Berkala Ilmiah Pendidikan Fisika
ISSN: 2337-604X (print)
ISSN: 2549-2764 (online)

Vol 9 No 3 2021
https://ppjp.ulm.ac.id/journal/index.php/bipf
page 285-297

Development of a Science Module on Temperature and Heat Topics to Improve Critical Thinking and Collaboration Skills

Mohamad Nor Aufa[1], Sutarto Hadi[2], Syahmani[3], Rusmansyah[4], Muhammad Hasbie[5], and Isnawati[6]

[1]Master of Natural Science Education, Postgraduate,
University of Lambung Mangkurat Indonesia
[2]Mathematics Education, Faculty of Teacher Training and Science Education,
Lambung Mangkurat University Indonesia
[34]Chemistry Education, Faculty of Teacher Training and Science Education,
Lambung Mangkurat University Indonesia
[5]Master of Natural Science Education, Postgraduate, University of Lambung Mangkurat
[6]SMPN 6 Banjarmasin, Indonesia
mohamadnoraufa@gmail.com

DOI:10.20527/bipf.v9i3.11142

Received : 14 July 2021 Accepted : 15 October 2021 Published : 31 October 2021

Abstract

This study aims to produce a science module based on mobile-collaborative-based science learning (m-CBSL) with the topic of temperature and heat and describe the resulting module's validity and practicality. The research design was Educational Design Research (EDR). The data collection techniques used were literature study, walkthrough, interview, and questionnaire. The instrument used in this study was a questionnaire of validity and practicality. Data analysis techniques include descriptive data analysis, validation sheets, and questionnaires. Module validation sheets were given to 5 validators. In contrast, practicality sheets were given to 9 students of class VII SMP Negeri 12 Banjarmasin (small group) and 62 students and three science teachers at SMP Negeri 6 & 12 Banjarmasin field test. The validity questionnaire analysis results concluded that the validity of the module was 3.71 "very valid" categories. The practicality level based on the teacher's questionnaire scored 87.04 in the "very practical" category. The small group questionnaire scored 85.19 in the "very practical" category, and the field trial questionnaire scored 86.42 in the "very practical" category. It means that the m-CBSL based science module is valid and practical in the learning process to improve critical thinking skills and collaboration.

Keywords: Collaboration Skills; Critical Thinking Skills; M-CBSL Model; Mobile Learning; Modules

How to cite: Aufa, M. N., Hadi, S., Syahmani, Rusmansyah, Hasbie, M., & Isnawati (2021). Development of a science module on temperature and heat topics to improve critical thinking and collaboration skills. *Berkala Ilmiah Pendidikan Fisika*, *9*(3), 183-195.

INTRODUCTION

In the concept of Society 5.0, technological advances are used to improve quality of life, social responsibility, and sustainable development. To overcome the

complexity of living conditions in the era of society 5.0, students should not only have reading, writing, and arithmetic skills, known as "Tree R" (read, writing, arithmetic), but they also need to have skills in critical matters 21st-century or Century Skill 21. It is the ability to communicate, innovate, think critically, and collaborate, or "Four-C" (communication, critical, creative, and collaboration).

The 21st-century skills are the necessary skills that everyone must master to successfully face the challenges, problems, life, and careers of the 21st-century. The rapid development of science and technology demands fundamental changes in education systems around the world (including Indonesia) to foster a generation of thinkers who can face life's challenges and problems that are different from the past (Astra, 2018; Shpeizer, 2018; Suryanti, Arifin, & Baginda, 2018; Zulmaulida, Wahyudin, & Dahlan, 2018). Educators can adopt a 21st-century learning framework so that Indonesian students can solve life problems that develop and become more holistic (Anazifa, 2017; Hastuti, Nurohman, & Setianingsih, 2018; Rachmawati, Prodjosantoso, & Wilujeng, 2019; Redhana, 2019). Critical thinking and collaboration skills are two skills of "Four Cs," including learning science's main objectives and one of the 2013 SMP/MTs science curriculum requirements to foster a quality Indonesian generation (Suryanti et al., 2018; Zulmaulida et al., 2018).

Critical thinking skills are skills in (1) problem solving, applying and using concepts, (2) freedom of thought, use of knowledge and responsibility for making decisions, (3) overcoming bias, bigotry and stereotypical thinking; thinking to make decisions, interpretation of problems, and (4) thinking based on skills and responsibilities that lead to assessments based on criteria and sensitive to problems (Ennis, 2011; Zivkovic, 2016). This study's critical thinking skills are 5 of 6 main critical thinking skills according to Facione's interpretation, analysis, evaluation, inference, and explanation.

Collaboration skills are the ability to interact with other people by working together to achieve goals by respecting differences, participating in discussions, giving suggestions, listening, and supporting others (K. A. Sari, Prasetyo, & Wibowo, 2017). The collaboration skills used in this research are actively contributing, working (Greenstein, 2012)productively, showing flexibility and compromise, showing respect, and showing responsibility (Greenstein, 2012).

The results of preliminary research on critical thinking skills and collaboration of class VII students of SMPN 6 Banjarmasin showed that the critical thinking skills of students with a percentage of 60.81% were in a low category and collaboration skills with a rate of 60.81% in the low category (M.N Aufa et al., 2021). The results of this study are also in line with research conducted by (Anantyarta & Sari, 2017; Daniati, Handayani, Yogica, & Alberida, 2018; Karim, 2015; Martawijaya, 2015), who also express their belief that Middle school students Low critical and collaborative skills. Students still use textbooks that emphasize the content dimension rather than the process and context dimensions. The textbooks provided are only in concept definitions, a series of formulas, and exercises so that students have not been able to develop critical thinking and collaborative skills.

According to (Hariyani, Asrori, & Novitasari, 2018; Rosnanda, Sarwanto, & Aminah, 2017; Zekri, Ganefri, & Anwar, 2020), to improve and empower critical thinking skills, collaboration skills can use teaching materials in the form of modules. Modules are

alternative teaching materials so that the learning process can be student-centered, making it easier for students to find concepts and develop the learning process (Imanda, Khaldun, & Azhar, 2017; Kurniawan, Pujaningsih, Latifah, & Latifah, 2018). Modules are teaching materials arranged systematically and attractively, including material content, methods, and evaluations that can be used independently and more objectively (Pummawan, 2007; Rachmatia, Aunurrahman, & Usman, 2017).

In module development, it is necessary to pay attention to the model's selection because this is the main point so that the developed module follows the desired goals (Mohamad Nor Aufa et al., 2020; R. D. M. Sari & Rachmawati, 2017). In this module, the development research used the Collaborative Based Science Learning (CBSL) model. It is because it is one of the innovative science models due to the strengthening of the problem-based learning, inquiry, and process-oriented guided inquiry learning models and is proven to improve students' critical thinking skills and collaboration (Isnawati, Ibrahim, Tjandrakirana, & Rusmansyah, 2018). However, given the Covid-19 pandemic period, time, location, and distance are significant obstacles in the learning process. One way to overcome problems and difficulties in the face-to-face learning process is to do a distance learning process. (Kusuma & Hamidah, 2020). This pandemic condition presents a challenge to all elements to keep the class action even though the school has closed with online learning by utilizing platforms in the form of applications, websites, social networks, and learning management systems(Bao, 2020; Basilaia & Kvavadze, 2020; Gunawan, Suranti, & Fathoroni, 2020).

One alternative to the online learning process is mobile learning because it can be accessed flexibly to be implemented anytime and anywhere (Calimag et al., 2014; Darmawan, 2013). Based on the preceding, researchers hope to develop modules by combining CBSL and mobile learning models to produce science-based mobile collaborative science learning (m-CBSL) modules expected to encourage the distance learning process and improve students' critical thinking skills and collaborative skills. Moreover, face the competing demands of the 21st century to compete in the complexity of community life 5.0.

The research's focus in this article is related to the validity and practicality of the m-CBSL-based science module. Validity is a measure that shows the level of validity of an instrument (Plomp, 2013). The validity referred to in this study is the level of module validity carried out by experts/experts. Practicality is a measure that emphasizes the level of efficiency of a product (Plomp, 2013). In this study, the practicality referred to the questionnaire's readability and students' and teachers' responses to the module.

METHOD

This research type of research is education development research or Education Design Research (EDR). Education Design Research is systematic research on designing, developing, and evaluating educational interventions (such as plans, learning strategies, and teaching materials, products, and systems) to solve several existing problems (Akker et al., 2010). The development model used in this development research is the Plomp model developed by Tjreed Plomp. This model is used because the development steps are more straightforward to understand. The Plomp development model includes the preliminary research stage, the development stage, and the assessment stage (Table 1).

Table 1 Evaluation Criteria in Development Research

Phases	Criteria	Activity Description
Preliminary Research	Emphasis on content validity	Problem analysis and literature study. The result of this phase is the initial prototype design form
Development Stage/ Prototype Formation Stage	Focus on consistency (construct validity) and practicality	The prototype development will be tested in stages and revised based on the formative evaluation stage
Assessment Stage	Practicality	Assess whether users can use the product practically (practicality)

(Ploomp, 2013)

The population in this study were students of class VII SMP/MTs, while the research samples were SMP Negeri 6 and SMP Negeri 12 Banjarmasin. Sampling using non-probability sampling with purposive sampling technique. The research was conducted from August to October 2020. Five experts reviewed the expert review stage consisting of 3 lecturers from Lambung Mangkurat University and two science teachers from SMP Negeri 6 and 12 Banjarmasin. Three students from SMP Negeri 12 Banjarmasin to do an individual trial. Small groups were conducted by nine students of SMP Negeri 12 Banjarmasin. Field tests on three science teachers and 62 students from SMP Negeri 6 and 12 Banjarmasin (31 students from SMP Negeri 6 Banjarmasin and 31 students from SMP Negeri 12 Banjarmasin). In the preliminary research phase, identification and analysis of the research needs of the development of m-CBSL-based science modules at temperature and heat were carried out for class VII SMP/MTs. The study of questions included needs analysis, curriculum analysis, student analysis, and concept analysis. Furthermore, a formative evaluation was carried out at the prototype formation stage/development stage on each resulting prototype. Formative assessment was carried out to design the products produced, in this case, in an m-CBSL-based IPA module. The formative evaluation in the prototype formation stage created prototypes I, II, III, and IV.

In prototype I, the realization resulted from the design process. The checklist system evaluated prototype I through self-assessment to see the completeness of the components making up the prototype and the prototype's actual errors. The results of the evaluation of prototype I were revised into prototype II. The prototype type II conducted a one-to-one assessment of three VII students of SMP Negeri 12 Banjarmasin with different learning abilities and was evaluated by five experts, three lecturers from Lambung Mangkurat University, and two science student-teachers from SMP Negeri 6 and 12 Banjarmasin. This individual trial was conducted to identify possible errors such as inadequate grammar comprehension, spelling errors, punctuation marks, unclear instructions, material system, ease of use, attractiveness, and student satisfaction. Simultaneously, the verifier performed an expert review to verify the module based on content, language, and representation. Based on one-to-one tests and expert reviews, the module was refined to get a better module. The result of the improvement of this module was called Prototype III. Prototype III was evaluated by a group of 9 grade VII students from SMP Negeri 12 Banjarmasin. Based on the results of the assessment, revisions were made. The

results of this revision were called prototype IV. Then prototype IV was tested in the field (field test) consisting of 3 science teachers from SMP Negeri 6 & 12 Banjarmasin and 62 students of SMP Negeri 6 & 12 Banjarmasin to produce the final product in the form of a science module.

The data collection technique was done through documentation, walkthrough, interview, and questionnaire. The documentation aimed to collect various supporting documents for the development of the m-CBSL-based science module. The exercise was included in the validator evaluation stage to determine the validity of the m-CBSL-based science module in terms of content, language, and representation. The interview was an individual evaluation stage to identify possible mistakes such as poor grammar, incorrect spelling, punctuation, unclear instructions, material system, ease of use, attractiveness, and student satisfaction. Finally, practicality questionnaires were given to small groups and field trials to determine students 'and teachers' assessments of the m-CBSL-based science module.

The data analysis technique consisted of descriptive data analysis, validation sheets, and questionnaire sheets. Descriptive data analysis was performed by analyzing data collected from documentation in validation sheets and questionnaires. The validation sheet and questionnaire data analysis were carried out by processing the values obtained at the expert validation stage and product practicality testing. A formula can determine the validity of the m-CBSL-based science module. The score obtained was divided by the total score (overall) 4 times and converted to Table 2. While the formula determined the practicality of the m-CBSL based module, the score obtained was divided by the total score times 100 and converted to Table 3.

Table 2. Validity Criteria

Interval	Validation
$3.25 < P \leq 4.00$	Very valid
$2.50 < P \leq 3.25$	Valid
$1.75 < P \leq 2.50$	Less valid
$1.00 \leq P \leq 1.75$	Invalid

Modification (Akbar, 2013)

Table 3. Practicality Criteria

Interval	Practicality
$P \geq 85\%$	Very practical
$70\% \leq P < 85\%$	Practical
$50\% \leq P < 70\%$	Less Practical
$P < 50\%$	Inpractical

Modification (Akbar, 2013)

RESULT AND DISCUSSION

This research produced an m-CBSL-based science module to improve critical thinking and collaboration skills. This research focused on validity and practicality while the effectiveness of further research will be carried out then. The m-CBSL-based science module was developed according to the three main stages of Educational Development Research (EDR): the preliminary stage (analysis stage), the product design stage, and the formative evaluation stage. The latest stage consisted of expert reviews, one-on-one, small groups, and field testing (Tessmer, 1993).

The validity and practicality of the m-CBSL-based science module were verified by validator evaluations, individual trials, small groups, and field trials. The validator carried out the truth to verify all aspects of content, language, and representation. Simultaneously, practicality is proven by asking students' opinions in questionnaires in individual trials, small groups, and field trials.

Preliminary Research Stage

The analysis stage is the initial step of this development research, including literature research and needs identification. Before determining needs,

the author first conducts preliminary research to support the m-CBSL-based science module's development needs. The main reason for developing m-CBSL-based science modules is to equip students with 21st-century skills to compete in society's very complex 5.0 life. Based on preliminary research results, students of class VII SMPN 6 Banjarmasin on critical thinking skills and collaboration of environmental pollutants, students' critical thinking skills are 60.81%, low category, and low collaboration skills. The gradient is 60.21%, and the category is low (Aufa et al., 2021).

Other research states that low critical thinking skills and collaboration, one of the factors are the lack of teaching materials that can develop and accommodate the needs of students to critical thinking and collaboration skills (Astika, Suma, & Suastra, 2013; Martawijaya, 2015; Prasetyorini, ., & Bachri, 2017; Rofiah, Aminah, & Sunarno, 2018). The results of interviews and researcher observations on several science teachers at SMPN 6 Banjarmasin, in general, the teachers' teaching materials were still not in by the demands of the 21st-century learning competence and the 2013 curriculum because they were still having difficulties in developing teaching materials.

It is in line with research (Makhrus, Harjono, Syukur, Bahri, & Muntari, 2019). Teachers' assessment of teaching materials ranged from 33% to 66%, so there still needs to be revisions and improvements. The teaching materials already contain critical thinking skills in presenting the material but do not cover all dimensions of critical thinking skills. Also, the results of (N. F. Sari, Ritonga, & Gultom, 2019) research show several causes of student difficulties in SMP /MTs science subjects, namely: (1) difficulty understanding school handbooks by 35.76%, (2) lack of learning media by 10.22%, (3) lack of other book sources is 5.84%.

After conducting library research, it is continued by determining the selection or determination of core competency needs (KI) and essential competencies (KD) based on Permendikbud Number 35 concerning the Junior High School / Madrasah Tsanawiyah Curriculum 2013 the year 2018. Besides, the design stage is divided into three phases: formulating learning indicators that can produce 15 learning indicators, compiling, or determining the proportion of material to be included in the module, and finally making the first draft of the m-CBSL-based science module.

Prototype Formation Stage/ Development Stage

The prototype stage is a micro research cycle with formative evaluation as follows:

Prototype design I

At this stage, the design and implementation results appear in teaching materials in the form of science modules on the topic of temperature & heat for class VII SMP / MTs. The design of teaching materials in the form of m-CBSL-based science modules on temperature & heat has module components in writing. The details in the module are based on the Teaching System with Modules book, according to (Suryosubroto, 1983). The members are as follows: Teacher Guidelines, Student Activity Sheets, Worksheets, Worksheet Keys, Test Sheets, and Test Sheet Keys. Also, the designed modules will be continued at the next module development stage. The following is a description and explanation of the resulting module. The module cover contains the logo, module title, author name, author agency, and target users. Module titles are used as information providers for module users to understand the material discussed in the module. Author and agency names provide

information for module users to find information about authors and author agencies. The module cover is designed in soft colors, against a blue and black background, and images related to the temperature and heat theme. Soft colors (like blue) are the most popular colors. Besides that, blue also symbolizes trust, comfort, and pleasing to the eye (Purbasari & Jakti, 2014).

Prototype II

Prototype II is the prototype produced after formative evaluation in the form of self-evaluation. The purpose of self-assessment is to carefully check the integrity of the components contained in the module. Based on the evaluation results, it was found that the prototype needed to be revised in several parts: improving the table of contents, reducing unnecessary words, adding questions, improving formula writing, completing learning indicators, correcting, and including each source's picture.

Prototype III

Prototype III is the prototype produced after formative evaluation in the form of individual trials and expert reviews. Individual evaluations and expert reviews were carried out on the revised prototype II. Three students concluded that the m-CBSL-based science module was good enough based on interviews and personal trials. It is supported by the language used, which was very easy to understand. The module's appearance of colors, letters, symbols, and image design can make students interested and excited to learn it. Expert assessment (expert review) aimed to get a scientifically valid prototype. The validation of prototype II was carried out by five validators, including three ULM lecturers and two science teachers at SMP Negeri 6 & 12 Banjarmasin. The validity data of prototype II can be seen in Table 4 and Figure 1.

Table 4. Data Validity of m-CBSL Based Science Module

Assessment Indicator	Item of Assessment	Average
	Content Aspects	
Suitability of material with the competencies in the curriculum	Completeness of the material	4.6
	Depth of material	4.6
Material accuracy	Accuracy of concepts and definitions	4.6
	Example accuracy	4.8
	Question accuracy	4.6
	Accuracy of drawings, diagrams, and illustrations	4.2
Supporting learning materials	Reasoning	4.4
	Linkages	4.6
	Communication	4.8
	Application	4.4
	Material attractiveness	4.8
Material finesse	Suitability of the material with the development of science	4.4
	Actual pictures, diagrams, and illustrations	4.8
	Up-to-date library	4.6
Content Aspect Total Score		**64.2**
Presentation Aspects		
Presentation	Systematic consistency of the module's presentation	4.8
Technique	Serving wrinkles	4.4
Serving Support	foreword	5

	Module characteristics	4.8
	Table of contents	5
	Summary / Conclusion	4.4
	Bibliography	4.8
	Glossary	4.8
Presentation of Learning	The involvement of students	4.8
Completeness of	Introduction section	4.6
Serving	Content section	5
	Closing Part	4.8
Total Score of Presentation Aspects		**57.2**
Aspects of Language		
Straightforward	The accuracy of sentence structure	4.4
	The effectiveness of sentences	4.2
	The rigor of the term	4.6
Communicative	Readability of information	4.4
	The accuracy of using language rules	4.6
Dialogue and	The ability to motivate messages or information	4.4
interactive	Ability to encourage critical thinking	5
Suitability with the level of development of students	Conformity with the intellectual development of students	4.8
	Conformity with the level of emotional development of students	4.6
Cluster and coherence of thought lines	Cluster and coherence between learning activities	4.8
	Cluster and cohesiveness between paragraphs	4.6
Use of terms, symbols, or icons	Consistent use of terms	4.4
	Consistent use of symbols or icons	4.6
Total Score of Language Aspects		**59.4**

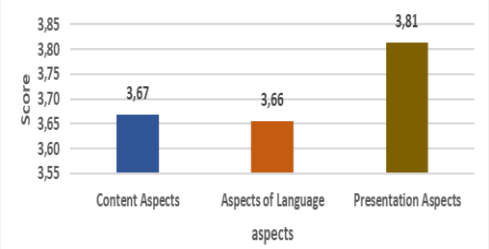

Figure 1 Validation Results

Based on the analysis of the verification results of Prototype II validity, it is known that the validity value of Prototype II is 3.71 with a very valid category. This research aligns with the research results (Feriyanto & Putri, 2020; Sawitri, Asrizal, Zulhendri, & Afrizon, 2019; Sugianto, Ahied, Hadi, & Wulandari, 2018). A quality learning module is suitable for use. It meets the evaluation of validity standards assessed by experts. However, although prototype II's validity is very high, some parts need to be revised to produce a valid prototype III.

Prototype IV

Prototype IV is the prototype produced after conducting a formative evaluation in a small group test. The small group test was carried out by nine students of class VII SMP Negeri 12 Banjarmasin. In prototype III has been revised. The purpose of conducting a small group test was to determine the practicality of the resulting prototype III. Based on the results of trials in small groups, temporary practicality data were obtained from prototype III as in Table 5 below:

Table 5 Practical Results for Small Groups

Students	Average	Category
S1	88.33	Very Practical
S2	86.67	Practical
S3	81.67	Practical
S4	80.00	Very Practical

S5	83.33	Very Practical
S6	85.00	Very Practical
S7	86.67	Very Practical
S8	86.67	Very Practical
S9	88.33	Very Practical
	85.19	Very Practical

S= Student

Based on the analysis of practical results in small group trials based on the content, language, and presentation of prototype III, prototype III has been practiced in the "very practical" category. However, although prototype III's practicality is in the "very practical" category, some parts still need to be improved to produce a valid and practical prototype IV. A valid and practical prototype IV will be tested in the field.

The Assessment Phase

The module that will be used in the field test is a module that has been revised based on research data obtained in the small group evaluation called prototype IV. Field tests were carried out on science teachers and grade VII students at SMP Negeri 6 & 12 Banjarmasin. Following is Table 6, the practical results of the field test (field test) for teachers and students.

Table 6 Practical Results for Field Test

Respondents	**N**	**Average Score**	**Category**
Teacher	3	87.04	Very Practical
Students	62	86.42	Very Practical

A practicality questionnaire in the field test (field test) was given to three science teachers at SMP Negeri 6 & 12 Banjarmasin. Based on the results of practical data analysis from 3 science teachers at SMP Negeri 6 & 12 Banjarmasin, the four aspects (content, language, presentation, and conformity) with the CBSL model scored 87.04 with the "very practical" category. Thus, based on several teachers' considerations, the m-CBSL-based science module is very practical and can be used in the seventh grade SMP / MTS science learning process. Meanwhile, the field test's practicality questionnaire was given to 62 students of class VII SMP Negeri 6 & 12 Banjarmasin. The results of practicality data analysis were obtained from four aspects: content, language, presentation, and conformity with the CBSL model, scored 86.42, with the "very practical" category. According to the results of previous research, if the module gets an average score in the practical/very practical category, it can be used in the learning process (Navisah, Wati, & Salam, 2021; Ningrum, Dewi, & Parmin, 2018)

CONCLUSION

Based on the results of the research, it can be concluded that: 1) The m-CBSL-based science module on the topic of temperature and heat improves critical thinking skills and collaboration of students, 2) Science module based on m-CBSL has validity and practical, based on the assessment of experts, students and science teachers so that the m-CBSL-based science module can be used in the learning process to improve critical thinking skills and collaboration.

REFERENCE

Akbar, S. (2013). *Instrumen perangkat pembelajaran*. Bandung: Rosdakarya.

Akker, J. van den, Bannan, B., Kelly, A. E., Nieveen, N., & Plomp, T. (2010). *An introduction to educational design research*. Netherland: Netherland Institute.

Anantyarta, P., & Sari, R. L. I. (2017). Keterampilan Kolaboratif dan metakognitif melalui multimedia berbasis means ends analysis collaborative and metacognitive skills through multimedia means ends analysis based. *Jurnal Biologi Dan Pembelajaran Biologi*, *2*(2), 33–43.

Anazifa, R. (2017). Project- based

learning and problem- based learning: Are they effective to improve student's thinking skills? *Jurnal Pendidikan IPA Indonesia*, *6*(2), 346–355. https://doi.org/10.15294/jpii.v6i2.11100

Astika, I. K. U., Suma, I. K., & Suastra, I. W. (2013). Pengaruh model pembelajaran berbasis masalah terhadap sikap ilmiah dan keterampilan berpikir kritis. *E-Journal Program Pascasarjana Universitas Pendidikan Ganesha Program Studi IPA*, *3*(2), 1–10.

Astra, I. M. (2018). Character building in physics learning for Indonesia children. *Journal of Physics: Conference Series*, *1040*(1). https://doi.org/10.1088/1742-6596/1040/1/012043

Aufa, M.N, Hadi, S., Syahmani, Hasbie, M., Fitri, M. A., Saputra, M. ., & Isnawati. (2021). Profile of students ' critical thinking, creativity, and collaboration skills on environmental pollution material Profile of students' critical thinking, creativity, collaboration skills on environmental pollution material. *In Journal of Physics: Conference Series*, *1760*(1), 1–5. https://doi.org/10.1088/1742-6596/1760/1/012027

Aufa, Mohamad Nor, Iriani, R., Saadi, P., Hasbie, M., Fitri, M. A., & Yunita, A. (2020). Module development with problem based learning (pbl) modal based on environmetal wetland to increase student learning outcomes. *Jurnal Kimia Dan Pendidikan Kimia*, *5*(2), 201–210.

Bao, W. (2020). COVID-19 and online teaching in higher education : A case study of Peking University. *Hum Behav & Emerrg Tech*, *2*(March), 113–115. https://doi.org/10.1002/hbe2.191

Basilaia, G., & Kvavadze, D. (2020). Transition to online education in schools during a sars-cov-2 coronavirus (covid-19) pandemic in georgia. *Pedagogical Research*, *5*(4), 1–9.

Calimag, J. A. N. N. V, Miguel, P. A. G., Conde, R. S., & Aquino, L. B. (2014). Ubiquitous learning environment using android mobile application. *International Journal of Research in Engineering & Technology (IMPACT: IJRET)*, *2*(2), 119–128.

Daniati, N., Handayani, D., Yogica, R., & Alberida, H. (2018). *Analisis tingkat kemampuan berpikir kritis peserta didik kelas vii smp negeri 2 padang tentang materi pencemaran lingkungan*. Universitas Negeri Padang.

Darmawan, D. (2013). *Teknologi pembelajaran*. Bandung: Remaja Rosdakarya.

Ennis, R. H. (2011). Critical thinking: Reflection and perspective-Part I. *Inquiry*, *22*(1).

Feriyanto, F., & Putri, R. O. E. (2020). Developing mathematics module based on literacy and higher order thinking skills (hots) questions to train critical thinking ability of high school students in mojokerto developing mathematics module based on literacy and higher order thinking skills. *Journal of Physics: Conf. Series*, (1594), 1–7. https://doi.org/10.1088/1742-6596/1594/1/012014

Greenstein, L. (2012). *Assessing 21st century skills: A guide to evaluating mastery and authentic learning*. California: Corwin.

Gunawan, Suranti, N. M. Y., & Fathoroni. (2020). Variations of models and learning platforms for prospective teachers during the covid-19 pandemic period. *Indonesian Journal of Teacher Education*, *1*(2), 61–70.

Hariyani, M., Asrori, A., & Novitasari, A. (2018). *Pengembangan Modul*

biologi berbasis sets pada materi pencemaran lingkungan untuk memperdayakan berpikir kritis siswa kelas vii smp/mts. Universitas Islam Negeri Raden Intan Lampung.

Hastuti, P. W., Nurohman, S., & Setianingsih, W. (2018). The Development of science worksheet based on inquiry science issues to improve critical thinking and scientific attitude the development of science worksheet based on inquiry science issues to improve critical thinking and scientific attitude. *Journal of Physics: Conference Series*, (1097), 1–7.

Imanda, R., Khaldun, I., & Azhar. (2017). Pengembangan modul pembelajaran kimia sma kelas xi pada materi konsep dan reaksi-reaksi dalam larutan asam basa. *Indonesian Journal of Science Education*, *5*(2), 41–48. https://doi.org/10.24815/jpsi.v5i2.9816

Isnawati, Ibrahim, M., Tjandrakirana, & Rusmansyah. (2018). Improving critical thinking skills and student responsibilities through collaborative based science learning (cbsl) model. *Advances in Social Science, Education and Humanities Research*, *274*, 112–116.

Karim, N. (2015). Kemampuan berpikir kritis siswa dalam pembelajaran dalam pembelajaran matematika dengan menggunakan model jucama di sekolah menengah pertama. *EDU-MAT: Jurnal Pendidikan Matematika*, *3*(1). https://doi.org/10.20527/edumat.v3i1.634

Kurniawan, W., Pujaningsih, F. B., Latifah, & Latifah, N. A. (2018). Analisis kebutuhan mahasiswa terhadap bahan ajar sebagai acuan pengembangan modul fisika gelombang bola dan tabung. *Jurnal EduFisika*, *3*(1), 17–23.

Kusuma, J. W., & Hamidah. (2020). perbandingan hasil belajar matematika dengan penggunaan platform whatapps group dan webinar zoom dalam pembelajaran jarak jauh pada masa pandemik covid 19. *Jurnal Ilmiah Pendidikan Matematika*, *5*(1), 97–106.

Makhrus, M., Harjono, A., Syukur, A., Bahri, S., & Muntari. (2019). Analisis rencana pelaksanaan pembelajaran (rpp) terhadap kesiapan guru sebagai "role model" keterampilan abad 21 pada pembelajaran ipa smp. *Jurnal Penelitian Pendidikan IPA (JPPIPA)*, *5*(1), 66–72. https://doi.org/10.29303/jppipa.v5i1.171

Martawijaya, M. A. (2015). Karakter peserta didik dan hubungannya dengan keterampilan berpikir kritis dalam pembelajaran fisika smp di pulau barrang lompo. *Journal of Educational Science and Technology (EST)*, *1*(2), 1–7. https://doi.org/10.26858/est.v1i2.1340

Navisah, S., Wati, M., & Salam, A. (2021). Developing circular motion physics module integrated with gumbaan local wisdom in cooperative learning setting to improving learning achievement. *Berkala Ilmiah Pendidikan Fisika*. scholar.archive.org. Retrieved from https://scholar.archive.org/work/j7cnsfypy5e5lfuxp54lt5opoq/access/wayback/https://ppjp.ulm.ac.id/journal/index.php/bipf/article/download/8450/pdf

Ningrum, M. N., Dewi, N. R., & Parmin, P. (2018). Pengembangan modul pop-up berbasis inkuiri terbimbing pada tema tata surya untuk kelas VII SMP. *Jurnal Inovasi Pendidikan IPA*, *4*(1), 1–10.

Plomp, T. (2013). *Educational design research: An introduction. Dalam T. Plomp, & N. Nieveen (Eds.), An introduction to educational design*

research. Enschede, the Netherlands: SLO.

Prasetyorini, H., . M., & Bachri, B. S. (2017). Pengembangan materi pada mata pelajaran ipa dalam platform course networking sebagai media pembelajaran secara blended learning untuk meningkatkan hasil belajar dan keterampilan kolaborasi peserta didik kelas vii smp. *Jurnal Pendidikan (Teori Dan Praktik)*, *1*(1), 50. https://doi.org/10.26740/jp.v1n1.p50-58

Pummawan, A. (2007). The development of an e-learning module on the sandy shores ecosystem for grade-8. *Educational Journal of Thailand*, *1*(1).

Purbasari, M., & Jakti, R. D. R. I. (2014). Warna dingin si pemberi nyaman. *Humaniora*, *5*(1), 357–366.

Rachmatia, E., Aunurrahman, & Usman, A. (2017). Pengembangan Modul pembelajaran kimia untuk kecakapan membangun dan menggunakan konsep redoks dan hidrokarbon kelas x sman 3 sungai kakap. *JPP:Journal of Prospective Learning*, *2*(1), 27–36.

Rachmawati, E., Prodjosantoso, A. K., & Wilujeng, I. (2019). Next generation science standard in science learning to improve student's practice skill. *International Journal of Instruction*, *12*(1), 299–310. https://doi.org/10.29333/iji.2019.12120a

Redhana, I. W. (2019). Mengembangkan keterampilan abad ke-21 dalam pembelajaran kimia. *Jurnal Inovasi Pendidikan Kimia*, *13*(1).

Rofiah, E., Aminah, N. S., & Sunarno, W. (2018). Pengembangan modul pembelajaran ipa berbasis high order thinking skill (hots) untuk meningkatkan keterampilan berpikir kritis siswa kelas viii smp/mts. *Inkuiri J Pendidik IPA*, *7*(2), 285–296.

Rosnanda, D., Sarwanto, & Aminah, N. S. (2017). Pengembangan modul pembelajaran berbasis masalah pada materi litosfer untuk meningkatkan keterampilan berpikir kritis siswa smp. *Jurnal Inkuri*, *6*(3), 141–152.

Sari, K. A., Prasetyo, Z. K., & Wibowo, W. S. (2017). Pengembangan lembar kerja peserta didik ipa berbasis model project based learning untuk meningkatkan keterampilan kolaborasi dan komunikasi peserta didik kelas VII. *Jurnal Pendidikan Matematika Dan Sains*, *6*(8), 4.

Sari, N. F., Ritonga, N., & Gultom, H. S. B. (2019). The analysis of the difficulties faced students at junior high school student of negeri on the subdistrict of medan city ' s biology using concept map and questionnaire. *Jurnal Pendidikan Biologi Nukleus*, *5*(2), 40–48.

Sari, R. D. M., & Rachmawati, L. (2017). Pengembangan modul pembelajaran berbasis problem based learning pada kd mendeskripsikan bank sentral , sistem pembayaran dan alat pembayaran dalam perekonomian indonesia kelas x iis sman 1 krembung. *Jurnal Pendidikan Ekonomi*, *5*(3).

Sawitri, Y., Asrizal, Zulhendri, K., & Afrizon, R. (2019). Pengaruh bahan ajar ipa tema kesehatan pencernaan kita bermuatan literasi saintifik dalam pendekatan saintifik terhadap kompetensi siswa kelas viii smpn 25 padang. *Pillar of Physics Education*, *12*(1), 105–112.

Shpeizer, R. (2018). Teaching critical thinking as a vehicle for personal and social transformation. *Research in Education*, *1*(100), 32–49.

Sugianto, S. D., Ahied, M., Hadi, W. P., & Wulandari, A. Y. R. (2018). Pengembangan modul IPA berbasis proyek terintegrasi STEM pada materi tekanan. *Natural Science Education Research*, *1*(1), 28–39.

Suryanti, Arifin, I. S. Z., & Baginda, U. (2018). The application of inquiry learning to train critical thinking

skills on light material of primary school students the application of inquiry learning to train critical thinking skills on light material of primary school students. *Journal of Physics: Conference Series*, *1108*, 1–8.

Suryosubroto, B. (1983). *Sistem pengajaran dengan modul*. Jakarta: Bina Aksara.

Tessmer, M. (1993). *Planning and conducting formative evaluations: Improving the quality of education and training*. London: Kogan.

Zekri, Ganefri, & Anwar, M. (2020). Pengembangan modul pembelajaran berbasis proyek pada mata pelajaran simulasi dan komunikasi digital smk. *Pedagogi: Jurnal Ilmu Pendidikan*, *20*(1), 33–42.

Zivkovic, S. (2016). A model of critical thinking as an important attribute for success in the 21st century. *Procedia-Social and Behavioral Sciences*, *232*, 102–108.

Zulmaulida, R., Wahyudin, & Dahlan, J. A. (2018). Watson-Glaser ' s Critical thinking skills watson- glaser ' s critical thinking skills. *IOP Conf. Series: Journal of Physics*, *1028*, 1–7. https://doi.org/Doi :10.1088/1742-6596/1028/1/012094