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DEVELOPMENT OF A HYPER-CONTENT E-MODULE USING A SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (STEM) APPROACH TO TRAIN COGNITIVE AND PSYCHOMOTORY LEARNING OUTCOMES OF JUNIOR HIGH SCHOOL STUDENTS

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Abstract

Education is essential and a right for all Indonesian citizens. The quality of education is seen in student learning outcomes. Based on observations at SMP N 1 Talun, as many as 85.3% of students' cognitive learning outcomes still need to be completed, and learning activities after the COVID-19 pandemic have yet to carry out learning activities that can hone students' psychomotor abilities. The use of teaching materials is also only based on printed package books. Therefore, it is necessary to develop teaching materials to train students' cognitive and psychomotor learning outcomes. Research & Development (R&D) research conducted using the 4D model. This study aims to determine the characteristics and validity of hypercontent e-modules with a STEM approach and the profile of students' cognitive learning outcomes and psychomotor learning outcomes after using e-modules. The average material and media validation results were 95.4% and 97.2%, which received very valid criteria. The cognitive and psychomotor learning outcomes profile shows that 76% and 79% of students get a complete score. Based on these results, hypercontent e-modules with a STEM approach are declared very valid and can train students' cognitive and psychomotor learning outcomes.

Keywords*: : E-module, Hypercontent, STEM, Learning Outcomes*

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INTRODUCTION

Law of the Republic of Indonesia no. 20 of 2003 concerning the national education system states that every Indonesian must improve their talents and potential for six years from the age of 7 – 15 through a learning process carried out by education providers. This learning process is carried out at the basic education level, namely Elementary School (SD) or Madrasah Ibtidaiyah (MI) and Junior High School (SMP) or Madrasah Tsanawiyah (MTs). The curriculum must contain learning about natural sciences (IPA) at the basic education level. Natural Sciences (IPA) is a science directly related to human life and discusses everything in the universe (Safira et al., 2020). Science learning aims to enable students to learn, understand, and develop analytical skills regarding the natural environment and its surroundings. Natural science contains facts, concepts, principles, processes, and products (Ramadanti, 2020). Based on this meaning, students learn theory and develop skills as crucial as knowledge. These aspects are several things that are assessed in student learning outcomes. Learning activities are essential because they play an important role in determining the quality of education (Amaliyah et al., 2021). The quality of education can be seen from the learning outcomes of students. High learning outcomes indicate good quality of education; conversely, if learning outcomes are low, then the quality of education is not good. There are still many problems regarding student learning outcomes, one of which is in science lessons.

Based on observations made at SMP N 1 Talun Kab. Cirebon, West Java, experiences the same thing, namely students' low science learning outcomes. The low level of science learning outcomes in the cognitive domain of students is known based on the results of the mid-semester assessment (PTS), namely that only 5 out of 34 students received the title of complete with a score above the minimum completeness criteria (KKM). The psychomotor domain assessment has yet to be implemented because learning activities that train students' psychomotor abilities have not been implemented. Based on the results of interviews with science teachers at SMP N 1 Talun, information was obtained that learning activities still used conventional learning methods and used teaching materials only from printed textbooks. After distance learning, practical activities that can train students' psychomotor skills have yet to be carried out again. Therefore, to produce good learning results, teaching materials are needed to attract interest in learning and contain activities that can train students' cognitive and psychomotor abilities.

Modules are one of the teaching materials that can support the learning process (Darmayasa et al., 2018). To create learning that utilizes technology and attracts students' interest, usually printed modules can be modified into E-modules. Using e-modules can train students' cognitive learning outcomes (Mutmainnah et al., 2021). E-modules can be used flexibly via electronic devices such as smartphones or laptops anytime and anywhere. One of the innovations in making e-modules is that they are made with the hypercontent concept. Hypercontent is a concept that can combine one material with another in a digital program (Prawiradilaga et al., 2017). The hypercontent concept can be applied by presenting text connected to specific sites (hyperlinks), QR codes, and videos. With these features, the E-module presented can be more exciting and make it easier for students to learn and clarify learning material by presenting learning videos (Sriwahyuni et al., 2019). *e*-module innovation can also use the Science, Technology, Engineering, and Mathematics (STEM) approach. The STEM approach was first put forward by the National Science Foundation (NSF) in the 1990s in the United States to introduce how vital the application of these four scientific disciplines is in the world of education and the general public (Putra, 2023). The concept of integrating science, technology, engineering and mathematics content is something crucial that must be considered to facilitate learning in the classroom (Ring et al., 2017). Integrating STEM education can produce positive student results (Cavlazoglu & Stuessy., 2017).

Based on research conducted by Safitri et al. (2018) shows that the use of STEM-based modules can train students' cognitive and psychomotor learning outcomes so that learning outcomes can increase. Research conducted by Manurung and Zubir (2023) also shows that using STEM-integrated learning e-modules can improve students' cognitive learning outcomes. Research on hypercontent has also been conducted by Handayani and Marisda (2020) stating that the application of hypercontent can improve students' cognitive learning outcomes. The research was also conducted by Ratnaningrum and Kholidya (2023); this research shows that using hyper-content modules can train students' cognitive learning outcomes to improve cognitive learning outcomes. Based on previous research, no one has combined hypercontent and the STEM approach to train student learning outcomes, so it is vital to research the development of hypercontent e-modules with a STEM approach to train cognitive and psychomotor learning outcomes for junior high school students.

RESEARCH METHODS

This research is development research (Research and Development), which uses a 4D development model with four stages, namely: 1) define, 2) design, 3) develop, and 4) disseminate. The data collection method used is the Linkert scale with a validation questionnaire method for material and media validators, a readability questionnaire for small-scale students, a posttest in the form of multiple choice questions and product assessment (Sugiyono, 2017).

RESEARCH RESULTS AND DISCUSSION

Defining the definition's meaning is the first stage carried out in the 4D model research series. This stage is carried out to discover the needs and problems faced in the learning process. Interviews with science teachers at SMPN 1 Talun were conducted to discover this problem. The results of the interviews show that the use of teaching materials is still in the form of conventional teaching materials so that students cannot access them flexibly and there are cognitive and psychomotor learning outcomes that still need to be met the minimum completeness criteria. The solution is to develop teaching materials in the form of electronic modules that can train students' cognitive and psychomotor learning outcomes. The design stage is carried out to design and make the product. What is done is determining indicators of achievement of learning objectives, question instruments, and approaches that will be used to suit the purpose of creating the e-module. The next step is designing the contents of the e-module and realizing the plan for making the e-module. The e-module is equipped with a QR code, hypertext, and YouTube videos, accompanied by a quiz at the end of each sub-chapter, and at the end of the e-module, there is an activity for making a solar system model. The STEM approach and the nature of hyper content were chosen so that the use of e-modules can train students' cognitive and psychomotor learning outcomes.

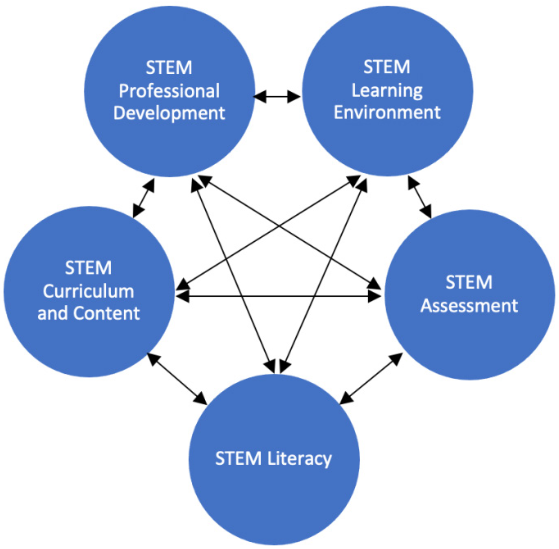

Figure 1. STEM Dimensions (Donmez, 2020)

At the development stage, an assessment of the product that has been created is carried out. Validators carry out this assessment and aim to determine the validity of the e-module that has been created previously. There are three validators, namely two lecturers and one teacher. The validator carries out an assessment based on the material and media aspects using the assessment rubric provided. Suggestions and input from validators are used as a reference to improve the e-module to make it better. Then, after that, the e-module can be said to be valid and was tested on nine students in class VIII E. The trial was carried out by distributing readability questionnaires to these students. After that, a large-scale trial was carried out in class VII H with 34 students. A large-scale trial was conducted to determine whether learning using hypercontent e-modules with a STEM approach can train students' cognitive and psychomotor learning outcomes. Dissemination is the final stage of the 4D research model. At this stage, valid e-modules are distributed and tested on small and large scales. The e-module was distributed to science teachers at SMPN 1 Talun.

Material Validity

The assessment of the validity of the material by the validators is seen from the aspects of the material and presentation. The indicators for each aspect assessed are (1) conformity with learning outcomes (CP) and learning objectives (TP); (2) conformity with indicators of achievement of learning objectives (IKTP); (3) completeness of material; (4) practice the questions presented are appropriate to the material; (5) the material presented contains STEM elements; (6) the consistency of the material presented; (7) the images used are appropriate to the material; (8) it is equipped with a guide to using the e-module; and (9) clarity of material. Assessing the overall validity results, validator 1 gave a score of 97.2%, validator 2 gave a score of 97.2%,

and validator 3 gave a score of 91.7%. The validity results of each validator separately per aspect are in Figure 2.

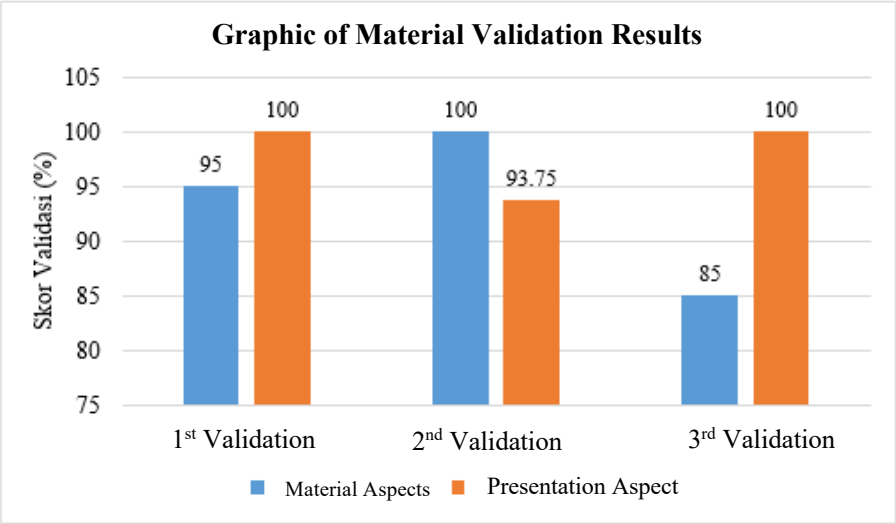

Figure 2. Graphic of Material Validation Results

The material aspect received very valid criteria. This is because the e-module created is by the assessment indicators. The e-module presents content by the learning achievements of the science understanding element. Namely, students elaborate on their understanding of the relative position of the earth-moon-sun in the solar system and the learning achievements of the process skills element. Students can plan, and process plans that have been designed and are by The learning objective achieved is understanding material regarding the solar system. Apart from that, the e-module is also an indicator of achievement of the learning objectives that have been formulated. The material in the hypercontent e-module with a STEM approach is about the solar system with sub-materials, namely the solar system, the earth and its satellites, and the sun. Each sub-material also has practice questions that can be done directly in the e-module. This practice question aims to determine the extent to which students understand the material they have studied. Repeating practice questions can also improve student learning outcomes (Yuliana & Listiadi, 2021).

The approach used in the e-module is a STEM approach with four elements: science, technology, engineering, and mathematics. The application of science elements in the e-module is in the form of material about the solar system in writing, pictures, and accompanying tables. This material also has YouTube videos and QR codes as technological elements. In the engineering element, students are asked to utilize technology to carry out the tasks provided by creating infographics. Meanwhile, the application of mathematical elements is in the material regarding Kepler's Laws which contain mathematical formulas. The presentation aspect also has very valid criteria. The material contained in the e-module is presented coherently and clearly. It is equipped with pictures that are appropriate to the material, making it easier for students to understand the material. This aligns with research conducted by Laili et al. (2019), which states that e-modules can make it easier for students to master the material more quickly. Apart from that, it is easier for students to use the e-module because the e-module has a user manual. This guide contains information about what is in the e-module and is equipped with how to use the e-module, such as how to use QR codes, take quizzes, and use hypertext.

Media Validation

The validity of the media was assessed by three validators, namely two lecturers and one teacher. Two aspects are assessed, namely in terms of appearance and media suitability. In the appearance aspect, several indicators are assessed, namely: (1) e-module cover design; (2) attractiveness of e-module content design; and (3) use of font and writing color. In the feasibility aspect, the indicators assessed are: (1) it is stand-alone; (2) it is user-friendly; and (3) all buttons can be operated properly. Overall media validation results, validator 1 gave a score of 95.8%, validator 2 gave a score of 100%, and validator 3 gave a score of 95.8%. Figure 3 shows a graph of validation results from media validators per aspect.

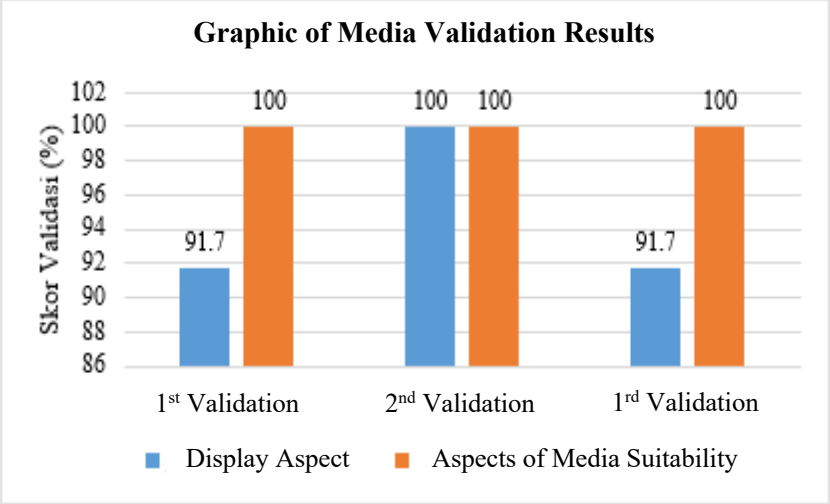

Figure 3. Graphic of Media Validation Results

In the display aspect, the validator gives a value in the very valid category. This is because the e-module has an attractive cover design. The e-module cover provides complete information regarding the identity of the e-module, such as what material is presented, for what lesson, what grade level it is intended for, and what semester the material is. The cover is also equipped with the words "hypercontent e-module with a STEM approach" so that users can know that the e-module is hypercontent and uses a STEM approach. Images related to the material and the colors used can attract the user's attention to read the content. The display in the e-module also includes exciting images and videos. Choosing the appropriate font, size and color is an important thing to do so that students can read the e-module easily.

The media feasibility aspect received a high score from the validator, which can be categorized as very valid. The e-module produced is an e-module that is stand-alone and user-friendly (easy to use). The e-module is stand-alone because the e-module can be used without downloading a particular application. However, the user must have an internet quota and can use it alone because the user manual and commands are already in the e-module. The e-module presents complete material accompanied by practice questions independent of other teaching materials. The title of user friendly is obtained because the e-module can be accessed and used by students easily, namely via smartphone, computer, or laptop. The e-module can easily be flipped to the next and previous pages. Apart from that, the e-module can be zoomed in or out correctly. This means that all buttons can be operated and function properly. Overall, the three validators considered the hypercontent e-module with a STEM approach very valid. E-modules that are said to be valid can then be used for large-scale trials (Karim et al., 2022). This large-scale trial was carried out on 34 students in class VII H.

Readability Questionnaire

E-modules whose validity has been tested by the validator and revised according to the validator's suggestions and input will be declared valid. The feasibility of the e-module will also be assessed from the student's perspective by distributing a readability questionnaire to 9 students in class VIII E. According to the students, this questionnaire aims to determine the shortcomings that still exist in the e-module. If there are deficiencies, the e-module will be revised again. If there are no shortages, the e-module can be tested on a large scale, namely on class VII H students with 34 people. The results of the student readability questionnaire showed that all 15 indicators received perfect criteria. There are three indicators with a perfect percentage of 100%, namely that the activities presented by the e-module have clear objectives, the information presented by the e-module is complete and transparent, and the appearance of the cover and content (design) of the e-module is attractive so that it makes students interested in reading the material, which is presented. The indicator with the lowest percentage is that the e-module explanation is coherent and clear, by the material students are studying with a percentage of 80.6%. The average percentage of all indicators received perfect criteria with a value of 93.14%.

E-module Characteristics

The process of creating an e-module starts with selecting the application used to create the e-module, determining the characteristics of the e-module, determining indicators, and determining the design and

content of the e-module. The applications used to create e-modules are Canva and Flip PDF Professional. The cover design and content writing were created in the Canva application and then saved in PDF format. After that, the PDF is inserted into the professional PDF flip application, and features are added, such as YouTube videos that can be played directly in the e-module and quizzes that can be done directly in the e-module. Flip PDF Professional makes the e-module look like a printed book, the pages of which can be turned and sound like the pages of a book being turned.

User-friendly characteristics make it easier for users or students to use e-modules (Kosasih, 2021). This characteristic is characterized by the presence of instructions for using the e-module which can guide users in using the e-module. The instructions for using the e-module explain the nature and approach used, what features are contained in the e-module, and how to use these features. Using e-modules in various media, such as laptops, computers, or smartphones, is also an element of user-friendliness. Pages can be changed by simply clicking the right or left arrow button or sliding the page like opening a page in a general printed book.

The e-module created is hypercontent in nature, where the e-module can connect the material in the e-module to other material outside the e-module. This material can be connected via hypertext, QR code, and YouTube videos, an application of the hypercontent concept (Prawiradilaga et al., 2017). The material outside the e-module can complement the material presented in the e-module because the material presented is still in line with the theme of the e-module material. The different writing colors make it easier for students to distinguish between regular text and hypertext. Hypertext is marked with blue writing and can be clicked on, and users can switch to another site. Users can use the QR code provided if they want to open another site using another device. The e-module is also equipped with videos from YouTube which can be played directly in the e-module to attract students' attention and make it easier for students to understand the material.

E-module applies a science, technology, engineering, and mathematics (STEM) approach. Besides the material, STEM is also applied to the e-module final assignment: making a solar system model. This final assignment is carried out to train students' psychomotor skills. The application of STEM in e-module material is differentiated in several colors so that students can easily differentiate between the STEM elements. Science elements are marked with a yellow box. Technological elements are marked with a red box. Engineering elements are marked with purple boxes. Finally, the mathematical element is marked with a blue box.

Cognitive Learning Outcome Profile

The profile of students' cognitive learning outcomes can be seen after the learning process uses the hypercontent e-module with a STEM approach. Students work on multiple choice questions totaling 19 questions which have been tested as valid and reliable. The questions presented have varying difficulty levels: easy, medium, and challenging. The differentiating power of each question also has various categories, namely fair, reasonable, and excellent. The aim of working on this question is to find out the effectiveness of the hypercontent e-module with a STEM approach in training the cognitive learning outcomes of junior high school students. Below are presented the results of students' cognitive learning in graphic form in Figure 4.

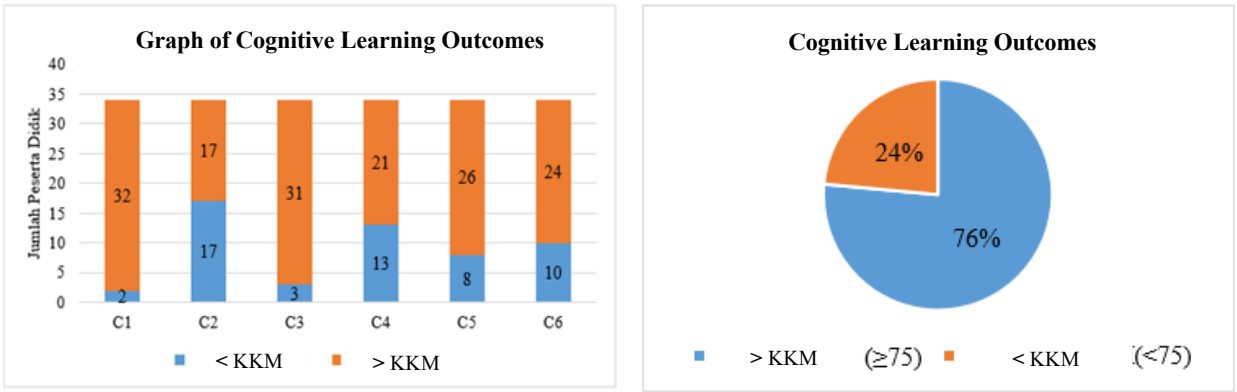

Figure 4. Graph of Cognitive Learning Results and Percentage of Cognitive Learning Results

For the overall cognitive learning results of class VII H students, totaling 34 people, Figure 4.7 shows that more students scored above the KKM than below the KKM. There were 26 students with scores above 75, which means 76% of the class VII H student population scored above the KKM. Another 24% of the class VII H student population, namely eight people, scored below the KKM. Based on the profile of cognitive learning outcomes, using hypercontent e-modules with a STEM approach can train students' overall cognitive learning

outcomes at SMPN 1 Talun class VII H. This aligns with research conducted by Wahyudi et al. (2022) and Agung et al. (2021), which states that using e-modules can develop and train students' cognitive learning outcomes. However, if learning outcomes are separated by cognitive level, then only three cognitive levels can be trained, namely C1, C3, and C5.

Profile of Psychomotor Learning Outcomes

The hypercontent e-module with a STEM approach is equipped with a project assignment at the end of the module to determine the profile of students' psychomotor learning outcomes. Students are asked to design and make solar system models in groups. Assessments are assessed from student worksheets (LKPD) and also assessments of the products made. Below are presented the results of students' psychomotor learning in graphic form in Figure 5.

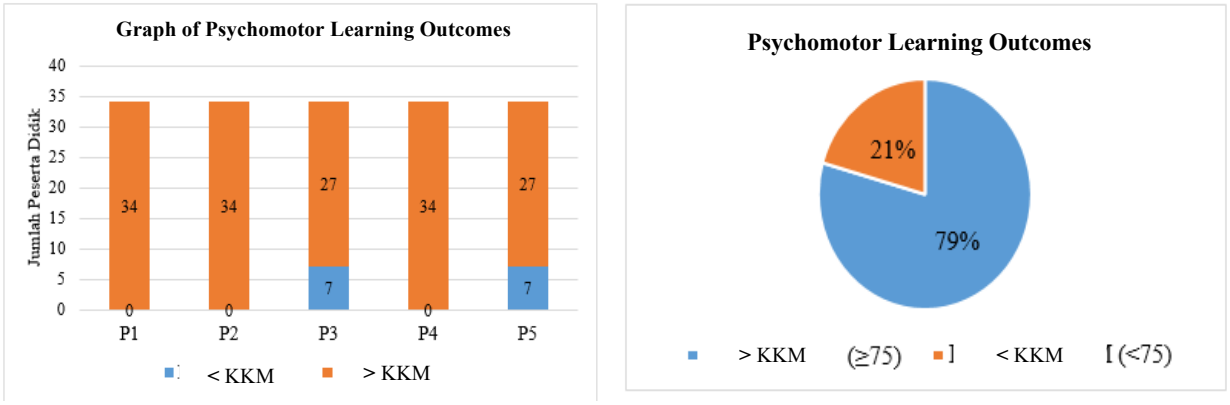

Figure 5. Graph of Psychomotor Learning Results and Percentage of Psychomotor Learning Results

Based on Figure 4, students' overall psychomotor learning results show promising results because only 21% of the class VII H population, namely seven people, scored below the minimum completeness criteria (KKM). There are 27 students with scores above the KKM, around 79% of the class population. Based on the profile of students' psychomotor learning outcomes, it can be concluded that the research is said to be successful, and the hypercontent e-module with a STEM approach can train the psychomotor learning outcomes of class VII H students at SMPN 1 Talun because ≥75% of students scored above the KKM. This is in line with research conducted by Saleh & Triyono (2022), Yulianto et al. (2022), and Yunus et al. (2022), which states that the use of e-modules in learning can train students' psychomotor learning outcomes.

CONCLUSIONS AND SUGGESTION

A. Conclusions

Hypercontent e-modules with a STEM approach have the characteristics of being easy for users to use (user friendly), being hypercontent (equipped with hypertext, QR code, and YouTube videos), and using a science, technology, engineering, and mathematics (STEM) approach. The validity of the hypercontent E-module with a STEM approach was categorized as very valid. The profile of cognitive learning outcomes of students at SMPN 1 Talun class VII H after learning using the hypercontent e-module with a STEM approach showed that 76% of students scored above the KKM so that the e-module was said to be able to train students' cognitive learning outcomes. However, several cognitive indicators, namely, C2, C4, and C6 cannot be trained. The profile of psychomotor learning outcomes of students at SMPN 1 Talun class VII H after learning using the Hypercontent e-module with a STEM approach showed that 79% of students scored above the KKM so that the e-module was said to be able to train students' psychomotor learning outcomes.

B. Suggestion

More applications of the four STEM elements can be added by including them in each sub-chapter of the material. Adding material that needs to be added to the e-module, namely regarding the sun's apparent motion, and completing material regarding asteroids. Distinguish material about the movement of the earth towards the sun into material due to the rotation of the earth and due to the revolution of the earth so that students can differentiate between the effects of rotation and the effects of the earth's revolution. Add activities that are able to train students' psychomotor skills in addition to the final assignment in the LKPD in the e-module.

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