JTK: Jurnal Tadris Kimiya 7, 1 (June 2022): 25-36
Website: http://journal.uinsgd.ac.id/index.php/tadris-kimiya/index
ISSN 2527-9637 **(online) ISSN** 2527-6816 **(print)**

Development of E-module Application Smartphone with Socioscientific Issue (SSI) in Biofuels

Erny Rohayu[1*] and Isana Supiah Yosephine Louise[1]
[1]Master of Chemistry Education Program, Faculty of Mathematics and Natural Sciences, State University of Yogyakarta, Indonesia
[*]E-mail: ernyrohayu.2020@student.uny.ac.id

Received: 09 May 2022; Accepted: 06 June 2022; Published: 30 June 2022

Abstract

This research is motivated by the lack of ability of chemistry teachers to prepare online learning media that requires students to achieve 4.0 technological developments. This research aims to create a valid and practical socio-scientific issue-based learning media. The development of this socioscientific-based e-module is carried out by applying the ADDIE (analysis, design, development, implementation and evaluation) development model. The data collection technique used in product validation is the questionnaire method. Theoretical validation in this study was carried out by expert lecturers, chemistry teachers, and peer reviewers. The validation of expert lecturers is described descriptively to the criticisms and suggestions given. Based on the validation result of the chemistry teachers and peer reviewers, respectively 88.8% and 87.9%, it was stated that the electronic module (e-module) was very eligible. The practicality of the e-module is known from the results of the student response questionnaire, which was a very eligible category. Based on the overall assessment results, the e-module product is feasible to be implemented in chemistry learning.

Keywords: biofuels, e-module, learning science, smartphone, socioscientific issue

DOI: http://dx.doi.org/10.15575/jtk.v7i1.17809

1. Introduction

Learning in the current era cannot be separated from increasing knowledge in the field of informatics and digital. Today's students prefer new technologies that can increase their interest and motivation in academics (Kowitlawakul et al., 2017; Logan et al., 2021). However, the implementation of learning by integrating the content of informatics, especially science in schools is still not optimal. Teachers still experience limitations in preparing learning materials with appropriate digital media to increase the enthusiasm of students in accepting learning (Mazidah et al., 2020). The difficulties experienced by teachers are designing and operating IT-based media, incomplete facilities and infrastructure, and teacher creativity (Winda & Davit, 2021). Learning activity in schools has changed from face-to-face to online learning. Online learning has now been integrated into all curricula in the world (Kowitlawakul et al., 2017). According to Rasmitadila et al. (2020) that teachers still have difficulty adjusting the time and media used due to drastic changes in teaching techniques from face-to-face to online learning. It will automatically affect the motivation of teachers in teaching.

Students need teaching materials that can be used independently so that teachers are no longer the only source in teaching and learning activities. An electronic module (e-module) is a form of presentation of self-study materials provided in an electronic format that is structured and systematically arranged into the smallest learning unit to achieve certain learning objectives (Nurmayanti et al. 2015; Pujiati et al. 2019). E-modules are very flexible to use anywhere because they can be

operated via tablets, laptops, or smartphones. Based on Communication and Information Department data in 2017, it is stated that more than half of students in Indonesia are already using smartphones, which is 70.98% and it increased even more in early 2020 when the online learning policy was implemented due to the pandemic (Dampati et al., 2020).

Based on the results of research from Dishadewi et al., (2020) stated that biofuels material is a material that has the potential to be raised in the context of socioscientific problems taught in chemistry learning. There are at least 9 chemical concepts that can be applied to the context of socioscientific problems in it, including mixed chemistry, covalent bonds (biofuels), chemical reactions (hydrocarbons and carbon compounds), intermolecular forces, stoichiometry, separation of foSSIl fuels, thermochemistry, impact combustion of carbon compounds, and carbon compounds. Therefore, with so many socioscientific problems, students have a great opportunity to use their chemistry to solve complex social problems in everyday life.

In social society, scientific social problems (socioscientific) are one of the most controversial issues (Yerrick, 2000; Sadler & Donnelly, 2006). Socioscientific issue (SSI) based teaching has been recognized as an effective strategy to support science learning and scientific literacy development. This is in accordance with the statement of Sadler & Zeidler, (2004) in Pratiwi et al. (2016) the reason SSI can be chosen as contextual learning is due to (1) science learning becomes more relevant to students; (2) generating an understanding of science; (3) improving argumentation; (4) improving the ability to evaluate scientific information; and (5) improving scientific literacy. Many studies have described and defined SSI-based teaching by science teachers in today's classroom learning practices (Genel & Topçu, 2016). SSI has scientific concepts or problems that are discussed by the community (Capkinoglu et al., 2020) so that the increase of complexity of problems in the social world can require students to contribute to society through their chemistry (Dishadewi et al., 2020). Overall, this e-module was created due to the difficulty of teachers in teaching chemistry during a pandemic. The e-module is not only a learning application but also is equipped with an online discussion room in a padlet.com website wall that is directly connected to the e-module as a means of training students in improving arguments based on socioscientific problems given that e-modules previously did not have. The purpose of this research is to develop valid and practical socioscientific-based learning media as an effort to train students to deal with complex social problems related to biofuels materials.

2. Research Method

This study used a Research and Development (RnD) research design. The Research and Development model used as a reference in product development was the ADDIE (Analysis, Design, Development, Implementation, and Evaluations) model. The validity of the e-module was obtained from theoretical validity data provided by expert lecturers, chemistry teachers, and colleagues while practicality was obtained from student response questionnaires. Subjects in this study were students of SMAN 4 Yogyakarta (Yogyakarta Public High School 4) with a total of 93 students for two times of data collection on a small and large scale. The research was conducted online in August, precisely in the odd semester of the 2021/2022 academic year. Data collection techniques used were questionnaires and documentation. Before the questionnaire instrument was used, validation was carried out in advance regarding the suitability of the contents of the e-module as well as the questionnaire which was validated by two expert validators, namely media and material experts. Questionnaires that have been corrected according to the advice of expert validators were given to three chemistry teachers and three peer reviewers, respectively. The practicality of the e-module was known by looking at student responses by conducting two trials on a small and large scale. The data analysis techniques used were

descriptive analysis and then the data were interpreted. The results of the responses were processed using a Likert scale with four categories. There are five stages of the ADDIE model:

2.1 Analysis stage
This stage is carried out by analyzing the needs of the e-module to be developed, namely by analyzing the curriculum, materials, and facilities available to support learning activities, as well as analyzing the needs of students in learning activities. In this stage, the material to be taught was adjusted according to the socioscientific-based e-module to be developed. The problems found then became a reference in developing e-module products.

2.2 Design Stage
The design stage is carried out by compiling a socioscientific-based e-module by 1) looking at standard competencies 3.2 and 3.3 of biofuels material for science class which consist of syllabus and lesson plans, 2) looking for socioscientific materials that will be lifted from various national and international news, 3) designing a socioscientific-based e-module product framework in the form of systematic determination, 4) preparing product assessment grids, and 5) processing of the determination of applications used in the manufacture of e-modules. The product design at this stage is still conceptual as the basis for the complete product design.

2.3 Development Stage
This stage is carried out by designing a socioscientific-based e-module product according to the design framework that has been made at the design stage so that it becomes a product ready to be implemented. The developed e-modules and instruments were further validated by expert lecturers, chemistry subject teachers, and peer reviewers.

2.4 Implementation stage
This stage is carried out to determine the practicality of the e-module by testing it on 93 students of SMAN 4 Yogyakarta (Yogyakarta Public High School 4). The small-scale trial stage was carried out on ten students and a large-scale on 83 students.

2.5 Evaluation stage
The validation results from media and material expert lecturers, subject teachers, and peer reviewers as well as student response assessments were used as the basis for product revisions to improve socioscientific-based e-module products. Revisions were made to produce better products according to student needs.

3. Result And Discussion

The purpose of this study is to develop an e-module product in the form of a smartphone application based on a socioscientific approach for second-grade students majoring in science. The e-module product developed contained descriptions of biofuels material, image manipulation, videos, and cases related to socioscientific problems. The e-module developed was supported by Microsoft Powerpoint which was already available on laptops and the help of iSpring Suite ten software to create quizzes or evaluations in the e-module. The application executable file formats are (.exe), (.app), and (.html). The e-module products were arranged into several initial menus such as Instructions for using e-modules, basic competencies and competency achievement indicators, motivation, learning activities, group discussions, evaluations, and bibliography according to Figure 1.

(a)

(b)

Figure 1. Display of The E-module (a) Interface (b) Menu

Based on Figure 1. (a) and (b) are The "Home" menu describes the initial cover page of the e-module. This menu is very important because students will focus first on the cover display before starting the lesson. The initial cover of this e-module used a chemical animation display and there is an opening background that can be listened to by students. There were three learning activities contained in the e-module and three socioscientific issues raised. Some brief explanations related to the content of the developed e-modules are listed in Table 1.

Table 1. Learning Activities and Socioscientific Issues in E-module

	Basic Competences	Learning Activities	Socioscientific Issues
3.2	Explains the process of forming biofuels fractions, separation techniques, and their uses.	Learning activities one. Learning videos related to the formation of biofuels, analyzing the difference between premium, pertalite, and pertamax by octane numbers.	Hydroelectric Power Plant continues to grow as the world begins to let go of its dependence on foSSIl fuels for energy. However, there are many pros and cons to hydroelectric energy. To build a hydropower plant, the flowing water source must be dammed so that living things in the water will be disturbed.
3.3	Identifies complete and incomplete combustion reactions of hydrocarbons and the properties of combustion products (CO_2, CO, carbon particulates)	Looking for the properties of each combustion product and providing opinions regarding complete and incomplete combustion.	Gasoline burned in a motorized vehicle engine will produce CO_2 and H_2O gas. If the combustion is not complete it will produce smoke and CO gas. CO gas is colorless and odorless but is very dangerous for humans because CO gas has a stronger binding capacity to hemoglobin than oxygen. This is pros and cons because gasoline has become a basic need that must be met.
4.3	Develops ideas on how to overcome the impact of	"MiSSIon to save the earth" students are asked	There are issues related to the development of Nuclear Power Plant in the future. Although

	Basic Competences	Learning Activities	Socioscientific Issues
	burning carbon compounds on the environment and health.	to document every activity in overcoming the impact of burning carbon compounds on the environment and health.	there are many nuclear power plants in various countries, in Indonesia there are pros and cons to the nuclear power plant development plan. Various risks and concerns (i.e. reactor accidents, radioactive waste, and human reproduction)

With the help of the padlet.com application, students can discuss openly related to learning activities and socioscientific issues given. Students can give each other the arguments they think are true. SSI open discussion is useful as a learning context because it can involve students in complex arguments (Osborne et al., 2008); Zeidler et al., 2009; Astarina et al. 2019). National news issues were also provided as a reference for knowledge related to ongoing learning activities. The display of the discussion wall that can be accessed by students online can be seen in Figure 2.

Figure 2. Display of Student Discussion Activity Wall

Based on Figure 2. students can explain how the octane volume affects the amount of oxygen and the properties of combustion products. The teacher gave references to national news issues related to pollution in Jakarta and its effect on the health of its citizens, this can be a reference for students in giving their arguments.

Before the implementation stage, the e-module product and questionnaire were validated using a material and media expert validator questionnaire. The results were then described based on criticism and suggestions from material and media experts.

3.1 Material expert

The e-module feasibility questionnaire which was corrected by a material expert had four aspects to be assessed, namely Introduction, Content, Learning, and Tasks/Exercise and Evaluation. The four aspects have their respective indicators described. In general, there were several inputs and suggestions given in correcting the questionnaires that have been made, including the need to readjust the aspects of the assessment; the addition of display/layout aspects; and the socioscientific context as the basis for the developed e-module can be added to the assessment of the questionnaire, both in

substance and in evaluation. The improvement of the questionnaire was then carried out by adding socioscientific material to the assessment questionnaire. Five basic points must be present in SSI learning, namely: (a) Authentic: the topic must be authentic and is currently being discussed in the community. (b) Relevant: the topic is relevant if the decision of each student will affect his present or future life. (c) Evaluation: SSI problems allow problem-solving from multiple perspectives. (d) Open discussion: SSI topics should be possible in a discussion on an open forum (e) Related to science and technology (Wittteck et al., 2013). Once fixed, questionnaire instruments can be used, especially on the assessment aspects used. In addition, the material expert also added suggestions regarding the material in the e-module made, among others: in learning activity two related to complete and incomplete combustion reactions, it is necessary to replace the term used, namely "total volume of oxygen" to "number of moles of oxygen", and high temperature coal materials need to be explained further. It aims to understand the concept of mole in chemistry. Mole is defined as the amount of substances containing basic entities (atoms, molecules, or other particles) as much as the number of atoms contained in 12 g (or 0.012 kg) of carbon-12 isotopes (Chang, 2004). It would be more appropriate if it were associated with a complete and incomplete combustion material that is mostly related to the atoms, molecules or other particles contained, and not only with the term volume. The appearance of the e-module after being repaired can be seen in Figure 3.

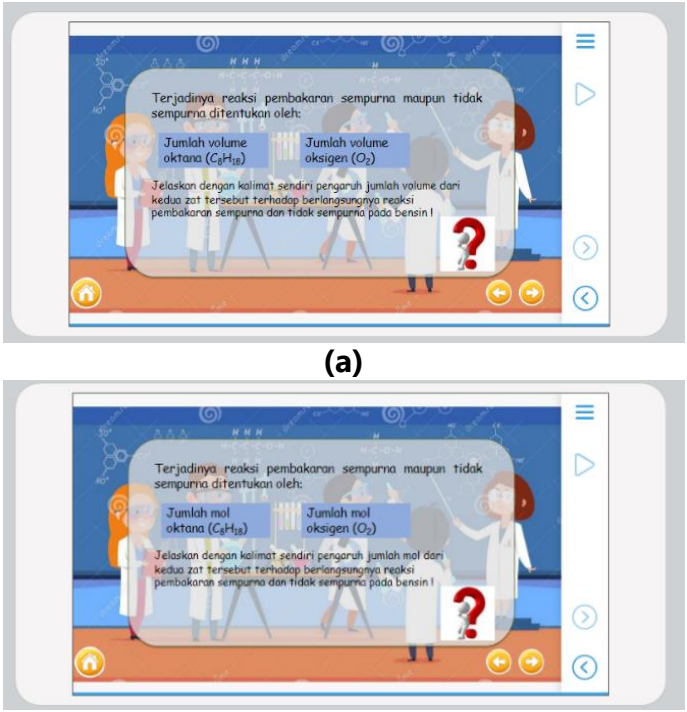


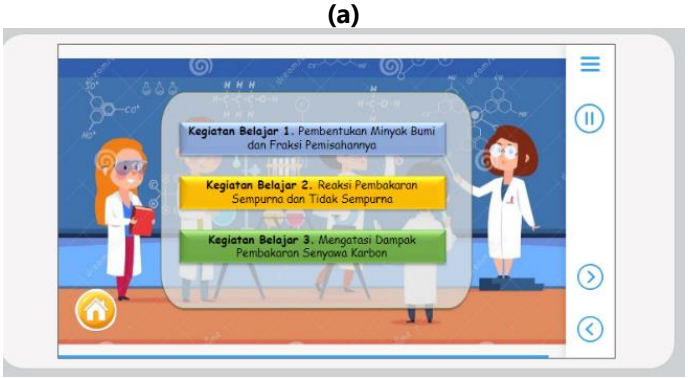
Figure 3. Concept Improvements from Volume to Mole of Oxygen (a) Before Repair (b) After Repair

Based on Figure 3. there were some repairs from the e-module obtained from criticisms and suggestions by material experts. The use of the word "volume" in (a) figure was replaced with "mole" in (b) figure to describe the amount of oxygen required for complete and incomplete combustion reactions.

3.2 Media Expert

The e-module feasibility questionnaire which was corrected by media experts, has three aspects to be assessed, namely: Appearance, Use, and Utilization which have their own indicators. In general, based on the results of the validation of media experts, there were several inputs and suggestions, namely in the animated video display about the origin of the formation of biofuels, researchers are expected to be able to readjust the visualization of the actual color of the biofuels liquid to solid black. In accordance with the statement of Donev et. al (2017) which stated that crude oil has a high content of hydrocarbons in large quantities. The presence of a very high hydrocarbon content causes the color of crude oil to become dark black. The results of media expert validation stated that there was a need for improvements to e-modules related to learning activities (1, 2, and 3). It is necessary to add the names of chapters or sub-topics so that students are more focused on learning and more receptive to learning materials. By knowing the names of chapters and sub-chapters on the menu of learning activities, students will have an idea regarding the learning objectives that will be obtained. It is included in one of the apperception activities in learning. According to Gagne's learning theory in Saidah et al, (2021) stated that there are stages of proceSSIng children's learning, one of which begins with attracting children's attention and providing learning objectives to be achieved. After the e-module underwent through the improvement process, it looks more clearly related to the distribution of learning activities which can be seen in Figure 4

(a)



(b)

Figure 4. Improvements in The Display of The Learning Activity Menu (a) Before Repair (b) After Repair

Based on Figure 4. It can be shown about e-module improvements obtained from criticisms and suggestions by media experts. In figure (a) the menu learning activity wasn't clear for students then in figure (b) after repair, the name of the chapter or sub-topic has been added.

The revised questionnaire based on the advice of material and media experts was then given to three chemistry teachers and three peer reviewers. Three aspects need to be assessed, namely related to Didactic, Construction, and Technical aspects. The validation results described in Table 2.

Table 2. Results of The Validation of Chemistry Teachers and Peer Reviewers

Aspects	Validator					
	Teacher 1	Teacher 2	Teacher 3	Peer reviewer 1	Peer reviewer 2	Peer reviewer 3
Didactic	95%	80%	85%	90%	85%	95%
Construction	97,1%	91,4%	82,8%	97,1%	80%	94,3%
Technical	90%	96%	82%	90%	76%	84%
Average	88,8%			87,9%		
Criteria	Very feasible			Very feasible		

Based on the results of the chemistry teacher and peer reviewer questionnaire assessments on these aspects, the average scores for both were 88.8% and 87.9%, respectively, with the "very feasible" criteria. The eligibility assessment criteria were based on the categorization according to Azwar (2012) which can be seen in Table 3.

Table 3. Eligibility Assessment Criteria for E-modules

Criteria	Score range
Very not feasible	X < M – 1,5SD
Less feasible	M – 1,5SD < X < M – 0,5SD
Feasible enough	M – 0,5SD < X < M + 0,5SD
Feasible	M + 0,5SD < X < M + 1,5SD
Very feasible	M + 1,5SD < X

(Azwar, 2012)

3.3 Practicality Test

The practicality of the developed e-module can be seen by the students through a practicality questionnaire. The assessment component of student responses consisted of an interest in the material, its appearance, and usefulness. Practicality refers to the condition of the learning modules developed that can be easily used by students so that the learning carried out is meaningful, interesting, fun, and useful for students' lives (Alfiriani & Hutabri, 2017). The statement submitted in this questionnaire consisted of 22 items. Practicality and readability were determined by testing the e-module product on 10 students on a small scale and 83 students on a large scale. Feedback, suggestions, and input at this early stage became a source of information for developers to improve the e-module.

Table 4. Student Trial Assessment Results

Aspects	Validator	
	10 students	83 students
Learning	82%	79,5%
Display	84%	81,5%
Usefulness	84,5%	78%
Average	83,5%	79,7%
Criteria	Very feasible	Very feasible

Based on Table 4, results of the assessment of student responses experienced a slight decrease from small to large scale, but both were still in the very feasible category. Small-scale groups of students have time to conveniently access e-modules without any lessons being given. The target of the small group was third-grade of science students who have received biofuel learning materials before. A large-scale group was a group of second-grade science students who were studying biofuels and have never received any materials before. This is one of the factors in the decline in assessment results related to student responses to e-modules. The difficulty factor in learning online while acceSSIng e-modules and many aSSIgnments but having little time to do these aSSIgnments, made students became confused about using e-modules simultaneously. This was evidenced

by the comments and suggestions of one student in the large group "the e-module has a very good system, but during learning, but it is still difficult to submit aSSIgnments at once during learning activities" while the comments of the small-scale group student "The e-module is very interesting, the material is easy to understand, the appearance is also creative, there is a back sound that is fun to listen while understanding the materials in the e-module, so you don't get bored." Therefore, in the future, e-modules can be readjusted by considering students' comfort in acceSSIng e-modules and submitting aSSIgnments during online learning. There were seven practical factors of children's teaching materials that must be met for the sake of the convenience of children's learning and one of these factors was the suitability of all learning activities with the allotted time (Widodo, 2016). In addition, differences in the character of the student in a large-scale group can also affect his response to the questionnaire. This can be seen from the number of students who receive e-modules positively when used together with online learning activities in the classroom. In general, large-scale groups have a larger number of students, so it tends to be clear that the differences in their characters will affect the average student response results. This was supported by the results of research conducted by Ramadhani et al., (2020) which stated that high school students have a lower learning character than students at universities during the online learning period due to the pandemic. Therefore, the adjustment of new learning activities for high school students tends to take time. The graph of the decline in student response assessment results can be seen in Figure 5.

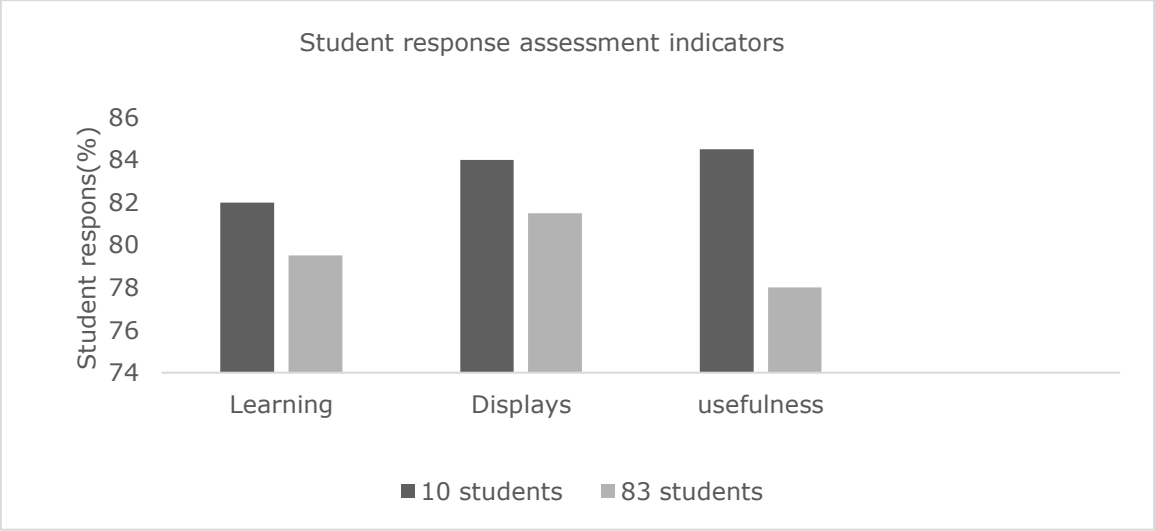


Figure 5. Graph of Student Response Assessment Results

The decrease in student response assessment results on a large scale was also generated because some students who used smartphones with the brand "Apple" failed to load or download the e-module so students had difficulty acceSSIng the e-module. This was evidenced by student comments stating "the e-module provided is very helpful for understanding the material, the display used is good, it's just that there are difficulties in installing the e-module on my smartphone even though other friends can". Therefore, the results of large-scale trials provided information to researchers for future e-module applications using more sophisticated technology so that all types of smartphones can access them.

4. Conclusion

This research produces a socioscientific-based e-module product that is valid and practical. Based on the results of the validation of material and media experts, the e-module has been improved according to criticisms and suggestions given. The assessment results of

chemistry teachers and peer reviewers were 88.8% and 87.9%, respectively, and it could be stated that the e-module was "Very Eligible" according to the interpretation of the data from the validation results. The results of the practicality assessment of e-modules for small and large scale were 83.5% and 79.7% and both were in the "Very Eligible" category. There was a decrease in practicality trial results between large and small-scale groups caused by several obstacles that occurred during learning and technical reasons when downloading e-modules. Based on the overall assessment results, the e-module product is very feasible to be implemented in chemistry learning.

References

Alfiriani, A., & Hutabri, E. (2017). Kepraktisan dan keefektifan modul pembelajaran bilingual berbasis komputer. *Jurnal Kependidikan, 1*(1). 12-23. https://doi.org/10.21831/jk.v1i1.10896

Aliyyah, R. R., Rachmadtullah, R., Samsudin, A., Syaodih, E., Nurtanto, M., & Tambunan, A. R. S. (2020). The perceptions of primary school teachers of online learning during the COVID-19 pandemic period: A case study in Indonesia. . *Journal of Ethnic and Cultural Studies*, *7*(2), 90-109. https://doi.org/10.29333/ejecs/388

Anita, A., Afandi, A., & Tenriawaru, A. B. (2019). Pentingnya keterampilan argumentasi di era ledakan informasi digital. *Prosiding Seminar Nasional FKIP Universitas Tanjungpura*, *August*. Retrieved from https://www.researchgate.net/publication/343859546_Pentingnya_Keterampilan_Argumentasi_Di_Era_Ledakan_Informasi_Digital

Astarina, A., Rahayu, S., & Yahmin , Y. (2019). Pengaruh pembelajaran pogil berkonteks socioscientific issues terhadap kualitas keterampilan berargumentasi siswa SMA pada Materi ikatan kimia. *Jurnal inovasi Pendidikan IPA, 5*(1), 31-44. https://doi.org/10.21831/jipi.v5i1.20890

Azwar, S. (2012). *Penyusunan Skala Psikologi edisi 2*. Yogyakarta: Pustaka Pelajar

Capkinoglu, E., Yilmaz, S., & Leblebicioglu, G. (2019). Quality of argumentation by seventh-graders in local socioscientific issues. *Journal of Research in Science Teaching*, *57*(6), 827–855 https://doi.org/10.1002/tea.21609

Chang, R. (2004). *Kimia dasar konsep-konsep inti*. Jakarta: Erlangga.

Dampati, P. S., Veronica, E., & Dwi Chrismayanti, N. K. S. (2020). Pengaruh Penggunaan Smartphone dan Laptop Terhadap Muskuloskeletal Penduduk Indonesia Pada Pandemi Covid-19. *Gema Kesehatan*, *12*(2), 57–67. https://doi.org/10.47539/gk.v12i2.135

Dishadewi, P; Wiyarsi, A; Prodjosantoso, AK; Nugraheni, A. R. . (2020). Chemistry-Based Socioscientific Issues (SSIs) As a Learning Context : An Exploration Study of Biofuels. *Journal of Physics: Conference Series*, 1440. https://doi.org/10.1088/1742-6596/1440/1/012007

Erna, M., & Anwar, L. (2020). Developing an Interactive Chemistry E-Module for Salt Hydrolysis Material to Face the Covid-19 Pandemic Developing an Interactive Chemistry E-Module for Salt Hydrolysis Material to Face the Covid-19 Pandemic. *Journal of Physics: Conference Series*, 1655. https://doi.org/10.1088/1742-6596/1655/1/012051

Genel, A., & Topçu, M. S. (2016). Turkish preservice science teachers' socioscientific issues-based teaching practices in middle school science classrooms. *Research in Science and Technological Education*, *34*(1), 105–123. https://doi.org/10.1080/02635143.2015.1124847

Hanania, J., Stenhouse, K., Suarez, L. V., & Doev J. (2021, December, 20). Energy Education-Crude oil. Retrieved from https://energyeducation.ca/encyclopedia/Crude_oil accessed June 24, 2022.

Kowitlawakul, Y., Chan, M. F., Tan, S. S. L., Soong, A. S. K., & Chan, S. W. C. (2017). Development of an e-Learning research module using a multimedia instruction approach. *CIN - Computers Informatics Nursing*, *35*(3), 158–166. https://doi.org/10.1097/CIN.0000000000000306

Logan, R. M., Johnson, C. E., & Worsham, J. W. (2021). Development of an e-learning module to facilitate student learning and outcomes. *Teaching and Learning in Nursing*, *16*(2), 139–142. https://doi.org/10.1016/j.teln.2020.10.007

Nurmayanti, F., Bakri, F., & Budi, E. (2015). Pengembangan Modul Elektronik Fisika dengan Strategi PDEODE pada Pokok Bahasan Teori Kinetik Gas untuk Siswa Kelas XI SMA. *Prosiding Simposium Nasional Inovasi Dan Pembelajaran Sains*, *337.* Retrieved from *https://ifory.id/proceedings/2015/z4pZjcJkq/snips_2015_fitri_nurmayanti_e4c8c1467da686b5b60dd953dd529ca3.pdf*

Osborne, J., & Dillon, J. (2008). *Science education in Europe*: Critical reflections. London: King College.

Pedersen, J. E., & Yerrick, R. K. (2000). Technology in science teacher education: Survey of current uses and desired knowledge among science educators. *Journal of Science Teacher Education*, *11*(2), 131-153. https://doi.org/10.1023/A:1009468808876

Pratiwi, Y. N., Rahayu, S., & Fajaroh, F. (2016). Socioscientific issues (SSI) in reaction rates topic and its effect on the critical thinking skills of high school students. *Jurnal Pendidikan IPA Indonesia, 5*(2), 164-170. https://doi.org/10.15294/jpii.v5i2.7676

Pujiati, P., Fanni Rahmawati, F., & Rahmawati, R. 2019). Pentingnya E-Module Pembelajaran Peserta Didik di Era Revolusi Industri 4.0. T*he 2nd Proceeding Annual National Conference for Economics and Economics Education Research, 2, 81-87.* Retrieved from http://econference.stkip-pgri-sumbar.ac.id/index.php/NCSE/SPSK

Sadler, T. D., & Donnelly, L. A. (2006). Socioscientific argumentation: The effects of content knowledge and morality. *International Journal of Science Education*, *28*(12), 1463-1488. https://doi.org/10.1080/09500690600708717

Saidah, K., Primasatya, N., Mukmin, B. A., & Damayanti, S. (2021). Sosialisasi Peran Apersepsi untuk Meningkatkan Kesiapan Belajar Anak di Sanggar Genius Yayasan Yatim Mandiri cabang Kediri. *Dedikasi Nusantara*, *1*(1), 18–24. Retrieved from https://ojs.unpkediri.ac.id/index.php/dedikasi/article/view/16065/2102

Stolz, M., Witteck, T., Marks, R., & Eilks, I. (2013). Reflecting socioscientific issues for science education coming from the case of curriculum development on doping in chemistry education. *Eurasia Journal of Mathematics, Science & Technology Education*, *9*(4),361-370. https://doi.org/10.12973/eurasia.2014.945a

Widodo, W. (2016). Wujud Kenyamanan Belajar Siswa, Pembelajaran Menyenangkan, Dan Pembelajaran Bermakna Di Sekolah Dasar. *Jurnal Ar-Risalah*. 18 (2). Retrieved from https://ejournal.iaiibrahimy.ac.id/index.php/arrisalah/article/view/1054

Winda, R., & Dafit, F. (2021). Analisis Kesulitan Guru dalam Penggunaan Media Pembelajaran Online di Sekolah Dasar. *Jurnal Pedagogi Dan Pembelajaran*, *4*(2), 211. https://doi.org/10.23887/jp2.v4i2.38941

Zeidler, D. L., Sadler, T. D., Simmons, M. L., & Howes, E. V. (2005). Beyond STS: A research-based framework for socioscientific issues education.