24 (3), 2023, 516-527

Jurnal Pendidikan MIPA

e-ISSN: 2685-5488 | p-ISSN: 1411-2531

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

Development of Project based Statistics e-Module with Scratch Assistance to Improve Students' Computational Thinking Skills

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Abstract: This study aims to develop a project-based e-module to improve the computational thinking skills in learning statistics. The research subjects were 15 of eight-grade students in class A and 32 students in class E. The research has succeeded in developing the learning module assisted by Scratch which found to be valid and effective in improving students' mathematical computational thinking skills. This is supported by the validation result of 3.10 with a valid category. Student responses to the e-module obtained an average score of 3.57 in the very practical category. The teacher's response to the e-module obtained a score of 3.40 in the practical category. The effectivity test of the module toward students' mathematical problem solving ability found that n-gain score was 68.93. These results conform that the developed e-module meets the valid, practical and effective criteria.

Keywords: e-module, project based learning, computational thinking.

Abstrak: *Penelitian ini bertujuan untuk melakukan pengembangan e-modul project-based learning berbantuan scratch untuk meningkatkan keterampilan berpikir komputasi siswa SMP Neger 2 Kuta. Subjek penelitian adalah siswa kelas VIII A yang berjumlah 15 orang serta kelas VIII E yang berjumlah 32 orang. Penelitian yang telah dilaksanakan pada kelas VIII SMP Negeri 2 Kuta ini telah berhasil mengembangkan perangkat pembelajaran meliputi E-Modul berorientasi PjBL berbantuan Scratch yang valid, praktis, dan efektif dalam meningkatkan kemampuan berpikir komputasi matematis peserta didik. Hal ini didukung dengan hasil skor validasi dari para ahli sebesar 3,10 dengan kategori valid. Respon peserta didik terhadap E-Modul diperoleh rata-rata skor 3,57 dengan kategori sangat praktis. Respon guru terhadap E-Modul diperoleh skor 3,40 dengan kategori praktis. Hasil gain score tes kemampuan pemecahan masalah matematis peserta didik sebesar 68,93 tergolong dalam kategori "efektif". Maka dari hasil tersebut dapat dinyatakan bahwa E-Modul yang dikembangkan memenuhi kriteria valid, praktis dan efektif.*

Kata kunci: *e-modul, project based learning, berpikir komputasi.*

▪ INTRODUCTION

Education is one aspect that is key in producing Human Resources (HR) who are able to face the challenges of globalization and the revolution of people's lives in a new paradigm (Hayati & Fauziah, 2023). Technological developments have led to the emergence of a new era filled with changes and increasingly fierce competition in various sectors. It is hoped that improving the quality of human resources can make changes to the fabric of people's lives for the better, so it is important to do something related to educational progress (Sriwindari et al., 2022). Looking at the importance of education, schools as a place where the educational process takes place need to be paid attention to and improved in order to achieve optimal learning outcomes for students. Through education, a student gets the opportunity to enrich knowledge and experience to face competition in society (Agung et al., 2022).

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DOI: http://dx.doi.org/10.23960/jpmipa/v24i3.pp516-527
Received: 08 August 2023
Accepted: 11 September 2023
Published: 26 November 2023

The development of the industrial era 4.0 provides various changes in people's living standards with increasingly rapid technological developments (Widana & Septiari, 2021). Education as the front line of the nation's foundation and hope to produce competent future generations should always adapt to various forms of changes that occur and developments over time, such as the emergence of artificial intelligence in the various devices we use (Yilmaz & Yilmaz, 2023; Sanusi et al., 2023; Tsopra et al., 2023). The rapid development of technology demands the development of students' abilities to have more complex thinking skills. Students, of course, must have the ability to face all forms of possible changes in technological developments (Hooijdonk et al., 2023). Facing these changes, it is important for students to develop computational thinking skills (Ningtyas et al., 2022). Computational thinking ability is the ability to think or understand which begins with problem solving efforts, then the problem solving is developed so that computers are used as a medium for solving the problem (Cahdriyana & Richardo, 2020).

Computational thinking abilities cause someone to be able to present the solutions they have planned or have done well (Nasiba, 2022; Guggemos, 2021) Computational Thinking (CT) is defined as a set of thinking patterns, designing a system using a computer as a medium or container aimed at solving problems (Wing, 2012; Celik, 2022). Facing developments in today's era, our thinking abilities as humans must also develop following the changes that occur. Computational Thinking (CT) has four stages that show the development of computational thinking abilities, namely Decomposition, Pattern Recognition, Abstraction, and Algorithm (Wing, 2012). The four stages that have been mentioned are stages that are very possible to apply in learning. The ability to think computationally should be one of the important abilities that is very useful in life in the digital era which is increasingly developing rapidly, creating an increasingly modern era, so computational thinking can help the problem solving process (Lestari & Annizar, 2020).

However, the reality is that students in Indonesia are still not fully able to maximize the development of their computing skills. This is reflected in the low ability of students to find a solution to a problem, shown by the results of PISA where PISA aims to measure participants' competence in science, mathematics and language skills. PISA held by the OECD in 2018 shows that Indonesia is in a position 74th out of 79 countries that participated in the test (Kemdikbud, 2019). In general, the PISA test aims to test students' abilities regarding how students can find a solution to a problem (Lestari & Annizar, 2020). The low PISA results of students in Indonesia indicate that students' computational thinking skills are still low, because computational thinking skills are a way to find solutions to problems (Cahdriyana & Richardo, 2020).

The problem of low computational thinking skills also occurs in mathematics learning, although computational thinking was initially used in computer science, the use of computational thinking skills is also relevant in other fields of science such as mathematics (Cahdriyana & Richardo, 2020); (Danindra & Masriyah, 2020). Computational thinking skills are very important for students to have since entering junior high school (SMP) as a form of change in the mindset of students at a higher level (Sa'diyyah et al., 2021). However, the results of initial observations carried out on junior high school students in Badung Regency, found that students' abilities in computational thinking were still low, especially in mathematics lessons, this was reflected in students' daily test scores which were still not optimal and there were still students whose scores

were still below minimum completion criteria. This condition indicates the importance of efforts to improve computational thinking skills to equip students to face the development and competition of the 4.0 era (Tian et al., 2021, Tabesh, 2017).

The low level of computational thinking skills in mathematics is indicated to be caused by various factors, including how teachers carry out learning in class (Wijnen et al., 2021). Observations show that teachers tend to more often carry out learning that is centered on themselves or known as teacher centered. The teaching pattern with the teacher as the center has learning characteristics that make students passive, considering that the learning uses the lecture method. This condition will cause a lack of active involvement of students in teaching and learning activities, resulting in a slow development of their computational thinking. Nurmayani (2018) states that the problems described above often occur as a result of teachers who still have a conventional view, where teachers view students as having to remember the material being taught, even though students' understanding of a concept is much more important than their ability to remember the material being taught. taught, this also causes teachers to not encourage students to think.

The Project Based Learning (PjBL) learning model is one of the learning models that is recommended for teachers to be implemented in the 2013 curriculum era. Knowledge is something that is built by the learner himself through a process of search, discovery and is explored by the learner so that knowledge is constructed (Amalia & Sujatmiko, 2022). Therefore, the learning atmosphere that must be created is a situation that encourages students to be more active in seeking information related to the concepts and scope of the material being taught, so that students can produce efforts in solving problems encountered in everyday life (Triantoro , 2022). Based on this explanation, the learning model chosen as the model in this research is project based learning or abbreviated as PjBL with the aim of providing an active and creative learning experience for students. The PjBL learning syntax is: Opening a lesson by asking a relatively challenging question, Carrying out project planning, Preparing an activity schedule, Supervising project implementation, Evaluation of products that have been made, Carrying out evaluations (Triantoro, 2022).

It is important to make a connection between computational thinking and Project Based Learning as an effort to expand the practice of computational thinking to digital creation, design, and personal expression, as well as a learning that is centered on making and a multidisciplinary approach. A feature of educational-based computational thinking is work on programming (Coding). A form of coding or programming that is able to integrate Project Based Learning (PjBL) is Scratch. Coding scratch is able to provide encouragement to students in searches related to ideas in mathematics. Scratch is a block-based Massachusetts Institute of Technology (MIT) development in a visual programming language that allows young people to create interactive media, such as games, stories, and simulations. By connecting programming blocks to create works in the digital world, it's like putting Lego together to create works in the physical world. Based on this, this learning is also considered suitable for integration with e-modules with the aim of improving students' computational thinking.

In order to achieve this, the ability of educators to apply innovation is very important, especially in compiling creative and innovative teaching modules for students or a module based on learning models. To support the creation of the intended learning

process, the use of electronic modules is important because it gives students a new color in learning, so e-modules are the right option to develop. e-module can be explained as a module that is created with the help of electronic media and can be accessed using electronic devices such as smartphones, computers, chromebooks and other electronic media. The e-module developed in this research contains several digital media in it such as learning videos, animations that are relevant to learning and materials, so that it becomes a creative and innovative learning tool that is suitable for application in classroom learning activities.

▪ METHOD

The population used was class VIII students at SMP Negeri 2 Kuta. The sample in this research is referred to as the research subject. These subjects include experts, students and teachers. The role of an expert is needed when testing the validity of the product being developed. Experts come from lecturers based on the expertise possessed by each expert. The students used as research subjects were 15 students in class VIII A of SMP Negeri 2 Kuta and 32 students in class VIII E of SMP Negeri 2 Kuta.

This type of research is classified as research and development. This development begins with the research stage, which begins with the stage of searching for information needs about the development of this product and looking for literature sources. The next stage of development takes place, namely the development of this product, starting to get a product that is correct or valid, practical and effective. The teacher's role is related to collecting data regarding the practicality of the products produced. The teachers referred to here are class VIII A and VIII E teachers at SMP Negeri 2 Kuta. The design of this development research uses the development model developed by Borg & Gall (2007) where there are ten steps in the development research procedure, namely; collection of initial information, planning, initial product development, initial trial, product revision, field trial 1, product revision, field trial 2, product revision, dissemination (spreading). The development stage will only be carried out at stage 7, considering the limitations in terms of time and researchers' abilities.

In collecting the data using assessment questionnaire techniques and mathematics tests. There are two types of data in this development research, namely: the results of a questionnaire review of content, media and design experts, teachers, and student assessments, mathematics test results for statistics material. Questionnaire and test instruments are instruments developed by researchers themselves. The computational thinking ability test instrument is structured based on competency indicators, there are three indicators of competency achievement, namely. Analyzing data related to the distribution of data provided which is used as question item number 1, Analyze various daily activities related to the mean, mode, and median which are used as question items number 2, 3, and 4, Analyze various daily activities to determine the size of the distribution of data used as question item number 5. All question items have a question item correlation index value (r_{count}) > 0.349 (r_{table}), so that the computational thinking ability test can be said to be valid. The results of the test reliability analysis obtained were 0.981 by carrying out a relatively high reliability interpretation. The questionnaire instrument was developed independently and validated by the supervisor. The content expert questionnaire consists of 15 statement items, while the media expert questionnaire consists of 17 statement items. The teacher response questionnaire consists of 12

statements and the student response questionnaire consists of 10 statements.

The data analysis techniques used were product validity analysis using the average score of the assessment questionnaire, product practicality analysis carried out using the average score interval of the assessment questionnaire, analysis of product effectiveness by calculating the gain score on the pretest-posttest values.

▪ RESULT AND DISSCUSSION

Based on the results of the validation analysis of the product scores developed, the validity score of the e-module developed is 3.10, which is included in the valid criteria. Validation process, experts/experts provide suggestions and comments to improve the e-module. The suggestions or comments from the validator are, "Based on observations of the Scratch-assisted Project Based Learning e-module that was created, there is a lot of elaboration, especially in the form of appearance, it has shown many changes that can attract students' interest in learning, apart from that in terms of content, there are there are many collaborations between Law, Middle and Hot Thinking which make this e-module almost perfect." Based on this, suggestions from validators include: The e-module needs to have an attractive cover, the features of the e-module need to be highlighted in the contents of the e-module.

Apart from the e-module, the experts also validate the expert presenters. The average validity score of material experts is 3.03, which is included in the valid criteria. In the validation process, experts/experts also provided several suggestions and comments for improving the PjBL Learning Media being developed. Some suggestions from validators include: PjBL learning media needs to have an attractive cover, it is necessary to fill in a foreword explaining the features of the PjBL learning media, instructions for using PjBL learning media need to be detailed.

This research develops a product in the form of a Scratch-assisted PjBL-oriented e-module that is in accordance with the curriculum implemented in schools and is linked to the components of the e-module so that it can be said to have met content and construct validity. There are reasons that support that the learning tools in the form of PjBL-oriented e-modules assisted by Scratch have met the valid criteria, because the learning tools developed in this research already contain Project Based Learning (PjBL) learning. The projects created by students are in the form of mathematical calculators in the Scratch application, according to the command blocks on the Student Worksheet, thus forming scripts that are used to program/run mathematical calculators in statistics learning. The learning activities and problems presented can facilitate students in improving students' computational thinking skills. The learning tools developed are in accordance with the curriculum applicable in Class VIII of SMP N 2 Kuta. This can be seen through the relevance of the basic competencies that must be achieved in mathematical learning activities in accordance with the syllabus, so that the learning tools can be applied well. The components in the e-module learning tool correspond to the validation sheet for each component and are adjusted to the revisions from the validator. On the e-module validation sheet, various aspects appear, including the contents presented and the construct. In the content aspect, we can see the clarity of the indicator formulation, the suitability of the content to the learning objectives, and the mathematical problems presented. In the construct aspect, it can be seen from the orientation of activities focused on students, the language used is in accordance with EYD, the sentences used are clear

and the pictures or tables presented are clear. The factors explained above have supported the learning tools developed to meet the criteria of being valid or suitable for application in learning activities.

It is hoped that contextual and experiential learning tools can provide students with broader opportunities to construct knowledge within themselves (Babu et al., 2020). This is what causes the e-module being developed to have the advantage of making students more active in thinking and exploring information more deeply. This is in accordance with research conducted by Wang & Wu (2023) and Gregoriou (2023) which explains that strengthening the ability of Students' thinking requires a teaching method that is contextual and makes students active in thinking. Other research conducted by Taar & Palojoki (2022) shows that the 21st century requires more complex thinking skills so that the use of the e-module developed can be considered worth trying.

The results of the analysis of student response questionnaires to the e-module product in this study showed that the average student response questionnaire to the e-module in the limited trial was 3.61. The mean obtained from a student response questionnaire was 3.57 in the field trial. So based on the practicality criteria in Chapter III, the e-module developed is based on practical criteria. Analysis of the response questionnaire data given by teachers to the e-module product in this study was divided into limited trials with an average score of 3.27 in the practical category and field trials with an average score of 3.40 in the practical category. The test for understanding mathematical concepts given to students consists of 5 questions in the form of descriptions which have previously been validated by 2 experts. The results of the analysis show that the mathematical computational thinking ability test score of class VIII students at SMP N 2 Kuta is 79.75 with a completion percentage of 84.38%. Based on the categories explained in Chapter III, these results show that the results of the student's computational thinking skills test are classified in the "Complete" category because the value is within $75 \leq X \leq 100$.

The response questionnaire sheet for class VIII students at SMP N 2 Kuta in a limited trial showed that the PjBL-oriented e-module with the help of Scratch that was developed included practical criteria. The findings during the implementation of the limited trial were that according to students, there were several questions in the e-module that were still difficult to understand, so emphasis needed to be placed on students to read the questions carefully, then identify what things they already knew to be able to find solutions. There are some students who do not understand learning activities that facilitate them to be able to discuss with other friends. This is in accordance with research conducted by Zynuddin et al. (2023) and Abdurrahman et al. (2023) state that the learning atmosphere is very important in making students understand the learning process.

Based on the results of reflection on limited trials at the first meeting, teachers and researchers continued learning activities to the second meeting. The implemented solution showed a positive impact at the second meeting. The product developed has met practical criteria, so it is ready to proceed to field trials.

Figure 1. Students experience in the field test

Based on the results of the student and teacher response questionnaire to the e-module product, the learning device meets the researchers' expectations, namely meeting the practicality criteria. The results of the normalized gain score describe the increase in students' abilities by looking at their initial abilities. Based on the results of the analysis, the average gain score of the students' mathematical computational thinking skills test in class VIII at SMP N 2 Kuta was 68.93. Based on the categories explained in Chapter III, these results show that the student's computational thinking skills test gain score is in the "effective" category because this value is within $56 \leq g \leq 75$. The following is the gain score data for each indicator achievement.

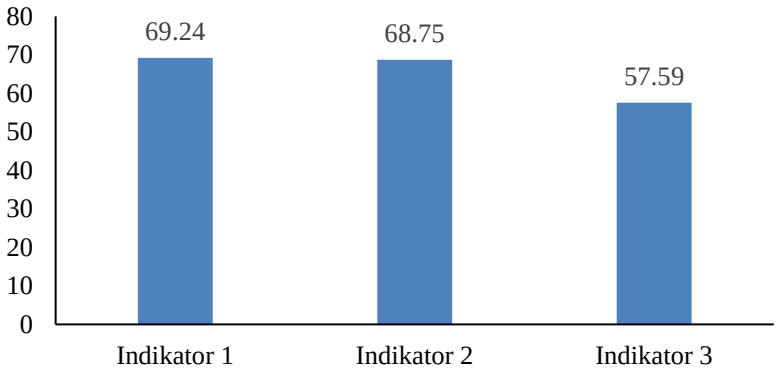

Figure 2. n-gain score for each indicator

Computational thinking questions that students work on, where students pay close attention to the questions in the form of evaluation so that they can solve the problems given. This is in accordance with research by Seung-Woo & Sangwon (2021) which explains how computational thinking can help someone do a job to get maximum results. Apart from that, the Algorithm indicator saw an increase in scores before and after learning was carried out with PjBL-oriented e-modules assisted by Scratch. This is proven by the pre-test scores, some students were not able to give the correct answer in determining the mean, median and mode values. Meanwhile, in the post-test results, students were able to give answers correctly and were able to include appropriate and sequential methods by providing appropriate conclusions regarding the problems given.

These computational thinking questions can improve the skills students have to solve a problem they face (Bhaw et al., 2023; Hassan et al. 2023; Park et al. 2023)

Improvements in learning tools from limited trials to field trials were also able to show the effectiveness of using learning tools in the form of PjBL-oriented e-modules assisted by Scratch. In limited trials, many students were still confused about connecting the correct algorithm to solve the activities and problems contained in the e-module and many students were still unable to provide logical reasons for the answers given. After revisions were made to the PjBL-oriented e-module with the help of Scratch, in the field trials the number of students who were confused about linking the algorithm decreased. So this has an impact on increasing the mathematical computational thinking abilities of Class VIII students at SMP Negeri 2 Kuta.

The learning tool developed in this research is in the form of an e-module. The material in the e-module is focused on the subject of statistics for class VIII students at SMP N 2 Kuta. The learning tools developed are PjBL-oriented with the help of Scratch, to stimulate students' computational thinking in the learning process. At the beginning of the e-module, basic competencies is presented, indicators of achieving competency, along with learning objectives to be achieved in statistics material. These three components are very important to include in the PjBL-oriented learning tool with the help of Scratch, so that students understand where learning will take place and what competencies they want to achieve. Through project management, learning can have a better impact on student development (Jääskä et al. 2022; Marnewick, 2023). If students are able to understand the objectives of the learning they will learn, it will make it easier for students to achieve those objectives (Shao et al., 2020).

In this research, the e-module has several characteristics and special features, namely the Project Based Learning (PjBL) oriented e-module with the help of Scratch was developed using 000webhost. The e-module file format is supported by the standard file format for digital books (ePub). The 000webhost reader software on E-Modul is capable of using laptops and Android. The e-module contains the e-module cover, basic competencies, learning objectives, concept map, learning sub-materials, summary, self-assessment, evaluation and bibliography. Apart from that, the e-module contains projects created by students in the form of mathematical calculators to solve statistics learning problems. The e-module developed is stand alone or does not depend on other learning materials or does not require other supporting equipment to use. Learning activities in the e-module are equipped with video, audio, illustrations and pictures.

Based on the characteristics and features above, this e-module is different from other e-modules, this difference is from research conducted by (Nasiba, 2022), namely the development of learning media with the help of secret safes to improve students' abilities in solving problems using computational thinking. , while in this research we developed a PjBL-oriented e-module assisted by Scratch to improve students' computational thinking skills. Research conducted by (Cahdriyana & Richardo, 2020) examined the computational thinking process of mathematics learning for students. Meanwhile, this research developed a PjBL-oriented e-module with the help of Scratch on statistical material to improve students' computational thinking skills. Research by (Susanto et al., 2023) namely the development of Thematic Learning Lecture e-modules. Meanwhile, this research developed a PjBL-oriented e-module with the help of Scratch on statistics material for class VIII middle school students to improve students'

computational thinking skills. Research conducted by (Amalia & Sujatmiko, 2022) examines the use of e-modules which are considered to be able to improve student learning outcomes in 2D and 3D animation engineering subjects in class Class VIII middle school. Research conducted by (Hayati & Fauziah, 2023) examined the PjBL-based physics experimental e-module, while this research developed a PjBL-oriented e-module assisted by Scratch on statistics material for class VIII middle school students to improve students' computational thinking skills.

Based on the differences in e-module development products above, this research was able to develop a PjBL-oriented e-module assisted by Scratch for class VIII middle school students according to the 2013 curriculum with statistical material to improve students' computational thinking skills. The importance of computational thinking skills is in line with the opinion of Lestari & Annizar (2020), computational thinking is a series of patterns that show the competence of thinking: understanding problems in solving problems with clear depictions, carrying out reasoning at the level of abstraction, and developing solutions that are carried out automatically . Computational thinking skills are very important for students to have since entering junior high school (SMP) as a form of change in the mindset of students at a higher level (Sa'diyyah et al., 2021).

▪ CONCLUSION

This research, which was carried out in class VIII of SMP Negeri 2 Kuta, has succeeded in developing learning tools including PjBL-oriented e-modules assisted by Scratch that are valid, practical and effective in improving the mathematical computational thinking skills of class VIII students of SMP Negeri 2 Kuta. This is supported by the results of the validation score from experts of 3.10 in the valid category. Student responses to the e-module got a mean score of 3.57 in the very practical category. The teacher's response to the e-module received a score of 3.40 in the practical category. The gain score result of the student's mathematical problem solving ability test was 68.93, classified in the "effective" category. So from these results it can be stated that the e-module developed is in accordance with the criteria of being valid, practical and effective.

The learning tools developed also have characteristics that differentiate them from other learning tools. These characteristics are a) The images in the e-module learning activities are attractive with several project-based worksheets so that they can stimulate students to improve their computational thinking skills by constructing their own knowledge through pictures and learning videos, b) The problems presented in the e-module contextual in nature so that it can stimulate students to improve their computational thinking skills by finding and completing their own learning and gaining direct experience in the learning process, c) student worksheets in the e-module have been adapted to learning projects to train students' computational thinking skills with the help of Scratch .

The learning tools developed are only limited to class VIII statistics material at SMP Negeri 2 Kuta, so that educational practitioners who are interested can develop similar learning tools with a wider range of material. The subjects in this research are only limited to class VIII students at SMP Negeri 2 Kuta, so that educational practitioners who are interested can develop similar products with a wider range of subjects. It does not rule out the possibility that teachers or any parties who use products developed in other learning models may find actions or alternatives that are not yet included in the product

developed, which can then be used as a guide for teachers in carrying out the learning process using the product developed. in this research.

▪ REFERENCES

Abdurrahman, A., Maulina, H., Nurulsari, N., Sukamto, I., Umam, A. N., & Mulyana, K. M. (2023). Impacts of integrating engineering design process into STEM makerspace on renewable energy unit to foster students' system thinking skills. *Heliyon*, *9*(4), 1–12.

Agung, I. D. G., Suardana, I. N., & Rapi, N. K. (2022). *E-modul IPA dengan model STEM-PjBL berorientasi pendidikan karakter untuk meningkatkan hasil belajar siswa* [Science e-module with the STEM-PjBL model oriented to character education to improve student learning outcomes]. *Jurnal Imiah Pendidikan dan Pembelajaran*, *6*(1), 120.

Amalia, I., & Sujatmiko, B. (2022). *Pengembangan e-modul berbantuan flipbook berbasis PjBL guna meningkatkan hasil belajar siswa pada mata pelajaran teknik animasi 2D dan 3D kelas XI multimedia (studi kasus: SMKN 2 Singosari)* [PjBL-based flipbook assisted e-module development to improve student learning outcomes in class XI multimedia 2D and 3D animation subjects (case study: SMKN 2 Singosari)]. *Jurnal IT-EDU*, *7*(1), 92–99.

Babu, A. R., Arulanand, N., & Chandran, V. S. (2020). Skill development through experiential learning -a case study for product development scenario. *Procedia Computer Science*, *172*(2020), 16–21.

Bhaw, N., Kriek, J., & Lemmer, M. (2023). Insights from coherence in students' scientific reasoning skills. *Heliyon*, *9*(7), 1–13.

Cahdriyana, R. A., & Richardo, R. (2020). *Berpikir komputasi dalam pembelajaran matematika* [Computational thinking in mathematics learning]. *LITERASI (Jurnal Ilmu Pendidikan)*, *11*(1), 50.

Celik, I. (2022). Exploring the determinants of artificial intelligence (AI) literacy: digital divide, computational thinking, cognitive absorption. *SSRN Electronic Journal*, *83*(7), 1–11.

Danindra, L. S., & Masriyah. (2020). *Proses berpikir komputasi siswa SMP dalam memecahkan masalah pola bilangan ditinjau dari perbedaan jenis kelamin* [Computational thinking processes of junior high school students in solving number pattern problems in terms of gender differences]. *MATHEdunesa*, *9*(1), 95–103.

Gregoriou, M. (2023). Possibility thinking pedagogy: Exploring the role of the teachers' meddling-in- the-middle in fostering children's possibility thinking by utilising learning resources linked to museum visits. *Thinking Skills and Creativity*, *49*(7), 1–15.

Guggemos, J. (2021). On the predictors of computational thinking and its growth at the high-school level. *Computers and Education*, *161*(10), 1–15.

Hassan, M. U., Alaliyat, S., Sarwar, R., Nawaz, R., & Hameed, I. A. (2023). Leveraging deep learning and big data to enhance computing curriculum for industry-relevant skills: A Norwegian case study. *Heliyon*, *9*(4), 1–13.

Hayati, P., & Fauziah, R. N. (2023). P*engembangan e-modul eksperimen fisika berbasis project based learning* [Development of a project-based learning physics experiment e-module]. *Journal on Education*, *05*(03), 10728–10734.

Hooijdonk, M. Van, Mainhard, T., Kroesbergen, E. H., & Tartwijk, J. Van. (2023). Assessing creative problem solving in primary school students. *Learning and Instruction*, *88*(7), 1–13.

Jääskä, E., Lehtinen, J., Kujala, J., & Kauppila, O. (2022). Game-based learning and students' motivation in project management education. *Project Leadership and Society*, *3*(7), 1–13.

Lestari, A. C., & Annizar, A. M. (2020). *Proses berpikir kritis siswa dalam menyelesaikan masalah PISA ditinjau dari kemampuan berpikir komputasi* [Students' critical thinking processes in solving PISA problems in terms of computational thinking skills]. *Jurnal Kiprah*, *8*(1), 46–55.

Marnewick, C. (2023). Student experiences of project-based learning in agile project management education. *Project Leadership and Society*, *4*(3), 1–10.

Nasiba, U. (2022). *Brankas rahasia : media pembelajaran numerasi berbasis berpikir komputasi untuk meningkatkan kemampuan pemecahan masalah* [Secret safe: learning media for numeracy based on computational thinking to improve problem solving skills]. *Jurnal Didaktika Pendidikan Dasar*, *6*(2), 521–538.

Ningtyas, A. R., Semarang, U. N., & Semarang, K. (2022). *Kajian teori : pengembangan bahan ajar model problem based learning bernuansa STEM* [Theoretical study: development of problem-based learning model teaching materials with STEM nuances]. *Seminar Nasional Matematika, Geometri, Statistika, Dan Komputasi*. *1*(1), 441-454.

Park, J. H., Li, Y., & Niu, W. (2023). Revisiting creativity and critical thinking through content analysis. *Journal of Creativity*, *33*(2), 1–7.

Sa'diyyah, F. N., Mania, S., & Suharti. (2021). *Pengembangan instrumen tes untuk mengukur kemampuan berpikir komputasi siswa* [Development of test instruments to measure students' computational thinking abilities]. *JPMI: Jurnal Pembelajaran Matematika Inovatif)*, *4*(1), 17–26.

Sanusi, I. T., Oyelere, S. S., Vartiainen, H., Suhonen, J., & Tukiainen, M. (2023). Developing middle school students' understanding of machine learning in an African school. *Computers and Education: Artificial Intelligence*, *5*(7), 1–11.

Seung-Woo, & Sangwon. (2021). Proposal of electronic engineering exploration learning operation using computing thinking ability. *International Journal of Advanced Culture Technology*, *9*(4), 110–117.

Shao, Z., Wang, L., & Wang, Y. (2020). The exploration of the teaching system for the training of computational thinking of new medical engineering talents. *International Conference on Education, Sport and Psychological Studies*, *1*(1), 177–183.

Sriwindari, W., Asih, T., & Noor, R. (2022). *Pengembangan e- modul berbasis PjBL (project based learning) materi daur ulang limbah* [Development of PjBL-based e-modules (project based learning) on waste recycling materials]. *Seminar Nasional Pendidikan IPA Tahun 2022*, *1*(1), 12–20.

Susanto, I. A., Mukminin, A., Anwari, A., & Jalal, M. (2023). *Pengembangan e-modul perkuliahan tematik terpadu menggunakan pendekatan pembelajaran aktif mikir dan project based learning pada program studi pendidikan dasar sumatera selatan Indonesia* [Development of integrated thematic lecture e-modules using an active thinking learning approach and project based learning in the basic education study

program of South Sumatra, Indonesia]. *Journal on Education*, *05*(04), 14414–14423.

Taar, J., & Palojoki, P. (2022). Applying interthinking for learning 21st-century skills in home economics education. *Learning, Culture and Social Interaction*, *33*(3), 1–11.

Tabesh, Y. (2017). *Computational Thinking: A 21st Century Skill*. Olympiade in Informaticss.

Tian, X., Li, C., & Zhao, Y. (2021). Investigation on computational thinking of normal students based on technology acceptance model. *ACM International Conference Proceeding Series*, *1*(1), 303–308.

Triantoro, M. (2022). *Pengembangan modul pembelajaran berbasis project based learning untuk membantu meningkatkan berfikir kreatif mahasiswa* [Development of project-based learning modules to help improve students' creative thinking]. *Konstruktivisme : Jurnal Pendidikan Dan Pembelajaran*, *14*(1), 13–22.

Tsopra, R., Peiffer-Smadja, N., Charlier, C., Campeotto, F., Lemogne, C., Ruszniewski, P., Vivien, B., & Burgun, A. (2023). Putting undergraduate medical students in AI-CDSS designers' shoes: An innovative teaching method to develop digital health critical thinking. *International Journal of Medical Informatics*, *171*(7), 1–10.

Wang, Y., & Wu, Z. (2023). Adapting or adopting? Critical thinking education in the East Asian cultural sphere: A systematic integrative review. *Thinking Skills and Creativity*, *49*(2), 1–13.

Widana, I. W., & Septiari, K. L. (2021). *Kemampuan berpikir kreatif dan hasil belajar matematika siswa menggunakan model pembelajaran project-based learning berbasis pendekatan STEM* [The ability to think creatively and students' mathematics learning outcomes using a project-based learning model based on the STEM approach]. *Jurnal Elemen*, *7*(1), 209–220.

Wijnen, F., Walma van der Molen, J., & Voogt, J. (2021). Measuring primary school teachers' attitudes towards stimulating higher-order thinking (SHOT) in students: Development and validation of the SHOT questionnaire. *Thinking Skills and Creativity*, *42*(7), 1–15.

Wing, J. M. (2012). *Computational thinking*. Computer Science Department.

Yilmaz, R., & Yilmaz, F. G. K. (2023). The effect of generative artificial intelligence (AI)-based tool use on students' computational thinking skills, programming self-efficacy and motivation. *Computers and Education: Artificial Intelligence*, *4*(6), 1–14.

Zynuddin, S. N., Kenayathulla, H. B., & Sumintono, B. (2023). The relationship between school climate and students' non-cognitive skills: A systematic literature review. *Heliyon*, *9*(4), 1–25.