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# Natural and Social Sciences Project Learning E-Module to Improve Science Process Skills in Aspects of Substances and Their Changes in Vocational Schools

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**Abstract:** Electronic modules are one solution to help students master and apply Science Process Skills in terms of creative economic and social aspects of substances and their changes. This research aims to provide a bibliometric literature review regarding developing the Natural and Social Sciences Project e-module. Articles were found using Publishing or Perish (PoP) software with the Google Scholar database. 67 out of 80 articles found in the Google Scholar database from 2015 to 2022 were analyzed in this research. Selected references are then managed using reference management software, namely Mendeley. After managing the database, this research classifies and visualizes it using VOSviewer software. This review provides an appropriate reference point for further research on the 'IPA E-module'. The research conclusion is that online tutorials are more effective than non-online for teaching science process skills to students. Through the Natural and Social Sciences Project e-module, which is practical and valid, the science process skills of vocational school students increase.

**Keywords:** science e-module, science process skills, online tutorials, publishing or peris

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## INTRODUCTION

Natural and Social Science Project subjects are to equip students to solve real-life problems in the 21st century, which relate to natural and social phenomena in their surroundings scientifically by applying scientific concepts. In other words, after studying Natural and Social Sciences Project subjects, students can gain the skills to make scientifically sound decisions in order to live more comfortably, healthier and better. So, based on this, to build 21st-century education, it is necessary to design effective science learning for students because it helps students develop critical and creative thinking skills, develop mastery of basic concepts, think scientifically, build self-confidence, and solve problems (Imamyartha et al., 2019; Khasanah & Herina, 2019; Hediansah & Surjono, 2019). Saqib et al. (2020) state that 21st-century science learning has the potential to be implemented within the framework of Education for Sustainable Development (ESD). Applying ESD in learning can form someone who is insightful, innovative, and expands opportunities and views to solve complex environmental problems for sustainable development. Integrating ESD in science learning can be done in various ways, one of which is through learning media (Purnamasari & Hanifah, 2021).

As a science teaching material, e-modules must be adapted to the nature of natural science, which accustoms students to inquiry by doing and doing things so that they are better able to gain understanding. It is necessary to apply science to train students to solve identified problems (Gaffar, 2018; Lin et al., 2018; Ng, 2019; Suryani et al., 2022). By solving problems using simple experimental activities carried out by students, it is hoped that they will be able to develop science process skills. In cultivating science process skills in students, treatments are applied, such as conducting simple experiments in the learning process so that students can construct their own understanding (Hartini et al., 2018; Rahmawati et al., 2013; Sari et al., 2018; Widyasari, 2017). The e-module, which is based on science process skills, focuses on direct student involvement in understanding concepts (Suryani et al., 2022; Safitri & Sari, 2022). Laboratory experiences provide opportunities to learn skills beyond chemistry content knowledge, such as how to properly use scientific instrumentation, collect and analyze data, and work in a team. The results show that students better understand group dynamics process skills such as teamwork and communication (Reynders et al., 2019).

Scientific Process Skills Test (SPST) in the context of "Matter and its Properties" investigates whether there is a predictive effect of demographic features and the status of those attending out-of-school learning opportunities on the Scientific Process Skills (SPS) level of 7th and 8th-grade students. As a result, it is determined that grade level, gender or maternal education level were essential predictor variables on the SPS level of secondary school students. It was also determined that learning opportunities outside of school, such as participating in science fairs, designing projects or reading scientific journals, had a critical predictive effect on students' SPS levels (Tosun, 2019). Didactical strategies based on the use of video examples have proven useful in improving inquiry behavior in primary science classes. This approach provides new possibilities for

understanding and practicing science skills for students with little experience and/or unfamiliar with the inquiry process. The students seemed to integrate through several hints and tips shown in the video examples, which had a positive effect on the performance of the students' science process skills (Solé-Llussà et al., 2020).

The effect of computerized inquiry-stage argumentation assistance on elementary school students' science process and argument construction skills shows that argumentation assistance positively improves students' science process and argument construction skills in terms of presenting claims, data, warrants, and rebuttals. These results suggest that computerized argumentation aids may promise to improve science processes and argument construction skills, and in particular that high-level argumentation skills may be improved (as providing warrants is more difficult than presenting claims and data, and producing rebuttals is a significant indicator of high-quality arguments) (Lin et al., 2018). The results of research by Sari et al. (2018) regarding the relationship between science process skills and conceptual understanding and scientific attitudes show a significant relationship between science process skills and conceptual understanding. In addition, there is a significant relationship between understanding concepts and scientific attitudes. However, there is no significant relationship between science process skills and scientific attitudes. The research results of Nwosu (1994), Akinbobola and Afolabi (2010), and Ongowo and Indoshi (2013) reveal that in national exams, exam institutions test more basic science process skills than integrated science process skills. Ongowo and Indoshi (2013) state that the reason for the overemphasis on basic science process skills could be because they are the easiest to learn and can be transferred to new situations compared to integrated science process skills, which require more consistent practice. Comparing the two categories of science process skills, basic and integrated science process skills, the results obtained were a high percentage of basic science process skills of 80.51% compared to integrated science process skills of 19.50%, indicating that the number of basic science process skills was very significant, higher than the number of integrated science process skills in the Examinations Council of Zambia (ECZ) 5070/3 chemistry practical exams in 2007-2016 (Siachibila, 2018).

Three aspects are measured in knowing students' perceptions regarding electronic modules (e-modules) as a distance learning medium: clarity and suitability of text, images, animations and videos in e-modules, presentation of material and usefulness of the e-module (Inanna at al., 2021). Providing experience in conducting inquiries through interactive media presented in the e-module is expected to improve students' understanding of concepts and scientific attitudes. This research aims to assess the extent to which the development of the ESD-oriented Natural and Social Sciences Project E-module on aspects of substances and their changes can improve the science process skills of vocational school students. Development in e-modules can be complemented by simple practicums in making prototypes or products through inquiry learning or project-based learning activities contained in student activity sheets.

## METHODS

This research was a type of research and development (R&D) proposed by Borg and Gall (2003). The development model used was the ADDIE model, which stands for Analyze, Design, Development, Implementation, and Evaluation by Branch (2009). According to the stages of product development, the ADDIE model is stated to be more rational and complete. In this research, (1) the analysis stage was carried out by collecting data and information related to the problem to be researched, (2) the design stage focused on designing storyboards for electronic modules and instruments, (3) the development stage was a step to create electronic modules with using relevant sources and validating instruments, (4) the implementation stage was by providing e-modules to students in the learning process, and (5) evaluation stage assessed the overall development stages carried out. A preliminary bibliometric study was conducted using the Publish or Perish 7 application on Google Scholar.

The reference data obtained was then saved in ris form to be processed using the VosViewer program to analyze top cites articles developing science e-module, Network Visualization on Google Scholar Data Base, Overlay Visualization on Google Scholar Data Base, and Density Visualization on Google Scholar Data Base. Research data was collected using a questionnaire filled out online by teachers and students using Google Forms. The population in this study was vocational school teachers who comprised around 35 teachers to determine the percentage of students' science process skills. This research was conducted at a vocational school in Cikampek, with 36 students taking the science process skills test. Teacher interview sheets and science process skills tests were the instruments used in this research. The test sheet contained seven science process skill components. The data obtained was analyzed descriptively. The results of this analysis were presented in the form of interpretation, which is divided into three categories for each component of science process skills: low, medium, and high. Categorization in this assessment used the formula from Azwar (2003), with three categories: high, medium, and low. This category is useful for interpreting students' science process skills. The results of categorizing the level of mastery of science process skills using the formula from Azwar (2003) are as follows.

**Table 2.** Category Level of Mastery Students' Science Process Skills

| Average Score | Category |
|---|---|
| X < 47.62 | Low |
| 47.62 < X < 66.67 | Medium |
| X > 66.67 | High |

To measure mastery of science process skills in 36 students, seven essay questions with science process skill indicators were used, namely formulating problems, developing hypotheses, designing experiments, identifying variables, collecting data, analyzing data, and making conclusions. ESD indicators were addressed through the broader categories of knowledge, skills, and values as key competencies in the field of education for sustainable development (ESD), as they help students understand the complexity and dynamics of natural, social, and economic systems (Schuler et al., 2018).

## RESULT AND DISCUSSION

Initial search results for articles using Publish or Perish and after going through refinement search produce different metric data. The following are the results of comparing initial search and refinement search metric data using Publish or Perish.

**Table 1.** Comparison Metric

| Publication year: | 2016–2022 |
|---|---|
| Citation years: | 6 (2016 – 2022) |
| Papers: | 80 |
| Citations: | 210 |
| Cites/year: | 35.00 |
| Cites/papers: | 2.63 |
| Authors/papers | 2.65 |
| h-index | 6 |
| g-index | 13 |
| hi, norm | 5 |
| hA, annuals | 0.83 |
| ha, index | 5 |

Of the 80 search and refinement articles, here are the top 6 articles with the highest number of citations:

**Table 2.** Top 6 Cited Articles

| Publication Year | Author | Title | Journals | Cites | Publishers |
|---|---|---|---|---|---|
| 2019 | F Kimianti, ZK Prasetyo | *Pengembangan e-modul IPA berbasis problem-based learning untuk meningkatkan literasi sains siswa* | Kwangsan Journal Educational Technology | 63 | journalkwangsan.kemdikbud.go.id |
| 2018 | IK Darmayasa, IN Jampel ... | *Pengembangan E-Modul IPA karakter di SMP Negeri 1 Singaraja berorientasi pendidikan* | Journal Edutech UNDIKSHA | 35 | ejournal.undiksha.ac.id |

| | | | | | |
|---|---|---|---|---|---|
| 2021 | AAMH Al-Ahdal, MA Alharbi | MALL in collaborative learning as a vocabulary-enhancing tool for EFL learners: A study across two Universities in Saudi Arabia | Sage Open | 24 | journals.sagepub.com |
| 2018 | W Ng | A partnership-designed online module on climate science: Impact on year 10 teachers and students | EURASIA Journal of Mathematics, Science and Technology Education | 12 | ejmste.com |
| 2019 | NKS Artiniasih, AAG Agung, IG Wawan Sudatha | *Pengembangan elektronik modul berbasis proyek mata pelajaran ilmu pengetahuan alam kelas VIII Sekolah Menengah Pertama* | Journal Edutech UNDIKSHA | 11 | ejournal.undiksha.ac.id |
| 2021 | A Ferry, Z Zulherman | Development of near pod-based e-module on science material "energy and its changes" to improve elementary school student learning achievement | International Journal of Education and Learning | 10 | pubs2.ascee.org |

Data from search and refinement results in Publish or Perish are then analyzed and visualized using VOSviewer. There are three visualizations displayed for text mining analysis, namely Network Visualization (Figure 1), Overlay Visualization (Figure 2), and Density Visualization (Figure 3).

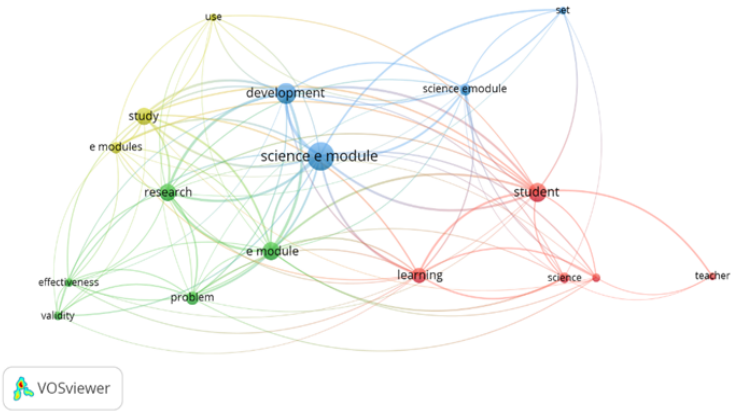


**Figure 1.** Network Visualization on Google Scholar Data Base

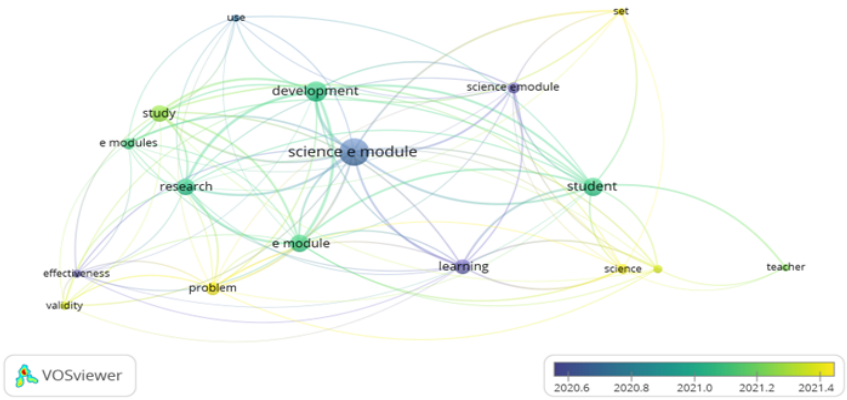


**Figure 2.** Overlay Visualization on Google Scholar DataBase

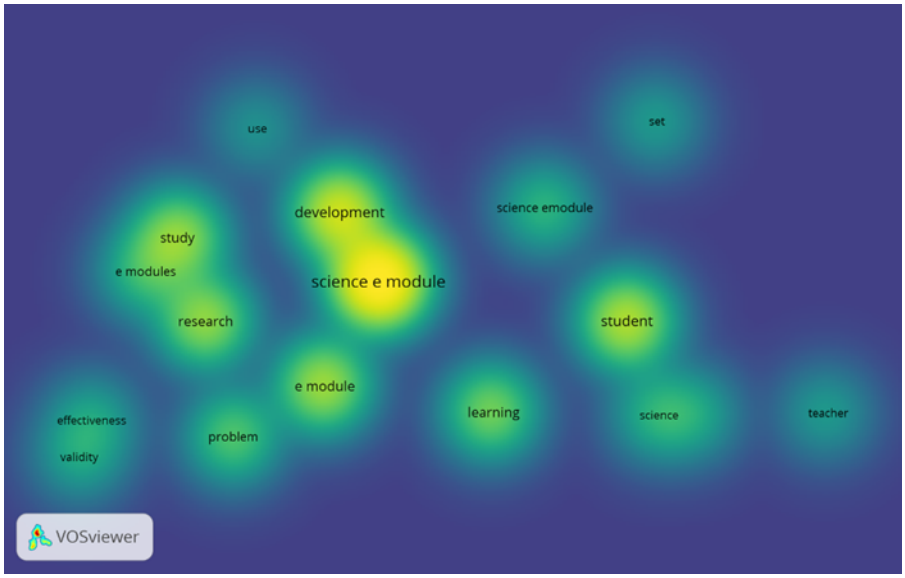


**Figure 3.** Density Visualization on Google Scholar Data Base

Based on the results of a survey in the form of a Teaching Material Needs Analysis Questionnaire using a questionnaire via Google Form among vocational natural and social sciences project teachers in Karawang Regency, of the 35 teachers who filled out the survey, the following results are obtained: 16% of teachers have used e-module teaching materials, 33% have used electronic books (BSE), 45% have used printed modules, and 6% have used others. Most teachers have applied technology in learning due to the demands of the COVID-19 pandemic, which has forced online learning globally, so it has become a habit to apply various delivery techniques using the Learning Management System (LMS) application. The obstacles faced in learning are internet signals and limited student quotas, making it difficult for teachers to implement inquiry-based learning, especially applying science process skills. This is evident from the survey results showing that the obstacles faced in learning methods that assess science process skills include inadequate computers, lack of student interest in learning, low student understanding, and limited time in making science process skill assessments.

Research using tests given to students consists of 7 essay questions. The question sheets provided are equipped with indicators of scientific process skills, including formulating problems, formulating hypotheses, designing experiments, determining variables, collecting data, analyzing data, and drawing conclusions. Based on data obtained from 7 test questions given to 36 students, they are grouped into high, medium, and low categories.

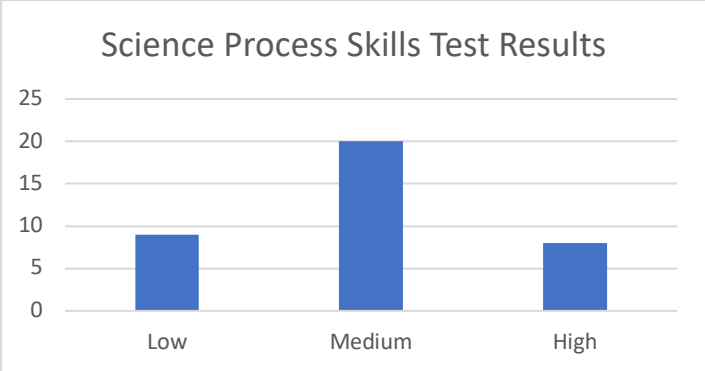


**Figure 4.** Science Process Skills Test Results

Based on the assessment, different science process skill values are obtained, divided into three groups, namely 25% low, 56% medium, and 19% high. Data analysis was conducted to determine the percentage of students' mastery of science process skills. Test results were analyzed using Microsoft Office Excel. The percentage of science process skills is known by calculating the score obtained from each science process skill indicator divided by the maximum score on the science process skills indicator. The results of this categorization can be interpreted for each indicator of science process skills as follows:

**Table 3.** Categories and Percentages for Each Indicator of Science Process Skills

| Indicator | Percentage | Category |
|---|---|---|
| Formulating problems | 77.78 | high |
| Formulating hypotheses | 63.89 | medium |
| Designing experiments (tests) | 66.67 | high |
| Determining variables | 44.44 | low |
| Collecting data | 63.89 | medium |
| Analyzing data | 25.00 | low |
| Drawing conclusion | 52.78 | medium |

Based on the data in Table 3 and Figure 5, the lowest percentage of scientific process skill indicators is in determining variables and analyzing data. Activities to determine variables and analyze data are included in the integrated science process skills section. If this skill is trained in students, it will have a positive impact on student learning achievement. Previous studies show a positive correlation between academic achievement and science process skills. These skills are needed to increase students' understanding. This is why scientific process skills cannot be separated from conceptual improvement. However, science process skills with scientific attitudes do not show a meaningful relationship (Sari et al., 2018).

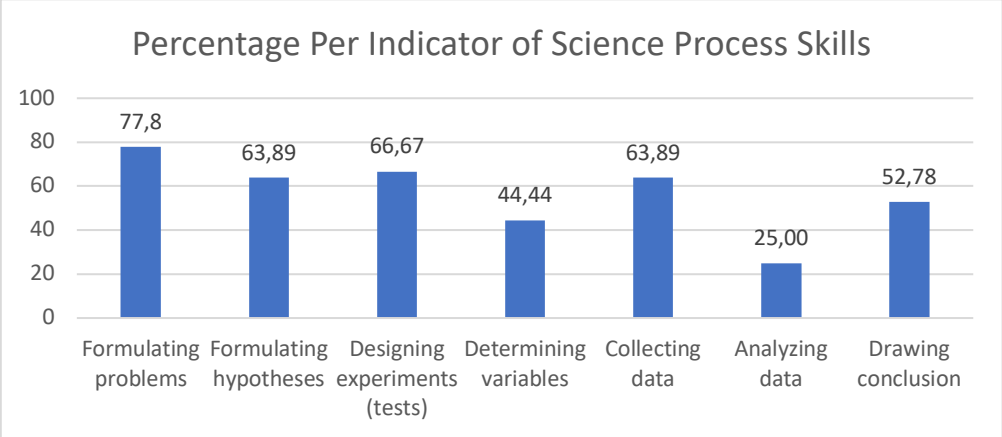


**Figure 5.** The Percentages of Each Science Process Skill Indicator

There are not many research references regarding ESD in learning. One of the relevant studies that have been carried out is by Sari and Purtadi (2013), Rahman et al. (2019), and Nikmah (2018) regarding the development of models in learning Chemistry, Biology modules, and ESD-based Mathematics teaching materials

which are limited to on the feasibility test alone and it was decided that the results were very feasible by expert validators. In their research, Clarisa et al. (2020) conclude that implementing the Flipped Classroom in the ESD context can improve students' cognitive abilities and build Sustainability Awareness after learning activities (Seibert et al., 2020). Teguh's research (2020) presents that using e-modules as a learning medium is very interesting because e-modules provide an attractive appearance that can increase students' enthusiasm for learning. Using e-modules as a learning media will make it easier for students to access and obtain information related to electronic-based teaching materials. Students' interest and learning motivation increase because the e-module displays are very attractive. Another thing is proven that learning cannot only be done face to face because, in distance learning, the teacher will also monitor students through evaluations on e-modules. Assessment can be measured through assignments and quizzes students answer in the e-module. Thus, electronic modules (e-modules) can be used as a medium for distance learning. To develop students' skills in experiments integrated with information technology, e-modules can present virtual labs as a learning medium that can improve students' skills, especially in experiments, allowing students to interact and learn without being limited by space and time. The purpose of the virtual lab in the e-module is to provide an interactive experience where students can observe and manipulate system objects, data, or generated phenomena to meet learning objectives. Therefore, with this aim, the virtual lab in the e-module provides an important function and role in mastering and improving students' skills. Virtual laboratories have been proven to increase students' understanding (Darby-white et al., 2019) and can improve students' thinking skills (Widowati et al., 2017).

## CONCLUSION

There are three needs in developing teaching materials to support improving students' process science skills, including electronic teaching materials that are easy to access and have applications that make it easier to practice virtually so that they understand concepts naturally. Learning supports student attitudes to improve students' cognitive abilities and build Sustainability Awareness after learning activities. Basic science process skills may be because they are the easiest to learn and can be transferred to new situations compared to integrated science process skills, which require more consistent practice. Several things that can improve science process skills include direct involvement of students in understanding concepts through laboratory or virtual laboratory experiences, learning opportunities outside of school such as participating in science exhibitions, designing projects, or reading scientific journals, and assistance with computerized inquiry argumentation. The existence of e-modules and e-learning materials changes the function of teachers from translators of educational information to managers of effective learning processes. Thus, learning with e-modules directs students to be independent in controlling and assessing their own knowledge.

## REFERENCES

Akinbobola, A. O., & Afolabi, F. (2010). Analysis of Science process skills in West African senior secondary school certificate Physics practical examinations in Nigeria. *American-Eurasian Journal of Scientific Research*, 5, 234-240.

Azwar, S. (2003). *Metode Penelitian*. Pustaka Pelajar

Borg, W. R., & Gall, J. P. (1996). *Educational research: An introduction*. Longman Publishing.

Budiarti, I. S., Triwiyono, T., & Panda, F. M. (2019). The development of discovery learning-based module to improve students' scientific literacy. *Jurnal Pembelajaran Fisika*, 9(1), 73-89.

Clarisa, G., Danawan, A., Muslim, M., & Wijaya, A. F. C. (2020). Penerapan Flipped Classroom dalam Konteks ESD untuk Meningkatkan Kemampuan Kognitif dan Membangun Sustainability Awareness Siswa. *Journal of Natural Science and Integration*, 3(1), 13-25.

Darby-White, T., Wicker, S., & Diack, M. (2019). Evaluating the effectiveness of virtual chemistry laboratory (VCL) in enhancing conceptual understanding: Using VCL as pre-laboratory assignment. *Journal of Computers in Mathematics and Science Teaching*, *38*(1), 31-48.

Erlina, R., Risdianto, E., Hamdani, D., Fathurrochman, I., Efendi, R., & Prananosa, A. G. (2022). An Analysis of Needs Response to the Development of E-Module Material Elasticity and Hooke Law at Lebong Regency High School. *JMKSP (Jurnal Manajemen, Kepemimpinan, dan Supervisi Pendidikan)*, 7(1), 163-187.

Friska, S. Y., Nurhalida, N., & Susilawati, W. O. (2022). Pengembangan E-Modul IPA tema 6 subtema 2 materi siklus hidup hewan berbasis Problem Based Learning berbantu flipbook maker di Kelas IV Sekolah Dasar. *JEMS: Jurnal Edukasi Matematika dan Sains*, *10*(2), 377-382.

Gaffar, A. A. (2018). Penerapan Model Pembelajaran Kooperatif Tipe Picture and Picture untuk Meningkatkan Hasil Belajar Siswa SMP pada Pembelajaran IPA. *Jurnal Bio Educatio*, *3*(1), 10-21.

Hartini, S., Isnanda, M. F., Wati, M., Misbah, M., An'Nur, S., & Mahtari, S. (2018, September). Developing a physics module based on the local wisdom of Hulu Sungai Tengah regency to train the murakata character. In *Journal of Physics: Conference Series*, 1088(1), 012045. IOP Publishing.

Hediansah, D., & Surjono, H. D. (2020). Hybrid learning development to improve teacher learning management. *JKTP: Jurnal Kajian Teknologi Pendidikan*, *3*(1), 1-9.

Imamyartha, D., Fitriyah, S. M., Tasnim, Z., Puspa, A., Fardhani, A. E., Wahjuningsih, E., ... & Arya, B. (2019). The efficacy of 4Cs-based reading to foster 21st-century learning competencies. *Indonesian Journal of Applied Linguistics*, *9*(2), 275-285. https://doi.org/10.17509/ijal.v9i2.20218.

Inanna, I., Ampa, A. T., & Nurdiana, N. (2021). Modul Elektronik (E-Modul) Sebagai Media Pembelajaran Jarak Jauh. *Seminar Nasional Hasil Penelitian* (1232-1241).

Jetly, M., & Singh, N. (2019). Analytical study based on perspectives of teacher educators in India with respect to education for sustainable development. *Journal of Teacher Education for Sustainability*, *21*(2), 38-55.

Khasanah, U., & Herina, H. (2019, March). Membangun karakter siswa melalui literasi digital dalam menghadapi pendidikan abad 21 (revolusi industri 4.0). *Prosiding Seminar Nasional Program Pascasarjana Universitas PGRI Palembang*.

Lin, C. H., Chiu, C. H., Hsu, C. C., Wang, T. I., & Chen, C. H. (2018). The effects of computerized inquiry-stage-dependent argumentation assistance on elementary students' science process and argument construction skills. *Journal of Computer Assisted Learning,* 34(3), 279–292. https://doi.org/10.1111/jcal.12241

Ng, W. (2019). A partnership-designed online module on climate science: Impact on year 10 teachers and students. *Eurasia Journal of Mathematics, Science and Technology Education, 15*(2).

Nwosu, A. A. (1994). Levels of acquisition of science process skills among year one senior secondary school students. *Journal of the Science Teachers Association of Nigeria, 29,* 47-53.

Oktari, B., Susilawati, S., & Copriady, J. (2020). Implementation of Oriented Literated Science E-Module to Improve Critical Skills Thinking About in Hydrocarbon Material. *Journal of Educational Sciences*, *4*(2), 347-356.

Ongowo, R.O & Indoshi, F.C. (2013). Science Process Skill in Kenya Certificate of Secondary Education Biology Practical Examination. Journal of Scientific research, 4(11): 713-717.

Purnamasari, S., & Hanifah, A. N. (2021). Education for Sustainable Development (ESD) dalam pembelajaran IPA. *Jurnal Kajian Pendidikan IPA*, *1*(2), 69-75.

Rahmawati, L., Sudarisman, S., & Suparmi, S. (2013). Pembelajaran Ipa Dengan Metode Eksperimen Menggunakan Pendekatan Home Dan Classroom Science Process Skill Ditinjau Dari Sikap Ilmiah Dan Rasa Ingin Tahu. *Bioedukasi,* 6(2), 28–45.

Rahman, A., Heryanti, L. M., & Ekanara, B. (2019). Pengembangan modul berbasis education for sustainable development pada konsep ekologi untuk siswa kelas X SMA. *Jurnal Eksakta Pendidikan (JEP)*, *3*(1), 1-8.

Raju, P., & Hickman, J. (2021). Sustainability. https://www.rcoa.ac.uk/sites/default/files/documents/2021-12/Medical Gases Final.pdf

Ramadan, C. P. (2021). Pengembangan E-Modul IPA SMP Terintegrasi Ayat-Ayat Al-Qur'an Berbantuan Simulasi Virtual Pada Materi Getaran, Gelombang, dan Bunyi [Undergradute Thesis, Universitas Islam Negeri Sultan Syarif Kasim Riau]

Reynders, G., Suh, E., Cole, R. S., & Sansom, R. L. (2019). Developing Student Process Skills in a General Chemistry Laboratory. *Journal of Chemical Education,* 96(10), 2109–2119.

Rozi, F., Prawijaya, S., & Ratno, S. (2021, November). Development of Interactive E-Modules Based on Google Docs in Basic Concepts of Biology Curriculum MBKM UNIMED FIP PGSD Study Program. In *6th Annual International Seminar on Transformative Education and Educational Leadership (AISTEEL 2021)* (850-856). Atlantis Press.

Safitri, R., & Sari, M. (2022). Pengembangan E-Modul Kimia Berbasis SETS (Science, Environment, Technology, and Society) untuk Siswa SMAN 1 Kecamatan Payakumbuh. *Journal of Chemistry Education and Integration*, *1*(1), 9-15.

Salsabila, S., Marina, N., & Marhamah, M. (2022). Implementasi Model Pembelajaran Poe Di Sekolah Dasar. *Dirasatul Ibtidaiyah*, *2*(1), 27-42.

Sambuaga, R., Sujono, I., & Suja'i, I. S. (2021). Pengembangan E-Modul Ilmu Pengetahuan Sosial (IPS) Kelas 8 Semester 1 di SMP Negeri 2 Ngunut. *Jurnal Pendidikan Tambusai*.

Saqib, Z. A., Zhang, Q., Ou, J., Saqib, K. A., Majeed, S., & Razzaq, A. (2020). Education for sustainable development in Pakistani higher education institutions: An exploratory study of students' and teachers' perceptions. *International Journal of Sustainability in Higher Education*, *21*(6), 1249-1267.

Sari, P. M., Sudargo, F., & Priyandoko, D. (2018). Correlation among science process skill, concept comprehension, and scientific attitude on regulation system materials. *Journal of Physics: Conference Series*, *948*(1). https://doi.org/10.1088/1742-6596/948/1/012008

Sari, R. L. P., & Purtadi, S. (2015). Pengembangan Eksperimen Kimia Berbasis Education for Sustainable Development (ESD) sebagai Model Penyiapan Siswa Menjadi Profesional Masa Depan. *http://eprints. uny. ac. id/id/eprint/2245*, *6*.

Schuler, S., Fanta, D., Rosenkraenzer, F., & Riess, W. (2018). Systems thinking within the scope of education for sustainable development (ESD)–a heuristic competence model as a basis for (science) teacher education. *Journal of Geography in Higher Education*, *42*(2), 192-204. https://doi.org/10.1080/03098265.2017.1339264

Seibert, J., Schmoll, I., Kay, C. W., & Huwer, J. (2020). Promoting Education for Sustainable Development with an interactive digital learning companion students use to perform collaborative phosphorus recovery experiments and Reporting. *Journal of Chemical Education*, *97*(11), 3992-4000.

Siachibila, B., & Banda, A. (2018). Science process skills assessed in the examinations council of Zambia (ecz) senior secondary school chemistry-5070/3 practical examinations. *Chemistry and Materials Research, 10 (5), 17, 23*.

Solé-Llussà, A., Aguilar, D., & Ibáñez, M. (2022). Video-worked examples to support the development of elementary students' science process skills: a case study in an inquiry activity on electrical circuits. *Research in Science & Technological Education*, *40*(2), 251-271. https://doi.org/10.1080/02635143.2020.1786361

Sopandi, W., Kadarohman, A., Rosbiono, M., Latip, A., & Sukardi, R. R. (2018). The Courseware of Discontinuous Nature of Matter in Teaching the States of Matter and Their Changes. *International Journal of Instruction*, *11*(1), 61-76. https://doi.org/10.12973/iji.2018.1115a

Suryani, L., Hodijah, S. R. N., & Taufik, A. N. (2022). Pengembangan E-Modul IPA Berbasis Science Process Skills dengan Tema Transportasi si-Hijau untuk Melatih Keterampilan Komunikasi Sains Siswa SMP Kelas VIII. *Pendipa Journal Of Science Education*, *6*(2), 322-330.

Tosun, C. (2019). Scientific process skills test development within the topic "Matter and its Nature" and the predictive effect of different variables on 7th and 8th grade students' scientific process skill levels. *Chemistry Education Research and Practice*, *20*(1), 160-174.

Widowati, A., Nurohman, S., & Setyowarno, D. (2017). Development of inquiry-based science virtual laboratory for improving student thinking skill of junior high school. *Jurnal Pendidikan Matematika dan Sains*, *4*(2), 170-177. https://doi.org/10.21831/jpms.v5i2.16708

Widyasari, E. (2017). Pembelajaran Inkuiri Materi Perubahan Fisika Kimia Berbasis Kesehatan Dan Lingkungan. *Prosiding SNPS (Seminar Nasional Pendidikan Sains)*, 146-149.