E-modules with Android Appy Pie Based on Socio-Scientific Issues to Improve Students' Critical Thinking Skills

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A B S T R A K

Pembelajaran terbatas dan belum maksimal dalam pemanfaatkan teknologi di setiap sekolah. Selain itu, pembelajaran yang masih terfokus pada guru sebagai sumber belajar, menyebabkan siswa kurang kritis dalam memahami persoalan yang ada, sehingga dibutuhkan pemanfaatkan teknologi, a dengan penerapan E-modul berbasis socio-scientific issue. Tujuan dalam penelitian ini yaitu untuk mengetahui pengaruh penerapan E-modul berbasis socio-scientific issue dalam meningkatkan keterampilan berpikir kritis siswa. Metode yang digunakan dalam penelitian ini adalah penelitian kuantitatif dengan pendekatan eksperimen semu. Desain penelitian dengan pretest-posttest control group design, dengan kelas X MIPA 1 sebagai kelas eksperimen dan kelas X MIPA 4 sebagai kelas kontrol. Hasil penelitian menunjukkan bahwa terjadi peningkatan keterampilan berpikir kritis siswa pada kelas eksperimen lebih tinggi dibandingkan kelas control. Hasil rata-rata observasi lebih tinggi pada kelas eskperimen. Peningkatan tersebut dapat dilihat dari paired samples statistik sebagai output signifikan. Hasil angket respon siswa menunjukkan kategori baik. Kesimpulan dalam penelitian ini adalah penerapan E-modul menggunakan android appy pie berbasis socio-scientific issue berpengaruh terhadap peningkatan keterampilan berpikir kritis siswa.

A B S T R A C T

Learning is limited and not maximized in the use of technology in every school. In addition, learning that is still focused on the teacher as a learning resource, causes students to be less critical in understanding the existing problems, so that technology is needed, with the application of socio-scientific issue-based E-modules. The purpose of this study is to determine the effect of implementing E-modules based on socio-scientific issues in improving students' critical thinking skills. The method used in this research is quantitative research with a quasi-experimental approach. The research design used a pretest-posttest control group design, with class X MIPA 1 as the experimental class and class X MIPA 4 as the control class. The results showed that there was an increase in students' critical thinking skills in the experimental class which was higher than the control class with the average difference between the pretest and posttest results in the control class. This increase can be seen from the statistical paired samples as significant output. The results of the student response questionnaire showed a good category. The conclusion in this study is that the application of E-modules using android appy pie based on socio-scientific issues has an effect on increasing students' critical thinking skills.

1. INTRODUCTION

The pandemic period is still a major problem in various countries, including Indonesia (Abuhammad, 2020; Siahaan, 2020). Almost all fields are affected by the pandemic, including the education sector, causing some aspects of teaching and learning activities to experience limitations (Adedoyin & Soykan, 2020; P. A. S. Lestari et al., 2020). Based on the results of an interview with one of the biology teachers of class X MIPA at SMA Negeri 1 Sliyeg and it is known that the activeness of students in online and face-to-face learning is still low, as evidenced by the lack of active students and submitting assignments on time. This affects the learning outcomes and students' understanding of the lessons given by the teacher. The use of technology has not been developed optimally in the success of technology-based learning and there are still limited complete interactive teaching materials both audio and visual that can be accessed in one place (Crawford et al., 2020; Hermanto & Srimulyani, 2021). In addition, the teaching and learning process is still centered on the teacher or teacher centered, causing students to be less independent in solving an existing problem (Bubb & Jones, 2020; McQuirter, 2020). Therefore, an explanation based on the representation of issues in biology learning material is needed in an effort to improve students' critical thinking skills which are very much needed today with the

application of technology in the learning process. Technology-based learning really needs problem solving skills and technical handling to achieve successful technology learning (Udin et al., 2022).

Socio-Scientific Issue learning is learning in aspects of everyday life by presenting issues related to the context of science and the community environment, so that SSI-based learning raises students' curiosity about controversial issues in everyday life (Chowdhury et al., 2020; Subiantoro & Treagust, 2021). SSI aims to stimulate intellectual, moral and ethical development regarding the relationship between science and social life (Pauzi & Windiaryani, 2021; Zeidler & Nichols, 2009). For this reason, the Socio-Scientific Issue is related to critical thinking skills in the learning process which requires students to analyze issues and make decisions. Critical thinking is an activity of analyzing, and evaluating ideas critically, being able to sharply distinguish an idea, selecting, identifying, critiquing, reviewing and developing it in a more perfect direction. This mental process analyzes ideas and information obtained from observations, experiences, common sense or communication (Riyanto & Mariani, 2019; Supena et al., 2021). Critical thinking skills are reasonable thinking, able to interpret, evaluate and be active in observation, information, and argumentation (Fisher, 2009; Suparno, 2018). E-module is a set of digital learning media that is used as independent learning material (Asrial et al., 2020; Priatna et al., 2017). For this reason, critical thinking skills are very important for every student which is fundamental to human maturity.

One of the efforts to improve the effectiveness of education today is the use of electronic teaching materials by using modules in the student learning process. This E-module teaching material can attract the attention of students so that it creates enthusiasm to understand the concept of the material being studied (Agung et al., 2020; Ningsih & Mahyuddin, 2021), thereby increasing the attention of students to focus on following the material presented in the form of pictures and videos which are very helpful in explaining the material. learning. By applying the electronic module as a supporting medium in the learning process is the right innovation in accordance with technological developments, where this electronic module can be accessed with the help of a computer or android either offline or online. Based on the problems faced, it is necessary to apply an E-module virus based on socio-scientific issues in improving the critical thinking skills of class X students at SMAN 1 Sliyeg. This research is expected to be able to provide updates and alternatives in utilizing Android-based technology in the learning process and is expected to be a solution to overcome the problems of limited online and face-to-face learning during this pandemic. In addition, it is hoped that students will easily understand the concept of the virus to the fullest, so that students can participate in tackling problems during the current pandemic. Students can apply healthy and clean living habits for themselves, their families and others around them.

2. METHOD

The method used in this study is a quantitative research method, with a quasi experiment (quasi-experiment). Quasi Experimental is used because in reality it is difficult to get a control group used for research. The research design used is the pretest-posttest control group design (Sugiyono, 2019). This research was conducted at SMA Negeri 1 Sliyeg which is located at Sleman-Jatibarang Indramayu Regency. The population in this study were all students of class X MIPA. In this study, two classes were used, namely class X MIPA 1 as the experimental class and class X MIPA 4 as the control class. The sampling technique is purposive sampling technique. The independent variable (X) in this study is the application of E-modules using android appy pie based on socio-scientific issues and the dependent variable (Y) in this study is students' critical thinking skills according to Alec Fisher.

Data collection techniques in this study were written tests (pretest and posttest), observation sheets and questionnaires. Assessment of the observation sheet is used to determine student learning activities. In this study using five indicators of critical thinking skills according to Alec Fisher which consist of 1) identifying the elements in the case being considered, 2) identifying and evaluating assumptions, 3) clarifying and interpreting statements and ideas 4) analyzing, evaluating and generating explanation, 5) analyze, evaluate and make decisions. The results of the pretest and posttest were used as data to measure students' critical thinking skills, both in the control class and the experimental class. The number of pretest and posttest questions is 30 reasonable multiple choice questions. The questions used contain five indicators of critical thinking skills and cognitive tiers from C4, C5 and C6. The pretest and posttest questions contain the main material of the virus, namely body structure, reproduction, the role of viruses in life and about the corona virus. Data were taken from students who worked on the pretest and posttest questions in the experimental class and control class.

Student response questionnaires were only given to the experimental class which aims to determine student responses to the application of biology learning using the Electronic module using Android appy pie based Socio-Scientific Issue in improving students' critical thinking skills. Questionnaires are given after students work on the posttest questions. The questionnaire used in this study consisted of 20 questions using a Likert scale. The statement in the student response questionnaire consisted of 10 types of negative responses and

10 types of positive responses. The contents of the statements in the questionnaire are adjusted to the use of five indicators of critical thinking skills. The data analysis technique used in this study begins with a preliminary analysis, namely the validity test, reliability test, difficulty level test and difference power test. Furthermore, the data will be tested and the results of the trials will be analyzed with normality test, homogeneity test, paired sample t-test and independent sample t-test.

3. RESULT AND DISCUSSION
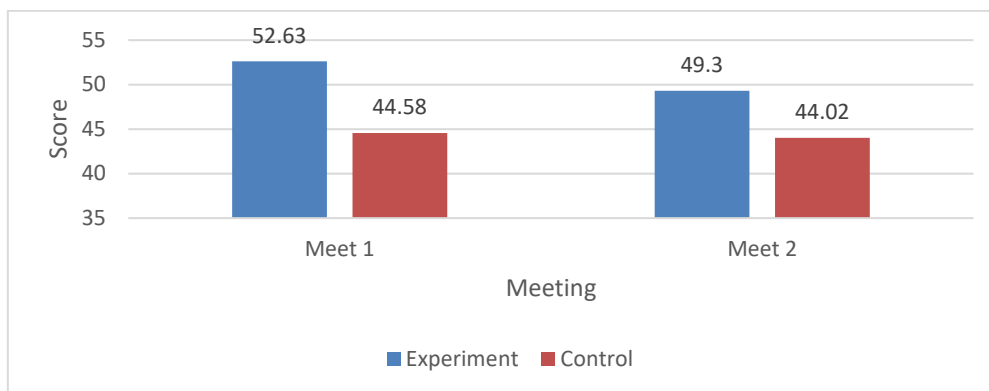
Result
Student Learning Activities

Figure 1. Graph of Overall Observations

The overall observation results show that the overall activity value of students has decreased in both the experimental class and the control class, although the decrease in value is not significant. Figure 1 shows the average results of observations at each meeting. At the first meeting the value of student activity was greater in the experimental class by 52.63 while in the control class it was 44.58. At the second meeting the value of student activity was greater for the experimental class by 49.3 while the control class was 44.02. The difference in observational values shows that the application of E-modules using android appy pie based on Socio-Scientific Issues can affect learning activities in improving students' critical thinking skills. The data is reinforced by the results of students' training gains between the control class and the experimental class, as shown in Figure 2.
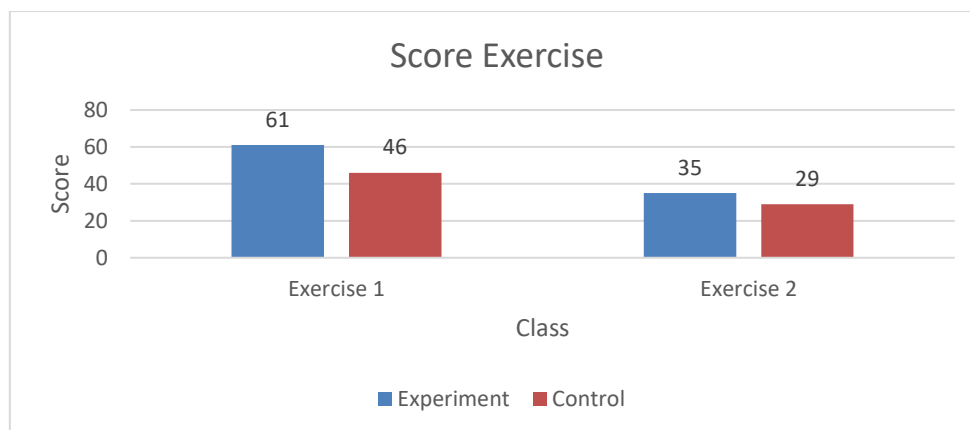

Figure 2. Graph of Practice Questions

Based on Figure 2, the average value of exercise one is 46 and exercise two is 29 in the control class. Meanwhile, in the experimental class, the average score for the first exercise was 61 and the second exercise was 35. The data above shows that the experimental class students' learning outcomes were higher than the control class.

Improving Students' Critical Thinking Skills

The results of the pretest and posttest in the control class and the experimental class is presented in Table 1.

Table 1. Score Pretest and Postest

Group	Pretest	Posttest	Difference	N-Gain (%)	Categories
Control	36	48	12	23,13	Ineffective
Experiment	26	44	18	26,66	Ineffective

Based on Table 1, the average pretest value in the control class is 36 while in the experimental class it is 26. The average posttest value in the control class is 48 while in the experimental class is 44. The difference between the average pretest results between the control class and the class the experimental class was 12 while the average difference between the posttest results was 18. Although the results of the pretest and posttest of the control class were higher than the experimental class, the difference between the pretest and posttest was higher in the experimental class. The data shows that there is an increase in students' critical thinking skills in the experimental class.

Student Responses to the Application of E-modules in the Biology Learning Process

The results of the questionnaire in this study is presented in Figure 3.
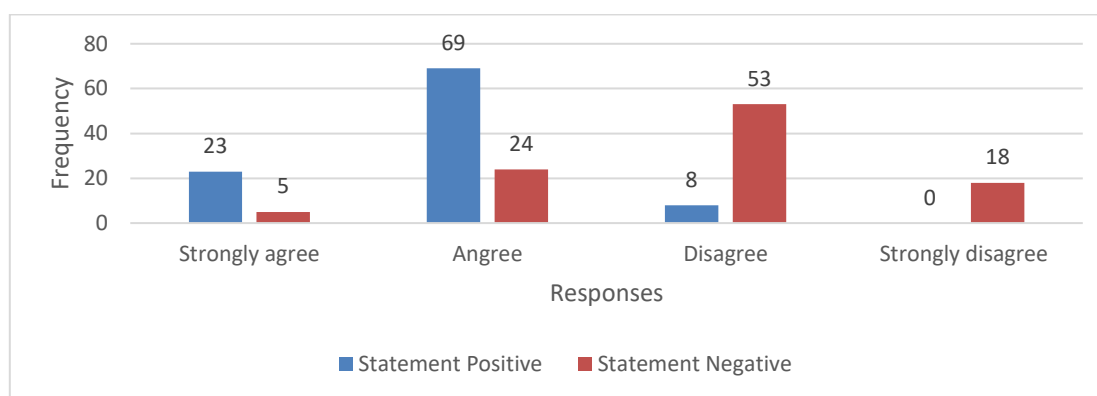
Figure 3. Responses of Quesionnaire

Based on Figure 3, it can be seen that there are differences in the results obtained from the results of a positive response and a negative response based on the available answer criteria. Student responses can also be seen through statistical descriptions, as shown in Table 2.

Table 2. Descriptive Statistics on Student Questionnaire Results

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
Score Questionnaire	30	34	63	97	74.20	6.733	45.338
Valid N (listwise)	30						

Based on Table 2, there are samples that fill out the student response questionnaire as many as 30 of 36 students. The maximum total score obtained from 20 statements in the questionnaire with a Likert scale of 4 (SS, S, TS, and STS) is 80. The results of the analysis show that the minimum total score is 63 while the maximum total score is 97, the data shows the average score a total of 74.20 with a range value of 34. The standard deviation in the table above is 6.73, indicating a heterogeneous distribution of data. In general, the results of obtaining positive statements and negative statements indicate that the application of E-modules using the socio-scientific issue-based android appy pie received a good response from students in the experimental class.

Discussion

Based on the results of the overall observations and practice questions that have been carried out, it is found that there is a difference in the average value of student activity which is higher in the experimental class compared to the control class, although the results are not significant. Judging from the achievement of each

indicator of critical thinking skills, the results show that not all students achieve a score of 4 and only a few students achieve that score. The most scores obtained by students are scores 2 and score 3. The highest achievement indicator is that students are able to clarify and interpret statements and ideas on viral material. Achievements in these indicators are shown in providing views on pandemics caused by viruses. The lowest indicator of critical thinking skills is that students are able to generate arguments or make decisions about the concept of a virus. During the lesson, the teacher tries to ask about whether or not vaccination is necessary. Students are only able to provide their views, without providing arguments about the effectiveness of the vaccine. Students are still not able to make a decision or conclusion, which is shown by students being less active in the discussion process and not being able to make conclusions from the learning outcomes obtained.

The lack of achievement of these observations is influenced by several factors. The first factor is that the face-to-face time for each subject is only 40 minutes, thus making researchers only focus on delivering the material, so that time for discussion and question and answer is limited. The second factor is the unavailability of rest or pause between one lesson and the next. For 2 hours students are required to understand three subjects. The third factor is that students are accustomed to online learning, thus making their thinking ability low. The increase in student learning activities was due to the treatment in the experimental class using E-modules using Android Appy Pie-based Socio-Scientific Issue equipped with pictures and videos, while the control class only used conventional textbooks available by the school. The results of this study are in accordance with research who stated that the use of android-based learning media using appy pie is very effective in learning (A. I. Lestari et al., 2019). Although these studies differ in the material and aspects they measure, they have in common using Android Appy Pie in the learning process so it can be concluded that the use of the Android Appy Pie based E-module based on socio-scientific issues has an influence on improving students' critical thinking skills.

This is also in accordance with research which states that there is an effect of using socio-scientific issues on students' critical thinking skills (Genisa et al., 2020; Kusumaningtyas et al., 2020). Other study emphasizes the importance of SSI to provide meaningful learning situations for students to be able to apply their biological knowledge to the social atmosphere in the classroom (Sadler, 2011). Socio-Scientific Issues are closely related to critical thinking skills because in the learning process students are required to actively start from analyzing issues that exist in society to making conclusions (Chen & Xiao, 2021; Kinskey & Zeidler, 2021; Zeidler & Nichols, 2009). The improvement of critical thinking skills in this study showed that the experimental class had a higher increase compared to the control class' critical thinking skills. This shows that the application of the Android Appy Pie-based E-module based on Socio-Scientific Issues in the biology learning process can improve students' critical thinking skills. The improvement of students' critical thinking skills in the experimental class is due to the application of E-modules that contain social issues that occur in society and daily life, making it easy for students to identify and solve problems that occur based on scientific explanations. These results are in accordance with research which states that learning activities based on socio-scientific issues produce students' critical thinking skills that are more well developed and affect student cognitive learning outcomes (Johnson et al., 2020; Minken et al., 2021; Wilsa et al., 2017). For this reason, critical thinking skills are very important, which must be present and possessed by students, which are supported by the development of technology and communication that continues to develop in the achievement of 21st century learning.

Critical thinking is a way of thinking of students in connecting beliefs to the knowledge that has been obtained during learning. Developing critical thinking skills in students is an effort to increase student learning outcomes and achieve learning objectives. Critical thinking skills can be applied to learning that requires students to carry out observation and analysis activities on social issues that exist in everyday life, seek the truth of existing issues and connect them with lessons. All of these activities can take advantage of technological developments through smartphones. Reviewing the results of student responses to the application of E-modules in learning based on the Likert scale criteria with a scale of 1-4 shows that the application of E-modules using android appy pie based on socio-scientific issue is in the good category to be applied in the learning process. The application of E-modules in biology learning makes it easy for students to understand the material, be able to create an environment as a place to learn, and be able to analyze issues around viruses scientifically. The results of this study are in accordance with research which states that teaching materials with the context of SSI (socio-scientific issue) have a great influence and teaching materials are easy to understand which contain issues that exist around students and are closely related (Gül & Akcay, 2020; Rostikawati & Permanasari, 2016). context in real life so that it motivates students to interpret the learning material they are studying. In this study also shows the number of student responses scores on the variable quality of teaching materials with the SSI context in the category of strongly agree. With the majority of students giving a positive response to the teaching materials and stating that the teaching materials in the SSI context are easy to understand and meet student learning expectations.

The results in this study are also in accordance with the results research which states that the application of socio scientific issues learning can be carried out very well and the socio scientific issues strategy is effective to be applied in biology learning (Siska et al., 2019). Student responses to the application of socio scientific

issues in the learning process show an agreeable response and can produce a positive response from students. Socio scientific issues are strategies that aim to stimulate the development of thinking intellectually, morally, ethically and awareness about relating science to the context of people's social life (Subiantoro et al., 2017). Socio-Scientific Issues is a new strategy in science and science learning that emphasizes social issues that develop in society, can be studied scientifically to be able to develop critical thinking skills, improve students' good morals and ethics. Socio-Scientific Issues can also train students in higher-order thinking including analyzing a problem, synthesizing, evaluating information, expressing arguments rationally, honestly and ethically, and being able to make the right decisions.

Teaching materials in the form of E-modules using Android Appy Pie based on socio-scientific issues contain material about viruses which are divided into three lessons, namely learning one about the history of viruses, characteristics, structures, and forms of viruses. In lesson 2 contains about the way of life of viruses, classification and reproduction of viruses. Learning 3 contains material about the role of viruses in life. In each lesson there are social issues around viruses such as the effectiveness of vaccines and the corona virus. E-modules using appy pie also contain images, videos, whatsAap services that are connected to the WhatsApp maker, and hyperlinks as in the words of the Indonesian Ministry of Health, which when clicked will connect to Google. The results of using Appy Pie in this study are in accordance with the results of research conducted by Lestari (2016) which says that the learning media developed using Appy Pie is in the form of an application with an apk format (Android application package) which contains KI/KD, videos, materials, sample questions, games, exercises and about the author. This application can be downloaded and used properly on smartphones that use the Android operating system so that it can be accessed easily by students wherever and whenever.

Based on the results of research on the application of E-modules using appy pie. It can be summarized that the use of appy pie has its advantages and disadvantages. The advantages of appy pie are the ease of making the process without going through a programming language (without coding), and can be made through the www.appypie.com service without having to have the software, it has a free version and the resulting application does not experience errors when using it. While the shortcomings in Appy Pie are 1) the features available are few, there are only displays for text and displays for videos or images and they are located separately, so it is quite difficult to make the module look attractive, 2) the resulting application is not proprietary but is still tied to appy pie according to the validity period of the application. The free version is only valid for 7 days from the initial manufacturing process, while the basic paid version has two options, namely monthly or annual subscriptions. Researchers use the monthly basic version, so the application can only be used for one month, 3) to get the application made, you must go through the publish stage to the playstore first. To be able to publish applications, researchers must have a developer account on the Google Play Console and pay once and for all. After completing all stages, the application can be installed through the playstore and, 4) the costs incurred are greater.

4. CONCLUSION

The increase in student learning activity in the experimental class was higher than in the control class. It is shown by the average result of the first observation in the experimental bigger than control class. The results of the second observation in the experimental class obtained an average value was higher than control class. Using the Android Appy Pie E-module based on the socio-scientific issue, the experimental class N-Gain results were better. These results showed that there was an increase in critical thinking skills in the experimental class. Student responses to the application of biology learning using the Android Appy Pie-based E-module based on the socio-scientific issue shows a good response from students. The socio-scientific-based Android Appy Pie-based e-module succeeded in improving students' critical thinking levels in the sample used.

5. REFERENCES

Abuhammad, S. (2020). Barriers to distance learning during the COVID-19 outbreak: A qualitative review from parents' perspective. *Heliyon*, *6*(11), e05482. https://doi.org/10.1016/j.heliyon.2020.e05482.

Adedoyin, O. B., & Soykan, E. (2020). Covid-19 pandemic and online learning: the challenges and opportunities. *Interactive Learning Environments*, *0*(0), 1–13. https://doi.org/10.1080/10494820.2020.1813180.

Agung, F. P., Suyanto, S., & Aminatun, T. (2020). E-Modul Gerak Refleks Berbasis Pendekatan Kontekstual untuk Meningkatkan Pemahaman Konsep Siswa SMA. *Jurnal Pendidikan: Teori, Penelitian, Dan Pengembangan*, *5*(3), 279–289. https://doi.org/10.17977/jptpp.v5i3.13238.

Asrial, Syahrial, Maison, Kurniawan, D. A., & Piyana, S. O. (2020). Ethnoconstructivism E-Module to Improve Perception, Interest, and Motivation of Students in Class V Elementary School. *JPI (Jurnal Pendidikan*

Indonesia), *9*(1), 30–41. https://doi.org/10.23887/jpi-undiksha.v9i1.19222.

Bubb, S., & Jones, M. A. (2020). Learning from the COVID-19 home-schooling experience: Listening to pupils, parents/carers and teachers. *Improving Schools*, *23*(3), 209–222. https://doi.org/10.1177/1365480220958797.

Chen, L., & Xiao, S. (2021). Perceptions, challenges and coping strategies of science teachers in teaching socioscientific issues: A systematic review. *Educational Research Review*, *32*. https://doi.org/10.1016/j.edurev.2020.100377.

Chowdhury, T. B. M., Holbrook, J., & Rannikmäe, M. (2020). Socioscientific issues within science education and their role in promoting the desired citizenry. *Science Education International*, *31*(2), 203–208. http://www.icaseonline.net/journal/index.php/sei/article/view/219.

Crawford, J., Butler-henderson, K., Rudolph, J., Malkawi, B., Glowatz, M., Magni, P. A., & Lam, S. (2020). COVID-19: 20 countries' higher education intra-period digital pedagogy responses. *Journal of Applied Learning & Teaching*, *3*(1). https://doi.org/10.37074/jalt.2020.3.1.7.

Fisher, A. (2009). *Berpikir Kritis Sebuah Pengantar*. Erlangga.

Genisa, M. U., Subali, B., Agussalim, A., & Habibi, H. (2020). Socio-Scientific Issues Implementation as Science Learning Material. *International Journal of Evaluation and Research in Education*, *9*(2), 311–317. https://eric.ed.gov/?id=EJ1256085.

Gül, M., & Akcay, H. (2020). Structuring a new socioscientific issues (SSI) based instruction model: Impacts on pre-service science teachers'(PSTs) critical thinking skills and dispositions. *International Journal of Research in Education and Science*, *6*(1).

Hermanto, Y. B., & Srimulyani, V. A. (2021). The Challenges of Online Learning During the Covid-19 Pandemic. *Jurnal Pendidikan Dan Pengajaran*, *54*(1), 46–57. http://repositori.ukdc.ac.id/id/eprint/833.

Johnson, J., Macalalag, A. Z., & Dunphy, J. (2020). Incorporating socioscientific issues into a STEM education course: exploring teacher use of argumentation in SSI and plans for classroom implementation. *Disciplinary and Interdisciplinary Science Education Research*, *2*(1), 1–12. https://doi.org/10.1186/s43031-020-00026-3.

Kinskey, M., & Zeidler, D. (2021). Elementary preservice teachers' challenges in designing and implementing socioscientific issues-based lessons. *Journal of Science Teacher Education*, *32*(3), 350–372. https://doi.org/10.1080/1046560X.2020.1826079.

Kusumaningtyas, P., Oktafiani, R., Nurhadi, M., & Sulistyaningwarni, S. (2020). Pengaruh Isu Sosiosaintifik Dalam Model Discovery Learning Terhadap Keterampilan Berpikir Kritis Siswa Pada Materi Asam Basa. *Orbital: Jurnal Pendidikan Kimia*, *4*(1), 64–74. https://doi.org/10.19109/ojpk.v4i1.5172.

Lestari, A. I., Senjaya, A. J., &, & Ismunandar, D. (2019). Pengembangan Media Pembelajaran Berbasis Android Menggunakan Appy Pie untuk Melatih Pemahaman Konsep Turunan Fungsi Aljabar. *Pedagogy: Jurnal Pendidikan Matematika*, *4*(2), 1–9. https://doi.org/10.30605/pedagogy.v4i2.1437.

Lestari, P. A. S., Gunawan, & Yulianci, S. (2020). Effectiveness of Online Lectures Using Digital Platform During The Pandemi Covid-19. *Indonesian Journal of Applied Science and Technology*, *1*(3), 107–115. https://journal.publication-center.com/index.php/ijast/article/view/595.

McQuirter, R. L. (2020). Lessons on Change: Shifting to Online Teaching during COVID-19. *Brock Education Journal*, *29*(2), 47. https://doi.org/10.26522/brocked.v29i2.840.

Minken, Z., Clarke, A., Marco-Bujosa, L., & Rulli, C. (2021). Development of teachers' pedagogical content knowledge during lesson planning of socioscientific issues. *International Journal of Technology in Education*, *4*(2).

Ningsih, S. Y., & Mahyuddin, N. (2021). Desain E-Module Tematik Berbasis Kesantunan Berbahasa Anak Usia Dini di Taman Kanak-Kanak. *Jurnal Obsesi : Jurnal Pendidikan Anak Usia Dini*, *6*(1), 137–149. https://doi.org/10.31004/obsesi.v6i1.1217.

Pauzi, R. Y., & Windiaryani, S. (2021). The critical thinking skills on global warming issue: Effect of the socio-scientific problems approach on problem-solving toward student's. *Biosfer: Jurnal Pendidikan Biologi*, *14*(2), 228–237. http://journal.unj.ac.id/unj/index.php/biosfer/article/view/19963.

Priatna, I. K., Putrama, I. M., & Divayana, D. G. H. (2017). Pengembangan e-modul berbasis model pembelajaran project based learning pada mata pelajaran videografi untuk siswa kelas X Desain Komunikasi Visual di SMK Negeri 1 Sukasada. *Jurnal Nasional Pendidikan Teknik Informatika: JANAPATI*, *6*(1), 70–78. https://doi.org/10.23887/janapati.v6i1.9931.

Riyanto, O. R., & Mariani, S. (2019). Mathematics Critical Thinking Reviewed from Self-efficacy and Motivation of Learning in Arias Learning. *Journal of Primary Education*, *8*(5), 243–250. https://journal.unnes.ac.id/sju/index.php/jpe/article/view/32690.

Rostikawati, D. A., & Permanasari, A. (2016). Rekonstruksi Bahan Ajar Dengan Konteks Socio-Scientific Issues Pada Materi Zat Aditif Makanan Untuk Meningkatkan Literasi Sains Siswa. *Jurnal Inovasi Pendidikan IPA*, *2*(2), 156–164. https://doi.org/10.21831/jipi.v2i2.8814.

Sadler, T. D. (2011). *Socio-Scientific Issues in the Classroom: Teaching, Learning And Research*. Springer.

Siahaan, M. (2020). Dampak Pandemi Covid-19 Terhadap Dunia Pendidikan. *Jurnal Kajian Ilmiah*, *1*(1), 73–80. https://doi.org/10.31599/jki.v1i1.265.

Siska, S., Yunita, Y., & Ubaidillah, M. (2019). Strategi Socio Scientific Issues untuk Meningkatkan Kemampuan Argumentasi Ilmiah Siswa pada Konsep Sistem Respirasi Di Kelas XI MIPA SMAN 1 Suranenggala. *Jurnal Ilmu Alam Indonesia*, *2*(1). https://www.syekhnurjati.ac.id/jurnal/index.php/jia/article/view/6274.

Subiantoro, A. W., & Treagust, D. F. (2021). Development and validation of an instrument for assessing high-school students' perceptions of socio-scientific issues-based learning in biology. *Learning Environments Research*, *24*(2), 223–237. https://doi.org/10.1007/s10984-020-09332-z.

Subiantoro, A. W., Treagust, D., & Tang, K. S. (2017). Indonesian Biology Teachers' Perceptions about Socio-Scientific Issue-Based Biology Instruction. *Asia-Pacific Science Education*, *1*, 1–25. https://brill.com/view/journals/apse/7/2/article-p452_8.xml.

Sugiyono. (2019). *Metode Penelitian Pendidikan*. Alfabeta.

Suparno, S. (2018). Development of E-Book Multimedia Model to Increase Critical Thinking of Senior High School Students. *Dinamika Pendidikan*, *12*(2), 196–206. https://doi.org/10.15294/dp.v12i2.13567.

Supena, I., Darmuki, A., & Hariyadi, A. (2021). The Influence of 4C (Constructive, Critical, Creativity, Collaborative) Learning Model on Students' Learning Outcomes. *International Journal of Instruction*, *14*(3), 873–892. https://eric.ed.gov/?id=EJ1304598.

Udin, T., Maufur, S., & Riyanto, O. R. (2022). Student's Self-Efficacy and Perceptions of Online Learning on the Use Learning Management System. *Journal of Education Technology*, *6*(1), 165–172. https://doi.org/10.23887/jet.v6i1.41884.

Wilsa, A. W., Susilowati, S. M. E., & Rahayu, E. S. (2017). Problem based learning berbasis socio-scientific issue untuk mengembangkan kemampuan berpikir kritis dan komunikasi siswa. *Journal of Innovative Science Education*, *6*(1), 129–138. https://doi.org/10.15294/jise.v6i1.17072.

Zeidler, D. L., & Nichols, B. H. (2009). Socioscientific issues: Theory and practice. *Journal of Elementary Science Education*, *21*(2), 49–58. https://doi.org/10.1002/sce.20048.