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# Higher-Order Thinking Skills Profile of Islamic Boarding School Students on Geometry through the STEM-based Video Approach

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**Abstract**

The Indonesia government has begun to focus and pay attention to the quality of education in Islamic Boarding School. Education is a provision for the future to create quality human resources. Education is strongly linked to the 21st century, where education has rapidly developed in science and technology to generate worldwide competitiveness. Students' higher-order thinking skills are fundamental, where this thinking ability is an ability to understand and find solutions to problems in varied and different ways. An appropriate learning approach must support Higher-order thinking skills. Higher-order thinking skills are intelligence with specific knowledge that leads to reasoning, analytical skills, problem-solving, and critical and creative thinking skills. Higher-order thinking skills are the major objective of educational institutions in implementing education that uses a quasi-experiment. Participants consisted of Islamic Boarding School students, ten male- and ten female students. A STEM-based video is a learning approach that can help students analyze, solve problems, investigate a phenomenon, create skills in students, and produce higher-order thinking skills. This study's STEM-based Video approach process is designed to solve functional mathematics problems in real life concerning geometry.

Keywords: Higher-order thinking skills, Islamic boarding school, STEM-based video approach

## INTRODUCTION

Islamic Boarding School is an Indonesian educational institution born for people who want to deepen their social sciences equipped with religious knowledge (Siregar, 2016). Islamic boarding schools have characteristics, visions, and missions distinctive in Indonesian society from an educational, cultural, political, or even economic perspective (Ida & Saud, 2020). At the beginning of the 20th century, Islamic Boarding School was an educational institution born due to a tug of war between traditional Islamic Boarding Schools with modern Dutch education and the desire and demands of the community their children acquire religious knowledge (Wekke, 2015). In its development, Islamic Boarding School is no longer seen as Islamic educational institution that focuses on religious sciences because it has undergone modernization to teach other general mathematics and sciences (Muhammad Rosyidi et al., 2020; Wekke & Hamid, 2013).

The Indonesian government has begun to focus on the quality of education in Islamic Boarding Schools. Education is a provision for the future to create quality human resources. Education is closely related to the 21st century, where education in the 21st century has

rapidly changed in science and technology to create international competition (Rubach & Lazarides, 2021; Yalçın & Erden, 2021).

Strategic factors, including laws and regulations, globalization demands, and technological advances, influence the 21st-century Indonesian education development dynamics. Thus, the strategies above influence education in Indonesia, including Islamic Boarding Schools. So that, to achieve the goals of Indonesian education, selective efforts are needed to achieve them. Students' superior competence is indispensable to compete in the 21st century, with learning experiencing a paradigm shift currently (Rubach & Lazarides, 2021; Yalçın & Erden, 2021). Learning activities are exchanging information or knowledge from educators to students (Cahyono et al., 2020). Still, students are required to take an active role in learning and use their cognitive abilities to higher-order thinking skills.

Higher-Order Thinking Skills (HOTS) are a person's high-level thinking skills (Wilson, 2020). HOTS are a person's skills in his cognitive domain by digging up new information linked to the story he previously had and processing it to solve a problem (Komara, 2019). The ability to think at a higher level makes a person or individual dig up new information linked to the information he has found and stored in his memory, which develops the knowledge to solve an existing problem. Higher-order thinking skills are closely related to thinking skills by the cognitive, affective, and psychomotor domains, which are integrated into the teaching and learning process (Gil-Glazer, 2019). The learning objectives in the mental aspect, according to the bloom level, are divided into two, namely Lower-Order Thinking Skills (LOTS) and Higher-Order Thinking Skills (HOTS) (Alrawili, 2020).

HOTS is a strategy for higher-order thinking in which students are encouraged to create information and ideas that give them understanding. The HOTS process motivated students to seek knowledge and curiosity independently by linking to the facts to solve problems. Through higher-order thinking skills, students can increase their thinking activities (Heong, 2020). HOTS is confirmed by another researcher, who can use HOTS to improve and maintain students' ability to solve problems (Jager, 2019; Pehlivan, 2020).

The following is an explanation of the taxonomic indicators of Bloom that are relevant in the cognitive dimension, according to Anderson and Krathwohl, as listed in Table 1.

Table 1. Cognitive Dimensions of HOTS

| No. | Indicator | Information |
|---|---|---|
| 1. | Analyze | This indicator asks students to break the material into several constituent parts and determine the relationship between these parts and the overall structure. And students can sort, construct, and complete. |
| 2. | Evaluate | This indicator asks students to re-examine or make decisions and criticize based on the criteria and standards. As well as students are capable of examining and criticizing. |
| 3. | Create | This indicator asks students to combine the information obtained to make their equivalent news to get the desired result. And students can formulate (create hypotheses), plan (design), and produce (contribute to creating a product). |

Students' higher-order thinking skills are fundamental, where this thinking ability is an ability to understand and find solutions to problems in varied and different ways. An appropriate learning approach must support Higher-order thinking skills. HOTS is intelligence with a specific set of knowledge that leads to reasoning, analytical skills, problem-solving, and critical and creative thinking skills (Israel-Fishelson & Hershkovitz, 2022; H.-C. Lin et al., 2021). Higher-order thinking skills are the primary goal of educational institutions to instill higher-order thinking skills in implementing education (Al-Hemiary et al., 2020; Hong et al., 2021).

Based on the above opinion, the dynamics of education development in the 21st century have strategic positions that can become certain factors and are interrelated for educational purposes in Indonesia. Also, along with the current educational paradigm change, it can create or produce students ready to compete in the 21st century by developing their higher-order thinking skills. Higher-order thinking skills students relate to solve and find solutions to a variety of problems (Hurwitz & Schmitt, 2020; Rosen et al., 2020). Higher-order thinking skills encourage students to think broadly and more deeply about the material they get (Araiza-Alba et al., 2021; Kong & Wang, 2021). So that these higher-order thinking skills become significantly relevant if applied to education today.

Based on the results of observations to several Islamic boarding schools in Banten, Indonesia, the facts found in the field are the need for various learning approaches to achieve learning objectives right on the target and sufficient to increase higher-order thinking skills. Students will be interested and stimulated to build higher-order thinking skills. It's just that this condition has not been maximized because the students' abilities are still in the Low Order Thinking Skills (LOTS) category. So that Higher-Order Thinking Skills (HOTS) still

needs to be improved and coupled with the demands of 21st-century education, students are obliged to develop their thinking skills actively.

The creation of students' higher-order thinking skills requires learning methods that lead to the same thing to achieve learning goals well. One of them uses the Science, Technology, Engineering, and Mathematics (STEM) approach in the learning process. This STEM approach can also be aligned with the demands of education in the 21st century (Abdurrahman, 2019; Phang, 2018). Simultaneously, applying the STEM approach in the mathematics learning process will foster student motivation in higher-order thinking skills (Rosidin, 2019; Yusuf, 2018). Students can create work concerning the application of mathematics learning.

The STEM approach is an approach that integrates four disciplines, namely science, technology, engineering, and mathematics, by focusing on the educational process in solving real problems in everyday life (Haryadi & Pujiastuti, 2020). STEM can form the mastery of knowledge, apply experience in solving problems, and motivate students to produce something new. Therefore, the STEM approach is suitable for the mathematics learning process to increase students' higher-order thinking skills.

Ideally, learning using the STEM approach builds students' thinking skills that are useful in improving higher-order thinking skills with the awareness to solve problems, make decisions, and analyze hypotheses, evaluation, and investigation. It can achieve the indicators of higher-order thinking skills where students must analyze, evaluate, and create according to the revised bloom taxonomy in the learning process. With the current revision of Bloom's taxonomy, it is relevant to the current demands of education. Higher-order thinking skills can be defined as cognitive skills at analyzing, evaluating, creating (Krathwohl, 2002).

The higher-Order Thinking Skills process is carried out elaborately based on students' material, such as analyzing, applying, evaluating critically, and creating a new product. Higher-order thinking skills can motivate students to have a scientific attitude balanced with learning using the STEM approach. Higher-order thinking skills can also analyze a problem that must be accompanied and maximized to create students ready to compete and compete at the international level (Saritepeci, 2019).

To ideally achieve the learning process by implementing STEM in increasing student higher-order thinking skills, it is necessary to have a solution that supports this. The answer to be taken and able to keep the learning process is with learning media in videos. Learning videos are a medium that has elements of audio and moving images, with Video serving as an introduction to information from teachers to students (H.-C. Lin et al., 2021; Schwarz et al.,

2021). With learning videos, the material is given in the form of a complete story (Chen, 2015; Es, 2008).

The learning STEM approach is a learning approach that emphasizes the four components of science, technology, engineering, and mathematics that create students to become experts in a field and are very important in today's education. In some countries, using the STEM learning approach during the learning process is one of the preparations for the 21st-century competition (LaForce et al., 2016; Mašková et al., 2022; Nguyen et al., 2021). So, it is necessary to apply the STEM approach to compete freely in the international realm so that students in Indonesia can compete freely.

Based on several experts' arguments, the Video is one of the supporting solutions in the effective learning process for students mastering learning concepts, especially in mathematics. Video as a learning medium can optimize learning both for collective class learning and learning that is done independently. It also positively influences teachers and students to be optimized with the media in these learning videos. By paying attention to the characteristics of a fair and effective learning video, it must contain clear content that can represent the meaning of each of the topics listed in the Video.

This research's novelty is applying STEM-Video to school students in Islamic Boarding Schools. STEM-based Video approach is a learning approach that can help students analyze, solve problems, create skills in students and produce higher-order thinking skills. Using the STEM-Video process is designed to solve functional mathematics problems in real life concerning geometry.

The purpose of the STEM-Video approach is to develop four STEM components that refer to individuals:

1. Science, behavior, and expertise in identifying problems and problems in life situations, explaining a matter in a natural and designed manner, and making conclusions based on STEM issues.
2. The existence of someone's interpretation of STEM disciplines' characteristics is like understanding, investigating, and designing STEM science.
3. Understanding the STEM disciplinary process adapts to the material, intellectual, and cultural environment.
4. A person's willingness to participate in STEM issues is also related to science, technology, engineering, and mathematics as a caring, constructive, and reflective human being.

## METHOD

The research was carried out using the STEM-Video learning approach on mathematics subject matter, namely, geometry, to determine the increase in the ability of higher-order thinking skills. The implementation of this research occurred during the Covid-19 pandemic. Even though it is still a Covid-19 pandemic, learning in Islamic boarding schools is carried out face-to-face. The Indonesian government only approves face-to-face learning only for Islamic Boarding School students. This research has also received approval from the Chairman of the Tebu Ireng 08 Foundation, Banten, Indonesia.

### Participants

In this study, 30 students were selected from representatives of Islamic Boarding School in Banten, Indonesia (15 males and 15 females; mean age: 17 years).

### Experimental design and procedures

The study was designed as a quasi-experiment with one group pre-and post-testing. The sampling method employed was sequential sampling, in which respondents were chosen based on predetermined criteria.

In this study, the first step taken was to give questions of higher-order thinking skills. The pretest was conducted to determine the students' initial higher-order thinking skills. After that, for six weeks, treatment was given using the STEM-Video learning model. Furthermore, students were given a posttest with the same questions during the pretest. The aim was to determine how far the students' higher-order thinking skills had increased after implementing the STEM-based Video approach.

### Research instruments

According to Bloom's taxonomy, the instrument used is a description of the geometry of higher-order thinking skills. The questions consist of 15 reports covering higher-order thinking skills, namely analyzing, evaluating, and creating. After collecting data from the pretest and posttest findings, we used the gain score formula (N-Gain) to determine higher-order thinking skills growth. The normalized gain score (N-Gain) offers an overview of improving students' higher-order thinking skills before and after treatment. Hake's formula is utilized. A normalized gain test (N-Gain) was carried out to determine whether students' cognitive learning outcomes improved after treatment. This increase was taken from the pretest and posttest scores obtained by students. Normalized gain, abbreviated as N-Gain, compares the actual score with the maximum gain score.

Theoretical validity is intended to consider an evaluation tool by the evaluator. The validation is carried out by several experts or people who are considered experts in the field.

Previously, the instruments of pretest and posttest questions to be tested had been validated by several experts based on sound judgment. The validation results by 3 (three) evaluators obtained seven items that were declared valid according to the HOTS question indicator.

To analyze the data with the instrument's reliability to see the device's coarseness or consistency. Reliability is a valuable instrument if the tool has a steady or consistent value. This study tried a test on a group of students by correlating the product-moment correlation technique, with the correlation results showing instrument reliability. Reliability is sourced from the test data for the question. Instruments that have been carried out until it is found that the results are obtained—forming the basis for selecting the appropriate question instruments to be used as measuring tools—testing the devices given to students who have received Sound Waves material. The instrument reliability value was 0.529.

**STEM-based video approach**

Applying the STEM-based Video approach, it is hoped that generations will emerge to find problems and overcome life problems using engineering technology and mathematics. The sequence of steps for learning the STEM model is as follows:

(1) Analyze; start by asking students higher-order thinking skills questions about their project or what they want to make about geometry? How will they design it?

(2) Stimulate; invite students to watch videos about geometry as an opportunity to make students curious and get their minds going.

(3) Experiment; Help students discover what similar products or solutions already exist and tell them how they can do better through video learning. (4) Visualize; After watching the video, students have the opportunity to brainstorm as many ideas as possible. At this stage, there is a collaborative process between fellow students. Through videos, students can open mind maps to be an excellent way to remember ideas about the project they are making.

(4) Project; invite students in groups to choose solutions and plan how to realize project geometry. Next, students consider their initial questions about project geometry and each student's different ideas from the video learning process. They are helping students by confirming student thinking and inviting students to put their ideas about project geometry on paper.

(5) Create; build a geometry project prototype using the plan the students just made. After watching a video about the concept of geometry, students are invited to be creative in geometry projects using their own hands. Through video learning, students find solutions to make geometry projects practically.

(6) Evaluate; ask students for feedback on what they would give themselves. Then offer suggestions or ask questions that will make them think. Provide opportunities for other students to review their project results to encourage in-depth thinking and collaboration. It is done to test how effective their creations are and record the results.

(7) Remedy; the final part of this stem-video lesson invites students to discuss how students can improve their ideas. Then, students have the opportunity to redesign their product, make amendments and build the next prototype. It can be done by watching the video repeatedly until they are satisfied with the result.

## RESULTS AND DISCUSSION

The following are the data obtained from the results of the study and then analyzed using the n-gain data processing technique (see Figure 1).

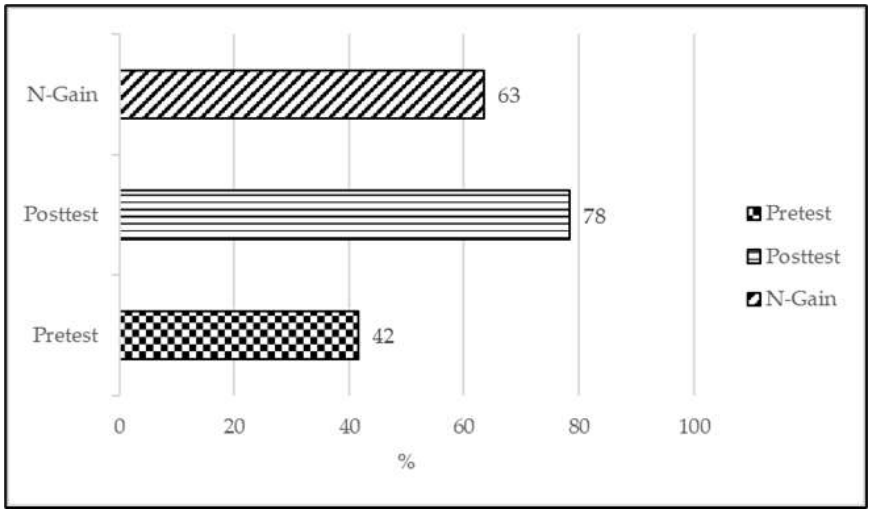


Figure 1. Results of higher-order thinking skills.

Figure 1 shows that the N-Gain for higher-order thinking skills is 63 percent, or 0.63. It demonstrates that children who receive direct learning therapy have a high level of thinking capacity. According to the N-Gain results, the STEM-based Video approach is constructive for boosting higher-order thinking skills. Throughout the learning process, educators have control over the content and breadth of learning materials, allowing educators to choose the extent to which students grasp the subject matter provided. In addition, the outcomes of each element of higher-order thinking skills (see Figure 2).

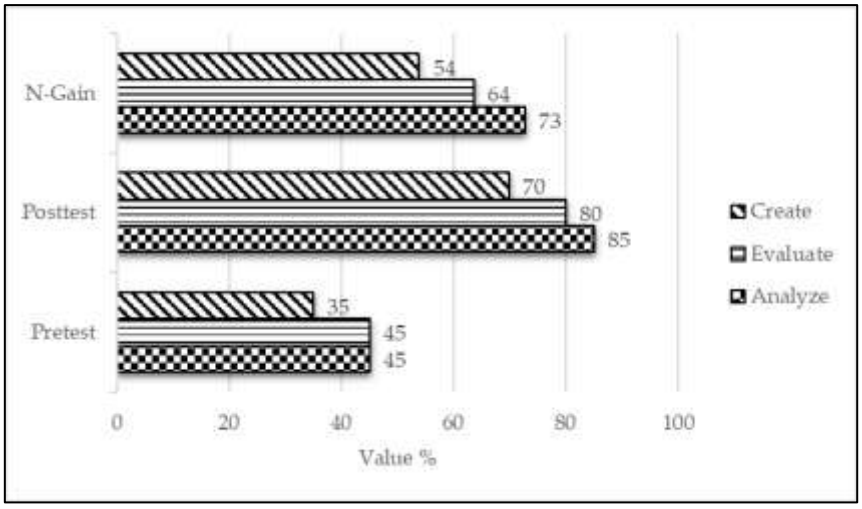


Figure 2. Results from each indicator of higher-order thinking skills.

Figure 2 shows how geometry learning through a STEM-based Video approach may increase students' higher-order thinking skills. Students increase from 45 percent to 85 percent throughout the analysis stage. The obtained N-gain is 73 percent, or 0.73. Based on the N-gain data, the observation aspect, including the high category, is 0.73. Analyze to the capacity to identify, separate, and distinguish components or aspects of a fact, concept, opinion, assumption, hypothesis, or conclusion, and then evaluate each component to discover whether there is a contradiction. The analysis focuses the description of the primary content into identifying the relationships of each item that is ordered methodically. Analyzing involves breaking down a substance into its constituent elements and detailing how these constituent parts connect or produce an overall structure or purpose. At this point, students can demonstrate the link between diverse ideas by comparing them to the standards, principles, or processes covered. Furthermore, pupils' capacity to evaluate has improved, allowing them to apply knowledge to new scenarios creatively. According to previous research findings, analytical ability is defined as a person's capacity to break down the material into pieces and connect those parts to clearly understand the content as a whole (Daher, 2020).

In addition, the evaluation results ranged from 45 to 80 percent. The obtained N-gain is 64%, or 0.64. These findings suggest that the capacity to conclude falls into the adequate group. Evaluating is described as the process of making choices based on predetermined criteria. The cognitive functions of assessing and critiquing judgments based on criteria are included in the evaluating category. In this context, evaluate ability is defined as a person's capacity to make the correct estimate or choice based on the criteria or knowledge that he possesses. At this level of evaluation, students can offer an assessment of the answers and

techniques utilized, critique the work processes, and re-test specific problems using STEM-video learning.

Then, at the create stage, it increases from 35% to 70%. The resulting N-gain is 54 percent, or 0.54. According to the N-gain results, the ability to produce is included in the adequate group. Students can generalize a concept or viewpoint on something, create a solution to a problem, and organize pieces or parts into a new structure that has never been before due to these outcomes. Students in the create stage can combine work stages into a new unit, develop ways of working, and are less able to locate or describe solutions in alternative formats for numerous problems. The capacity to mix materials to produce a unique structure is referred to as creative ability. Solving issues with more than one answer, devising a solution, and inventing something new are all examples of creative talent.

The STEM-based Video approach will assist Industry 4.0 by providing the 21st-century abilities required, especially higher-order thinking skills. Islamic boarding school students aseare trained to have higher-order thinking abilities to tackle the industrial revolution 4.0. STEM-Video is a new pedagogy designed to meet the requirements of students and improve their interest in science, technology, engineering, and mathematics. The STEM-based Video approach instructs educators to bundle learning with a learning strategy that students manage with instructor support. In this example, pupils gain comprehension through asking questions that pique their interests.

The STEM-based Video approach can assist students in independently creating information based on each student's ability. Teacher ability in data collection and analysis may be utilized to lead and examine the outcomes of project geometry studies in STEM-based Video approach activities, which can help students develop higher-order thinking skills. Students may focus on essential scientific topics by monitoring their surroundings while planning and working on geometrical projects using the STEM-based Video approach. Students can immediately learn about their surroundings by watching the films that have been given. Students gain hands-on experience by using Video as a learning resource, making learning more relevant and functional. The STEM-based Video approach makes it more difficult for pupils to build higher-order thinking abilities since videos allow students to improve their graphics when working on geometry assignments.

Students utilize technology to display the results of their efforts by posting them to social media sites such as YouTube. Students used their mobile cameras to film while working on the geometry assignment. Students can re-enact the process by watching the video. How students measure, monitor, and produce data is the mathematical idea employed

by students in this STEM-Video learning. Students construct a variety of geometric structures out of discarded cardboard. Students collecting and presenting data will be able to build student stimuli. Following that, students debate the best size for manufacturing. STEM-Video teaches and practices the essential skills and practices required for higher-order thinking skills.

The findings of a study onboarding school students who received therapy in the STEM-based Video approach revealed an improvement in learning outcomes in elements of higher-order thinking skills, as shown in Figures 1 and 2. The learning outcomes investigated were the differences between the pretest and posttest scores, which were translated to N-Gain. It demonstrates that STEM-Video learning may increase students' higher-order thinking abilities to the subject matter taught and influence learning outcomes.

The usage of STEM-Video in the learning process draws attention to project geometry, which increases students' willingness to study. The increase in learning motivation affects pupils' understanding of the content they have acquired. Students have a better grasp of the subject given. STEM-Video can see the steps that the subject (human) takes to reach the actual item (things and work tools) displayed on the monitor screen, LCD, or projector projection. The STEM-based Video approach can illustrate and convey the stages required to work on a geometry project by using moving pictures developed in this manner.

Learning videos are part of the media in the learning process for students. As a learning medium, video has a role, namely, introducing information between teachers and students. Advances in information technology also allow teachers to determine many types of media that support material delivery. The use of learning media continues to be developed with the development of technology, starting from simple media to multimedia, a combination of two or more media types. Video is an advancement of technology that has a positive influence on humans (Pujiastuti & Haryadi, 2020). Using video, students can no longer obtain various information, knowledge, and entertainment. Video is a recording or display of a moving image accompanied by sound and scenarios. So that Video is one of the learning media based on how to learn in an audio-visual style that can stimulate listening and seeing skills. With this Video, students can use learning media to learn by listening to see pictures and increasing student interest in learning. Existence of video media in learning, teachers are supported when delivering material as well as the learning atmosphere is not dull and can help students understand the material quickly.

The learning process using video media can provide accurate illustrations, especially in delivering explanations related to real-life. Videos helpful in learning are made equipped with

a narrative, text, images, audio recordings, and simulations that are real in their visualization. Videos in education can encourage interaction between users and video content. The Video itself is passive media that its users only use to watch.

Video is a medium that, in its delivery, includes audio-visual media. Video is divided into two types; the first is equipped with sound and image functions in the original audio-visual media unit. Motion picture, television, and Video, both audio-visual media, are impure, including samples of slides, opaque, OHP, and other visual equipment that is sounded. Meanwhile, according to (Seo et al., 2021), there is information conveyed in fact or fictitious; it can be informative, educational, or instructional in a video. So that with the use of Video in learning, it can provide alternative means for educators to create exciting learning situations.

In developing learning videos, it is necessary to pay attention to the made learning videos' usefulness. Among them, the learning video can help those in need optimize learning outcomes with the help of Video as a learning medium. According to (Y.-N. Lin et al., 2021; Peixoto et al., 2021), Video usefulness in question is academic and non-academic uses in the educational field. The material must be useful to improve students' abilities. Simultaneously, non-academics deserve to be provisions in life skills in the form of applied knowledge, skills, and attitudes that he needs in everyday life.

Based on the arguments above, it is concluded that instructional videos are a suitable medium for teachers and students to improve learning outcomes. Utilizing teacher learning videos can help deliver audio-visual material and is ideal in implementing 21st-century learning, which is involved in enhancing and using technological advances. Video as a learning medium can also help teachers produce an attractive and not monotonous learning atmosphere for students and make it easier to understand the material well.

The results of other researchers also show that STEM learning can improve student learning outcomes. STEM approach states that STEM education is an essential element of the global response to climate change or other technological problems facing contemporary society. Therefore, applying the STEM approach to the learning process can produce human resources experts in specific fields, and STEM-based education has become one of the educational reforms to date. Therefore, it is supported by their writing arguments, which state that STEM education is built on reforming mathematics and science education (Haryadi & Pujiastuti, 2022).

Other researchers support this, and the STEM approach is an approach that integrates four disciplines, including science, technology, engineering, and mathematics, by focusing the educational process on solving real problems in everyday life (Gheyssens et al., 2021; Um

& Cho, 2022). STEM can develop students' thinking through engineering and technology learning and other integrated sciences STEM education. STEM-based learning can train students to apply their knowledge to make designs to solve environmental problems through technology (Haryadi et al., 2021).

The learning steps that use the STEM-based Video approach are: (1) Learning is given in the form of science to form scientific concepts in students used to support the engineering process. (2) Use technology to engineering processes in real life. The stages of learning with the STEM-based Video approach are described in Table 2.

The STEM-based Video approach applied in the learning process is very relevant to the demands of 21st-century education. So that each student is required to be active and expert in science, the STEM-Video approach to learning can develop and build student potential in higher-order thinking skills, which is much needed. The higher-order thinking skills process motivated students to seek information and curiosity independently by linking to the facts in solving problems. Students, through higher-order thinking skills, can increase their thinking activities (H.-C. Lin et al., 2021; Yang et al., 2021).

Students' higher-order thinking skills are significant where this thinking ability becomes the ability to understand and get solutions to problems in varied and different ways. Higher-order thinking skills are skilling to connect, manipulate, and change knowledge and experiences that have been critically and creatively to solve problems in new situations. Higher-order thinking skills are a metacognitive process that can teach students how to use observation and make ideas in thinking (Rowe et al., 2021; Stoeffler et al., 2020).

Based on the above opinion, higher-order thinking skills are individual skills in the cognitive domain to explore or find new information, which is then linked to a report that he previously found and processed to solve a problem. Besides, higher-order thinking skills reach the Bloom taxonomic indicator at the level of analyzing, evaluating, and creating. Higher-order thinking skills themselves are relevant to the demands of education and help students develop their thinking potential. The importance of increasing higher-order thinking skills in 21st-century learning can create students in producing, developing, and implementing their cognitive in conceptual and procedural.

Table 2. Stages of learning based on the STEM-based Video approach

| Stages Learning | Learning Activities |
|---|---|
| Preliminary activities | |
| | 1. The teacher starts the learning activity by saying greetings and praying.<br>2. The teacher checks student attendance.<br>3. The teacher directs students to gather with heterogeneous group friends<br>4. Apperception |
| Core activities | |
| Science Process, asking questions and defining problems | 1. The teacher displays a video in the form of physical phenomena related to the material, which is expected to trigger questions that students will ask<br>2. Students are given problems by the teacher from the questions students have asked |
| Model development and use | Students are asked to design a solution to the problem given. |
| Plan and conduct investigations | 1. Plan and conduct trials on the models that have been made as an investigative step to obtain quantitative data<br>2. Students evaluate what the shortcomings of the designs that have been made are<br>3. Students do a redesign to get results that can answer teacher challenge |
| Analyze and interpret data | Students analyze and interpret the investigation result data based on the trial process. |
| Using mathematics and computational thinking | 1. Students perform mathematical calculations related to physical quantities to be determined by the data obtained<br>2. Students process the experimental data using a computer program |
| Develop an explanation and design a solution | 1. Students make improvements to the products they have made<br>2. Students determine solutions that can be used to overcome problems and answer challenges from the teacher |
| Arguments based on evidence | 1. Students explain their arguments regarding the solutions they take relating to the products being made<br>2. Students prove based on the arguments they have presented |
| Evaluate and communicate | Students re-communicate the results they can in front of the class to exchange ideas with other groups and evaluate together. |
| Closing Activities | 1. The teacher provides confirmation or reinforcement related to student findings.<br>2. The teacher invites students to ask questions if the material has not been understood.<br>3. The teacher closed the meeting by saying greetings. |

## CONCLUSION

The STEM-based Video approach allows students to relate their classroom knowledge to real-life situations via videos. STEM-Video provides an engaging learning experience for students since it will enable them to think critically while solving issues. STEM-Video can

also encourage students to participate, giving them the chance to contribute ideas, enhance products, and use design skills. The STEM-based Video approach can stimulate and require critical thinking and analysis from students, improving higher-order thinking skills.

As a result, using the STEM-Video approach substantially impacts students' higher-order thinking skills when it comes to geometry content. The STEM-based Video approach has followed the current globalization trend, which means that the STEM-based Video approach already has a purpose in agreement with the features of the 21st century, which makes pupils have higher-order thinking skills.

## REFERENCES

Abdurrahman. (2019). Developing STEM Learning Makerspace for Fostering Student's 21st Century Skills in the Fourth Industrial Revolution Era. In *Journal of Physics: Conference Series* (Vol. 1155, Issue 1). https://doi.org/10.1088/1742-6596/1155/1/012002

Al-Hemiary, N. J., Cucchi, A., Al-Nuaimi, A. S., Al-Saffar, H., & Al-Ani, K. (2020). Inter-personal versus content: assessment of communication skills in Iraqi physicians. *Heliyon*, *6*(10), e05145. https://doi.org/https://doi.org/10.1016/j.heliyon.2020.e05145

Alrawili, K. S. (2020). Effect of scaffolding strategies on higher-order thinking skills in science classroom. *Journal of Baltic Science Education*, *19*(5), 718–729. https://doi.org/10.33225/jbse/20.19.718

Araiza-Alba, P., Keane, T., Matthews, B., Simpson, K., Strugnell, G., Chen, W. S., & Kaufman, J. (2021). The potential of 360-degree virtual reality videos to teach water-safety skills to children. *Computers & Education*, *163*, 104096. https://doi.org/https://doi.org/10.1016/j.compedu.2020.104096

Cahyono, A. N., Sukestiyarno, Y. L., & Asikin, M. (2020). LEARNING MATHEMATICAL MODELLING WITH AUGMENTED REALITY MOBILE MATH TRAILS PROGRAM : HOW CAN IT WORK ? *Journal on Mathematics Education*, *11*(2), 181–192.

Chen, C. M. (2015). Effects of different video lecture types on sustained attention, emotion, cognitive load, and learning performance. *Computers and Education*, *80*, 108–121. https://doi.org/10.1016/j.compedu.2014.08.015

Daher, W. (2020). Students' positioning and emotions in learning geometric definition. *Journal on Mathematics Education*, *11*(1), 111–134. https://doi.org/10.22342/jme.11.1.9057.111-134

Es, E. van. (2008). Mathematics teachers' "learning to notice" in the context of a video club. *Teaching and Teacher Education*, *24*(2), 244–276. https://doi.org/10.1016/j.tate.2006.11.005

Gheyssens, E., Consuegra, E., Engels, N., & Struyven, K. (2021). Creating inclusive classrooms in primary and secondary schools: From noticing to differentiated practices. *Teaching and Teacher Education*, *100*, 103210.

https://doi.org/https://doi.org/10.1016/j.tate.2020.103210

Gil-Glazer, Y. (2019). PhotoLingo—Development and Improvement of Higher-Order Thinking and Language Skills Through Photographs. *Journal of Education*, *199*(1), 45–56. https://doi.org/10.1177/0022057419843523

Haryadi, R., & Pujiastuti, H. (2020). Use of bungee jumping with stem approach to improve science process skills. *Journal of Physics: Conf. Series*. https://doi.org/10.1088/1742-6596/1480/1/012073

Haryadi, R., & Pujiastuti, H. (2022). Enhancing Pre-service Physics Teachers' Higher-Order Thinking Skills Through STEM-PjBL Model. *International Journal of STEM Education for Sustainability*, *2*(2), 156–171. https://doi.org/10.53889/ijses.v2i2.38

Haryadi, R., Situmorang, R., & Khaerudin, K. (2021). Enhancing Students' High-Order Thinking Skills through STEM-Blended Learning on Kepler's Law During Covid-19 Outbreak. *Jurnal Penelitian Dan Pembelajaran IPA*, *7*(2), 168. https://doi.org/10.30870/jppi.v7i2.12029

Heong, Y. M. (2020). Integration of learning styles and higher order thinking skills among technical students. *Journal of Technical Education and Training*, *12*(3), 171–179. https://doi.org/10.30880/jtet.2020.12.03.018

Hong, J.-C., Hsiao, H.-S., Chen, P.-H., Lu, C.-C., Tai, K.-H., & Tsai, C.-R. (2021). Critical attitude and ability associated with students' self-confidence and attitude toward "predict-observe-explain" online science inquiry learning. *Computers & Education*, *166*, 104172. https://doi.org/https://doi.org/10.1016/j.compedu.2021.104172

Hurwitz, L. B., & Schmitt, K. L. (2020). Can children benefit from early internet exposure? Short- and long-term links between internet use, digital skill, and academic performance. *Computers & Education*, *146*, 103750. https://doi.org/https://doi.org/10.1016/j.compedu.2019.103750

Ida, R., & Saud, M. (2020). The Narratives of Shia Madurese Displaced Women on Their Religious Identity and Gender Citizenship: A Study of Women and Shi'as in Indonesia. *Journal of Religion and Health*, *0123456789*. https://doi.org/10.1007/s10943-020-01001-y

Israel-Fishelson, R., & Hershkovitz, A. (2022). Studying interrelations of computational thinking and creativity: A scoping review (2011–2020). *Computers & Education*, *176*, 104353. https://doi.org/https://doi.org/10.1016/j.compedu.2021.104353

Jager, T. de. (2019). Impact of eportfolios on science student-teachers' reflective metacognitive learning and the development of higher-order thinking skills. *Journal of University Teaching and Learning Practice*, *16*(3).

Komara, E. (2019). The effect of cooperative integrated reading and composition (Circ) models on improving the capability of higher order thinking skills (hots) in teaching social studies students of class VIII in smpn 15 bandung city. *International Journal of Advanced Science and Technology*, *29*(5), 1295–1300.

Kong, S. C., & Wang, Y. Q. (2021). Item response analysis of computational thinking

practices: Test characteristics and students' learning abilities in visual programming contexts. *Computers in Human Behavior*, *122*, 106836. https://doi.org/https://doi.org/10.1016/j.chb.2021.106836

Krathwohl, D. R. (2002). *A Revision of Bloom ' s Taxonomy : 41*(4), 212–219.

LaForce, M., Noble, E., King, H., Century, J., Blackwell, C., Holt, S., Ibrahim, A., & Loo, S. (2016). The eight essential elements of inclusive STEM high schools. *International Journal of STEM Education*, *3*(1). https://doi.org/10.1186/s40594-016-0054-z

Lin, H.-C., Hwang, G.-J., Chang, S.-C., & Hsu, Y.-D. (2021). Facilitating critical thinking in decision making-based professional training: An online interactive peer-review approach in a flipped learning context. *Computers & Education*, *173*, 104266. https://doi.org/https://doi.org/10.1016/j.compedu.2021.104266

Lin, Y.-N., Hsia, L.-H., & Hwang, G.-J. (2021). Promoting pre-class guidance and in-class reflection: A SQIRC-based mobile flipped learning approach to promoting students' billiards skills, strategies, motivation and self-efficacy. *Computers & Education*, *160*, 104035. https://doi.org/https://doi.org/10.1016/j.compedu.2020.104035

Mašková, I., Mägdefrau, J., & Nohavová, A. (2022). Work-related coping behaviour and experience patterns, career choice motivation, and motivational regulation of first-year teacher education students – Evidence from Germany and the Czech Republic. *Teaching and Teacher Education*, *109*, 103560. https://doi.org/https://doi.org/10.1016/j.tate.2021.103560

Muhammad Rosyidi, R., Priyanto, B., Putu Wisnu Wardhana, D., Tsaniadi Prihastomo, K., & Kamil, M. (2020). COVID-19 and its impact on Neurosurgery: Our Early Experience in Lombok Island Indonesia. *Interdisciplinary Neurosurgery: Advanced Techniques and Case Management*, *22*(July), 100868. https://doi.org/10.1016/j.inat.2020.100868

Nguyen, N. D., Nguyen, T. D., & Dao, K. T. (2021). Effects of institutional policies and characteristics on research productivity at Vietnam science and technology universities. *Heliyon*, *7*(1), e06024. https://doi.org/https://doi.org/10.1016/j.heliyon.2021.e06024

Pehlivan, F. C. (2020). Development of mathematics teachers' moves that support students' higher order thinking skills through lesson study. *Turkish Journal of Computer and Mathematics Education*, *11*(3), 774–813. https://doi.org/10.16949/turkbilmat.683535

Peixoto, B. M., Lavi, B., Dias, Z., & Rocha, A. (2021). Harnessing high-level concepts, visual, and auditory features for violence detection in videos. *Journal of Visual Communication and Image Representation*, *78*, 103174. https://doi.org/https://doi.org/10.1016/j.jvcir.2021.103174

Phang, F. (2018). Cooperative Problem-Based Learning to Develop 21st Century Skills among Secondary School Students through STEM Education. In *Proceedings - 2017 7th World Engineering Education Forum, WEEF 2017- In Conjunction with: 7th Regional Conference on Engineering Education and Research in Higher Education 2017, RCEE and RHEd 2017, 1st International STEAM Education Conference, STEAMEC 201* (pp. 405–409). https://doi.org/10.1109/WEEF.2017.8467122

Pujiastuti, H., & Haryadi, R. (2020). The Use of Augmented Reality Blended Learning for

Improving Understanding of Food Security. *Jurnal Pendidikan IPA Indonesia*, *9*(1), 59–69.

Rosen, Y., Wolf, I., & Stoeffler, K. (2020). Fostering collaborative problem solving skills in science: The Animalia project. *Computers in Human Behavior*, *104*, 105922. https://doi.org/https://doi.org/10.1016/j.chb.2019.02.018

Rosidin, U. (2019). A combined HOTS-based assessment/STEM learning model to improve secondary students' thinking skills: A development and evaluation study. *Journal for the Education of Gifted Young Scientists*, *7*(3), 435–448. https://doi.org/10.17478/jegys.518464

Rowe, E., Almeda, M. V., Asbell-Clarke, J., Scruggs, R., Baker, R., Bardar, E., & Gasca, S. (2021). Assessing implicit computational thinking in Zoombinis puzzle gameplay. *Computers in Human Behavior*, *120*, 106707. https://doi.org/https://doi.org/10.1016/j.chb.2021.106707

Rubach, C., & Lazarides, R. (2021). Addressing 21st-century digital skills in schools – Development and validation of an instrument to measure teachers' basic ICT competence beliefs. *Computers in Human Behavior*, *118*, 106636. https://doi.org/https://doi.org/10.1016/j.chb.2020.106636

Saritepeci, M. (2019). Developing Computational Thinking Skills of High School Students : Design-Based Learning Activities and Programming Tasks. *The Asia-Pacific Education Researcher*. https://doi.org/10.1007/s40299-019-00480-2

Schwarz, B. B., Swidan, O., Prusak, N., & Palatnik, A. (2021). Collaborative learning in mathematics classrooms: Can teachers understand progress of concurrent collaborating groups? *Computers & Education*, *165*, 104151. https://doi.org/https://doi.org/10.1016/j.compedu.2021.104151

Seo, K., Dodson, S., Harandi, N. M., Roberson, N., Fels, S., & Roll, I. (2021). Active learning with online video: The impact of learning context on engagement. *Computers & Education*, *165*, 104132. https://doi.org/https://doi.org/10.1016/j.compedu.2021.104132

Siregar, I. (2016). Indonesian Islamic institutions between the foundation and endowment laws: a critical legal analysis. *SpringerPlus*, *5*(1), 1–9. https://doi.org/10.1186/s40064-016-2772-6

Stoeffler, K., Rosen, Y., Bolsinova, M., & von Davier, A. A. (2020). Gamified performance assessment of collaborative problem solving skills. *Computers in Human Behavior*, *104*, 106036. https://doi.org/https://doi.org/10.1016/j.chb.2019.05.033

Um, S. J., & Cho, H. (2022). Creating the space of possibility: The dynamics of multiculturalism, neoliberalism, and nationalism in South Korean prospective teachers learning to teach for social justice. *Teaching and Teacher Education*, *110*, 103605. https://doi.org/https://doi.org/10.1016/j.tate.2021.103605

Wekke, I. S. (2015). Arabic Teaching and Learning: A Model from Indonesian Muslim Minority. *Procedia - Social and Behavioral Sciences*, *191*, 286–290. https://doi.org/10.1016/j.sbspro.2015.04.236

Wekke, I. S., & Hamid, S. (2013). Technology on Language Teaching and Learning: A Research on Indonesian Pesantren. *Procedia - Social and Behavioral Sciences, 83*, 585–589. https://doi.org/10.1016/j.sbspro.2013.06.111

Wilson, D. M. (2020). Investigating teachers' implementation and strategies on higher order thinking skills in school based assessment instruments. *Asian Journal of University Education, 16*(1), 70–84. https://doi.org/10.24191/ajue.v16i1.8991

Yalçın, V., & Erden, Ş. (2021). The Effect of STEM Activities Prepared According to the Design Thinking Model on Preschool Children's Creativity and Problem-Solving Skills. *Thinking Skills and Creativity*, *41*, 100864. https://doi.org/https://doi.org/10.1016/j.tsc.2021.100864

Yang, S., Lee, J. W., Kim, H.-J., Kang, M., Chong, E., & Kim, E. (2021). Can an online educational game contribute to developing information literate citizens? *Computers & Education, 161*, 104057. https://doi.org/https://doi.org/10.1016/j.compedu.2020.104057

Yusuf, I. (2018). Implementation of E-learning based-STEM on quantum physics subject to student HOTS ability. *Journal of Turkish Science Education, 15*, 67–75.