, students answer these questions to determine whether students answer the problem. After students understand the problem, students to create a problem solving model. Then students look for solutions to problem solving and present their models in front of the class (Aziz & Irwan, 2020)

Based on the six principles in designing MEAs, it needs to be emphasized that the activities carried out focus on creative mathematics and involve students in the process of developing their creativity. MEAs approach effectively improves students' ability to solve math problems compared to conventional learning. Similar research is also confirmed by (Handajani et al., 2018) verified that there are differences in the effect of MEAs that integrate 4C skills and traditional learning on learning outcomes. This is because MEAs that combine skills can boost creativity, communication, teamwork, and problem-

solving abilities. Therefore, with the application of the Model Eliciting Activities (MEAs) approach it will involve students in non-routine problem solving in linear programming and develop students' creative mathematics, critical thinking skills, which are aspects of higher order thinking skills, and student activeness so that they become quite effective alternatives in managing the classroom by the teacher.

CONCLUSION

High level thinking or HOTS is a thought process that has a high level of hierarchy in managing cognitive abilities in various aspects of the transfer of knowledge, problem solving, critical and creative thinking. There are some of the efforts that should be made to increase students' HOTS in learning mathematics: (1) Students are invited to be actively involved in non-routine activities in solving problems; (2) provide facilities to students to develop critical thinking (analysis and evaluation) and creative thinking (the ability to create); (3) stimulate students to construct their own knowledge becomes meaningful learning.

Model Eliciting Activities (MEAs) are a learning approach that focuses on student activities to obtain solutions from real problems given through the process of applying mathematical procedures to form a mathematical model. MEAs are an approach that provides solutions that can be applied by educators to improve creativity skills, communication skills, collaboration skills, and student problem solving skills that through the

application of the MEAs learning approach it is hoped that it can improve students' HOTS abilities. MEAs teach students how to break down context or real world problems into discrete parts, comprehend the connections between these elements, and interpret the results of student building.

REFERENCES

- Akhmad, G. P. A., & Masriyah. (2014). Efektivitas pembelajaran matematika dengan pendekatan Model-Eliciting Activities (MEAs) pada materi persamaan dan pertidaksamaan linear satu variabel di kelas VII-A SMP Negeri 1 Lamongan. *Jurnal Ilmiah Pendidikan Matematika*, 3(2), 97–102.
- Ariyana, Y., Ari Pudjiastuti MPd Reisky Bestary, M., & Zamroni, Mp. (2018). *BUKU PEGANGAN PEMBELAJARAN BERORIENTASI PADA KETERAMPILAN BERPIKIR TINGKAT TINGGI*.
- Atikah, N., Nisa, K., Widyastuti, R., & Hamid, A. (2018). Pengembangan Instrumen Assessment Higher Order Thinking Skill (HOTS) pada Lembar Kerja Peserta Didik Kelas VII SMP. *Prosiding Seminar Nasional Matematika Dan Pendidikan Matematika*, 543–556.
- Aziz, S. A., & Irwan, I. (2020). Validity of Mathematical Learning Material Based on Model Eliciting Activities (MEAS) Approach to Improve Mathematical Creative Thinking Skill of Students. *Journal of Physics: Conference Series*, 1554(1). <https://doi.org/10.1088/1742-6596/1554/1/012066>
- Coxbill, E., Chamberlin, S. A., & Weatherford, J. (2013). Using model-eliciting activities as a tool to identify and develop mathematically creative students. *Journal for the Education of the Gifted*, 36(2), 176–197. <https://doi.org/10.1177/0162353213480433>
- Dinni, H. N. (2018). HOTS (High Order Thinking Skills) dan Kaitannya dengan Kemampuan Literasi Matematika. *PRISMA, Prosiding Seminar Nasional Matematika*, 1, 170–176. <https://journal.unnes.ac.id/sju/index.php/prisma/>
- Handajani, S., Pratiwi, H., & Mardiyana, M. (2018). The 21st century skills with model eliciting activities on linear program. *Journal of Physics: Conference Series*, 1008(1). <https://doi.org/10.1088/1742-6596/1008/1/012059>
- Hanik, U., Mardiyana, I. I., & Rosid, A. (2020). Peningkatan Kompetensi Guru dalam Mengintegrasikan HOTS (Higher Order Thinking Skills) Pada Pembelajaran. *Jurnal Ilmiah Pangabdhi*, 6(1), 44–48.
- Irvine, J., Telford, W., Anusic, V., & Alves, P. (2016). A Straightforward Model Eliciting Activity and the Power of “What If?” in Supporting Students’ Higher-Order Thinking. *Journal of Mathematical Sciences*, 3(1), 7–22.

- Istianah, E. (2013). Meningkatkan kemampuan berpikir kritis dan kreatif matematik dengan pendekatan Model Eliciting Activities (MEAs) pada siswa SMA. *InfinityJ Urnal Ilmiah Program Studi Matematika STKIP Siliwangi Bandung*, 2(1).
- Ogan, G. C., & George, N. R. (2015). Investigating difficult concepts in senior secondary school mathematics curriculum as perceived by students. *International Journal of Academic Research and Reflection*, 3(6), 67–74. www.idpublications.org
- Saido, M. G., Siraj, S., Nordin, A. B. bin, & Al_Amedy, O. S. (2015). Higher Order Thinking Skills Among Secondary School Students in Science Learning. *The Malaysian Online Journal of Educational Science*, 3(3), 13–20. <http://www.raosoft.com/samplesize.html>
- Tambunan, H. (2018). Impact of Heuristic Strategy on Students' Mathematics Ability in High Order Thinking. *International Electronic Journal of Mathematics Education*, 13(3). <https://doi.org/10.12973/iejme/3928>
- Thompson, T. (2008). Mathematics teachers' interpretation of higher-order thinking in Bloom's taxonomy. *International Electronic Journal of Mathematics Education*, 3(2), 96–109. <http://www.iejme.com/022008/d2.pdf>