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Development of Sound Wave Modules Based on CPS Learning Models to Improve Creative Thinking Skills and Learning Motivation

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Abstract: This examination plans to deliver a sound wave module in light of the CPS learning model that is reasonable for use in the secondary school/Mama physical science educational experience. The sort of exploration utilized is improvement research (R&D) with the ADDIE model (Analyze, Plan, Advancement, Execution, Assessment). The examination instruments utilized were approval sheets and reaction sheets for instructors and understudies with a size of four likerts given to 3 specialists, 3 educators, and 26 understudies of SMA Negeri 1 Kampar Timur. The information was examined quantitatively founded on the aftereffects of master approval, educator, and understudy reactions. The aftereffects of approval utilizing the typical score directed by three master validators were in the Substantial classification with a typical score of material specialists of 3.67, educational specialists a typical score of 3.53, and media specialists a typical score of 3.60. The reaction of educators from 3 instructors got a typical educator reaction score of 3.71 and was in the generally excellent classification and the members' reaction got a typical understudy reaction score of 3.62 with an excellent classification. In light of the information acquired, the sound wave module given the CPS learning model is substantial and appropriate for use in the secondary school material science growing experience.

Keywords: development; modules; CPS Learning Model

Introduction

The era of the Industrial Revolution 4.0 and the development of technology are affecting people's habits and lifestyles. Life's challenges and competition are increasing, jobs are getting tougher, and many jobs are being replaced by robots that can work automatically, work tirelessly, and at low cost. All human needs can be served by machines quickly (Gunadi et al., 2022; Susanti et al., 2020). Dependence on technology makes us live in two worlds, namely the real world (physical space) and the inseparable virtual world (Andembubtob et al., 2023). Competition in this era not only requires monotonous skills but there must also be changes to be more critical, creative, and innovative., as well as having interpersonal and intrapersonal skills (Deguchi & Hirai, 2020).

In the 21st century, one of the fields that need to be transformed is education (Meyer & Norman, 2020). The aim is to ensure learners have the knowledge and skills to survive and compete in this era of globalization (Higgins). Knowledge alone is not successful enough to deal with an increasingly complex and rapidly changing life. Life in the context of an open world requires students to continuously pursue quality and excellence to be able to survive and compete in the acceleration of change that occurs (Siregar, 2019; Susanti et al., 2020).

Learning and innovation skills are the 21st-century skills students must master to succeed in life. These skills include critical thinking, creative thinking, problem-solving, communication, collaboration, creativity, information, and media literacy (Guntur., 2020). These skills can be taught in schools by applying her 21st-century learning principles such as: Student-centered,

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holistic, interactive and inclusive, participatory, project-based learning, fostering creativity and innovation, using appropriate learning tools, contextual and real-world relevant learning, enhancing metacognition (Muhali, 2019; Zubaidah, 2016).

The quality of education in Indonesia is getting worse every year. This can be seen from the results of international standards TIMSS (Trends in International Mathematics and Science) and PISA (Program for International Student Assessment). In the TIMSS field of science, Indonesia was ranked 32nd out of 38 participating countries in 1999, ranked 37th out of 46 participating countries in 2003, and ranked 35th out of 49 participating countries in 2007, far behind neighboring countries such as Singapore and Malaysia at the age of three. In the PISA survey in 2003, Indonesia was ranked 36th out of 40 countries in the field of science. In 2006, Indonesia's ranking dropped from 36th out of 40 countries (2003) to 54th out of 57 countries with an average score. from 395 (2003) to 393 (2006), and in 2009 Indonesia was ranked 60th out of 65 countries, with the average score dropping from 393 (2006) to 383 (2009). Based on the results of the TIMSS (2007) and PISA studies, it can be seen that student achievement in Indonesia is still low compared to other countries (Sudaryati, 2016).

Poor student performance also indicates poor student thinking skills. Novak and Levinger say "how to learn or thinking to learn, learning to think". If teachers can provide higher-order thinking skills so that students have creative thinking and critical thinking that are used for independent personal construction and can manage their learning (self-regulated learning) and build their knowledge (Puspitasari et al., 2016).

21st-century skills not only help learners be successful in all areas of formal schooling, but they are also necessary to adapt and thrive in a constantly changing world (Brandt, 2020). A good and appropriate learning plan can facilitate knowledge construction, while learners' self-knowledge can result in more effective knowledge construction in solving real-world problems (Peters-burton & Stehle, 2019). Technology is one of the good learning supporters. Technology contributes to providing facilities that can equip educators and students to achieve 21st-century competence. The role of technology in the context of learning 21st-century competencies can be realized through creation, utilization, and processing to improve the quality of learning in the short term and improve performance in long-term learning (González-Pérez & Ramírez-Montoya, 2022; González-Salamanca et al., 2020; Warsita, 2017).

Revolution 4.0 provides training for teachers to be wise and able to understand and use digital technology, means of communication and access it. The goal is that students can use learning media in helping the learning process. Current developments have made a good contribution to the learning and teaching process (Mubarok et al., 2022; Zulkifli et al., 2022).

The ability to think creatively is one of the core elements of the learning process (Miranda et al., 2021). Creative thinking is a skill that begins with being sensitive to a situation and seeing or identifying the situation as a problem to be solved, so the ability to think creatively is very important for all students. The ability to think creatively refers to thinking abilities that consist of aspects of fluency, flexibility, originality, and the explanation of ideas developed to generate new ideas and enhance metacognition. (Zulirfan et al., 2022). Therefore, in its implementation, learning in the classroom is important to involve students actively so that this skill can be developed properly (Nurlaila et al., 2016).

Physics is a form of natural science, which discusses all natural phenomena both microscopic and macroscopic. At this time, physical science supports the development of technology, industry, communication, chemistry, biology, and others. This makes physics a very important scientific aspect in the world of education. Seeing the importance and influence of physics on the development of the world, it is necessary to develop an interesting physics learning process for students (Azhar, 2013; Yolanda, 2021).

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Other research results, the low ability to think creatively and student learning motivation is caused by several factors, including teachers still using direct learning models (direct instruction), opening-example-exercise-close learning flow, which is doing practice questions with steps as exemplified by the teacher, when learning students only record the material explained by the teacher and provide feedback on the teacher's explanation, In practicum activities, students only rely on the teacher's explanation and direction (Damayanti et al., 2020; Sarnita et al., 2019; Umamah & Andi, 2019).

One of the elements that support efforts to improve students' creative thinking skills in learning is the use of materials that are tailored to student characteristics and needs. Modules that promote creative thinking skills are

modules that are supported through the use of appropriate learning models so that students can learn effectively (Swestyani et al., 2016).

The learning model used as support for the modules is the Creative Problem Solving (CPS) model. According to Karen (2004), the creative problem-solving (CPS) model is a learning model that focuses on problem-solving skills and subsequently reinforces creative thinking skills (Wahana, 2019). The learning model used as support for the modules is the Creative Problem Solving (CPS) model. According to Karen (2004), the creative problem-solving (CPS) model is a learning model that focuses on problem-solving skills and subsequently reinforces creative thinking skills.

CPS-based modules aim to improve students' creative thinking skills, and this CPS model focuses on problem-solving skills that select and develop student responses to specific problems. In addition to mindless memorization, problem-solving skills also enhance learners' thought processes. Creative thinking skills are enhanced and he consists of four domains: Fluency, Flexibility, Originality, Evaluation, and Elaboration (Treffinger &; Selby, 2004).

Based on the above explanation, researchers are interested in developing a learning medium in the form of teaching materials, namely a sound wave module based on the CPS learning model, aiming to enhance the creative thinking ability and motivation to learn of high school students.

Method

The research methodology used in this study is research and development (R&D) using the ADDIE (analysis, design, development, implementation, evaluation) model (Sagita & Aminatun, 2019). This research focused on developing a sound wave module based on the CPS learning model for high school students. The ADDIE research procedure is shown in Figure 1.

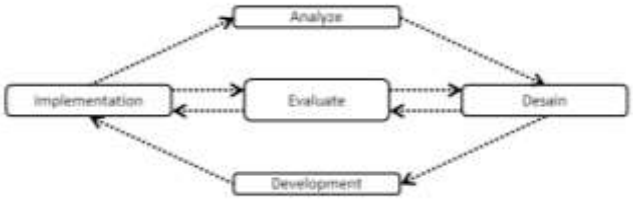

Figure 1. ADDIE Research Procedure

Analysis Stage

The analysis stage is the stage where researchers analyze the need for the development of sound wave physics modules based on the CPS learning model and analyze the feasibility and requirements of the development procedure. The stages of analysis carried out consist of reviewing textbooks used in the learning process, reviewing the learning media used by teachers at SMA Negeri 1 Kampar Timur, and observing the learning process that is less varied in teaching methods.

Design Stage

In the design stage of the sound wave module based on the CPS learning model to improve students' creative thinking ability and motivation to learn, Design I is created as the first product according to the analysis done earlier.

Development Stage

The development phase is carried out through the preparation of modules and validated by educational, materials, and media experts. The purpose is to determine whether the module is suitable as a medium for teaching physics in the classroom.

Implementation Stage

The implementation phase carried out module testing on 29 students of grade XI MIPA 1 at SMA Negeri 1 Kampar Timur. This product trial is equipped with teacher and student response instruments to determine the feasibility of the product in helping the learning process. Data collection techniques are carried out by providing a draft of learning modules along with assessment sheets to experts or experienced experts to assess the modules that have been designed (Hastani et al., 2021). Then experts or experts are asked to provide an assessment in the form of suggestions and scores for each assessment item against the module developed. Expert validation is required to assess the feasibility of modules that have been created. The data obtained from the expert validation sheet is expressed on a Likert scale with 4 assessment criteria stating the level of approval of the assessment item. The Likert scale criteria used can be seen in Table 1 (Sugiyono, 2019).

Table 1. Likert Scale Assessment Categories

Score	Description
1	Strongly Disagree
2	Disagree
3	Agree
4	Strongly Agree

An assessment item is valid if all experts give a minimum score of 3. Meanwhile, the module draft is declared valid as a whole if all items have been declared valid by all experts or the value of each item ≥ 3.00. The criterion of module draft validity can be expressed by

the overall average of the items. The criteria for the validity of the module draft can be stated in Table 2.

Table 2. Module Validation Category

Value	Criterion
≥ 3.00	Valid
< 3.00	Invalid

After obtaining the validity value of the module and being declared valid, the next stage is a small group test on 26 students, at this stage students are given questionnaires. At this stage, teachers are also given questionnaires to get input from practitioners' perspectives to be able to see the feasibility of the module, and input and suggestions are used as material for module improvement. Data obtained from expert validation sheets, teachers, and students are expressed on a Likert scale.

Furthermore, the results of the percentage assessment of teacher and student response questionnaires are converted into quantitative values as presented in Table 3.

Table 3. Criteria for Teacher and Student Response Questionnaire

Average Response Score	Criterion
3.25 > x ≤ 4	Very good
2.5 > x ≤ 3.25	Goog
1.75 >x ≤ 2.5	Enough
1 > x ≤ 1.75	Not good

Based on the table 3, it can be analyzed the practicality of the product, where the product developed is said to be a practical use for teachers if at least the criteria achieved are good.

Result and Discussion

The developed CPS learning model-based sound wave module was then tested for grade XI learners. This sound wave module based on the CPS learning model presents various kinds of problems related to the phenomenon of sound waves that must be studied by students based on the analysis of surrounding events (Hartsell et al., 2019). This module is also equipped with a practicum that utilizes mobile media as one of the tools used in practicum with the aim of training students to better utilize mobile phones for more useful things. The sound wave module based on the CPS learning model provides innovation in physics learning media because it trains students to think more creatively in the form of problems contained in the module. The view of the STEM-based module is presented in Figure 2.

Figure 2. Module View

The results of validation by 3 expert validators, 3 practitioners (teachers), and small group trials by 29 students on sound wave modules based on the CPS learning model are as follows.

Expert Validation

The CPS learning model-based sound wave module was feasibility tested by 3 validators before being used for small group trials. The instrument's validation score is analyzed using an average value which is then converted into a validation criterion interval. Assessment of sound wave modules based on CPS learning models based on material, pedagogic, and media aspects. Comments and suggestions given by validators to the module are then revised before the CPS learning model-based module is implemented in small group trial classes. The results of validation by 3 validators for CPS learning model-driven modules are shown in Table 3, Table 4, and Table 5.

Table 4. Material Expert Validation Results for CPS Learning Model-Based Modules

Assessment Indicators	Average Score	Criterion
Material Suitability	3.72	Valid
Material Accuracy	3.50	Valid
Material Updates	3.50	Valid
User-Friendly	3.50	Valid
Benefits	3.33	Valid
Adaptive	3.67	Valid
Average	3.67	Valid

The third assessment of media expert validators in Table 3, obtained an average validation of the CPS learning model-based module obtained a score of 3.67. Based on the validation criteria, the module shows that the score of the result is within the valid criteria.

Table 5. Results of Pedagogic Expert Validation of CPS Learning Model-Based Modules

Assessment Indicators	Average Score	Criterion
Serving	3.67	Valid
Language	3.33	Valid
Constructivism	3.33	Valid
CPS	3.67	Valid
Benefits	3.50	Valid
Adaptive	3.67	Valid
Average	3.53	Valid

The assessment of the three pedagogic expert validators in Table 4, obtained an average validation of modules based on the CPS learning model and obtained a score of 3.53. Based on the validation criteria, the module shows that the score of the result is within the valid criteria.

Table 6. Results of Media Expert Validation of CPS Learning Model-Based Modules

Assessment Indicators	Average Score	Criterion
Format	3.83	Valid
Organization	3.67	Valid
Attraction	3.78	Valid
Typography	3.56	Valid
Consistent	3.67	Valid
Language	3.17	Valid
Benefits	3.50	Valid
Average	3.60	Valid

The third assessment of media expert validators in Table 5, obtained an average validation of CPS learning model-based modules obtained a score of 3.60. Based on the validation criteria, the module indicates that the result score is within the valid criteria.

Based on the assessment of the three expert validators (material, pedagogic, and media) showed that the validation score results were included in the valid category so that the CPS learning model-based module developed was suitable for use in the learning process of sound wave material.

Small Group Trials

Small group trials were conducted in class XI MIPA 1 consisting of 26 students and 3 physics teachers of SMA Negeri 1 Kampar Timur in the form of teacher and student responses. Small group trial scores were analyzed using average values and then converted into validation criteria intervals. Assessment of teacher responses to modules based on the CPS learning model is assessed based on aspects of material, presentation, language, design, and benefits. The results of 3 teachers' responses to the CPS learning model-based module are shown in Table 6.

Table 6. Results of Teacher Responses to CPS Learning Model-Based Modules

Assessment Aspect	Average Score	Criterion
Material	3.44	Excellent
Serving	3.67	Excellent
Language	4.00	Excellent
Design	4.00	Excellent
Benefit	3.44	Excellent
Average	3.71	Excellent

The assessment of the three teachers in Table 6 obtained an average validation of the CPS learning model-based module of 3.71. Based on the questionnaire criteria, the teacher's response showed that the result score in the criteria was very good.

Assessment of student responses to modules based on the CPS learning model is assessed based on aspects of ease of use, benefits, and attractiveness. Results obtained from a small group trial by 29 learners for the CPS learning model-based module are shown in Table 7.

Table 7. Results of Student Responses to CPS Learning Model-Based Modules

Indicators	Average Score	Criterion
Ease of Use	3.74	Excellent
Benefit	3.40	Excellent
Attraction	3.75	Excellent
Average	3.62	Excellent

Assessment of the results of student responses to the CPS learning model-based module in Table 7 obtained an average score of 3.62. Based on the questionnaire criteria, student responses showed that the result scores in the criteria were very good.

Based on the results of small group trials in the form of teacher and student responses, the average criteria were obtained to enter the very good category. This shows that according to teachers and students, modules based on the CPS learning model on sound wave material are very good and can help in the physics learning process in schools.

Conclusion

Based on module development research, it can be concluded that a sound wave module based on the CPS learning model has been produced for high school / MA students developed through the ADDIE development model (analysis, Design, Development, Implementation, Evaluation), and small group trials. Sound wave modules based on the CPS learning model are categorized as suitable for use as teaching materials. This is based on the validation stated that the feasibility of the

module by three expert validators is in the valid category with an average score of material experts of 3.67, pedagogic experts an average score of 3.53, and media experts an average score of 3.60. Teachers consider the sound wave module based on the CPS learning model good and practical to use in learning. This is in accordance with the average teacher response score of 3.71 and is in the very good category. Students consider the sound wave module based on the CPS learning model easy and practical to use in the learning process, in accordance with the acquisition of an average student response score of 3.62. The results of research and development show that the sound wave module based on the CPS learning model is declared valid and suitable for use in the physics learning process.

Author Contributions

This paper was written by two people, namely H and YH. This paper was completed with team collaboration at each stage.

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Conflicts of Interest

The authors declare no conflict of interest.

References

Andembubtob, D. R., Keikhosrokiani, P., & Abdullah, N. L. (2023). A Concise Review on the Concept of Metaverse: Types, History, Features, and Technological Perspectives. *Handbook of Research on Consumer Behavioral Analytics in Metaverse and the Adoption of a Virtual World*, 40–67. Retrieved from https://www.igi-global.com/chapter/a-concise-review-on-the-concept-of-metaverse/321596

Azhar, A. (2013). Pendidikan fisika dan keterkaitannya dengan laboratorium. *Jurnal Geliga Sains: Jurnal Pendidikan Fisika*, *2*(1), 7–12. Retrieved from https://jgs.ejournal.unri.ac.id/index.php/JGS/article/view/1582

Brandt, W. C. (2020). *Measuring Student Success Skills: A Review of the Literature on Self-Directed Learning*. *21st Century Success Skills*. National Center for the Improvement of Educational Assessment. Retrieved from https://eric.ed.gov/?id=ED607782

Damayanti, S. A., Santyasa, I. W., & Sudiatmika, A. A. I. A. R. (2020). Pengaruh Model Problem Based-Learning Dengan Flipped Classroom Terhadap Kemampuan Berpikir Kreatif. *Jurnal Kependidikan: Penelitian Inovasi Pembelajaran*, *4*(1), 83–98. https://doi.org/10.21831/jk.v4i1.25460

Deguchi, A., & Hirai, C. (2020). Correction to: Society 5.0. *Society 5.0: A People-Centric Super-Smart Society*, C1-C1. https://doi.org/10.1007/978-981-15-2989-4_9

González-Pérez, L. I., & Ramírez-Montoya, M. S. (2022). Components of Education 4.0 in 21st century skills frameworks: systematic review. *Sustainability*, *14*(3), 1493. https://doi.org/10.3390/su14031493

González-Salamanca, J. C., Agudelo, O. L., & Salinas, J. (2020). Key competences, education for sustainable development and strategies for the development of 21st century skills. A systematic literature review. *Sustainability*, *12*(24), 10366. https://doi.org/10.3390/su122410366

Gunadi, G., Haryono, H., Purwanti, E., Raya, B. R., Pinoh Barat Melawi, T., & Kalimantan, W. (2022). The Analysis of 21 st Century Learning Implementation and Competency Achievement of Junior High School Students in 3T Regions. *Innovative Journal of Curriculum and Educational Technology*, *11*(1), 10–18. Retrieved from https://journal.unnes.ac.id/sju/index.php/ujet/article/view/44847

Hartsell, C., Mahadevan, N., Ramakrishna, S., Dubey, A., Bapty, T., Johnson, T., Koutsoukos, X., Sztipanovits, J., & Karsai, G. (2019). Model-based design for CPS with learning-enabled components. *Proceedings of the Workshop on Design Automation for CPS and IoT*, 1–9. https://doi.org/10.1145/3313151.3313166

Hastani, F. S., Sudarmin, S., & Pancawardhani, H. (2021). The critical problem solving (CPS) E-module development on ethnoscience-integrated thermochemistry topics. *International Journal of Active Learning*, *6*(2), 91–99. Retrieved from https://journal.unnes.ac.id/nju/index.php/ijal/article/view/31147

Meyer, M. W., & Norman, D. (2020). Changing design education for the 21st century. *She Ji: The Journal of Design, Economics, and Innovation*, *6*(1), 13–49. https://doi.org/10.1016/j.sheji.2019.12.002

Miranda, J., Navarrete, C., Noguez, J., Molina-Espinosa, J.-M., Ram'irez-Montoya, M.-S., Navarro-Tuch, S. A., Bustamante-Bello, M.-R., Rosas-Fernández, J.-B., & Molina, A. (2021). The core components of education 4.0 in higher education: Three case studies in engineering education. *Computers & Electrical Engineering*, *93*, 107278. https://doi.org/10.1016/j.compeleceng.2021.107278

Mubarok, A. Z. Z., Ismet, I., & Kistiono, K. (2022). Pengembangan Modul Elektronik Fisika untuk Meningkatkan Kemampuan Berpikir Kreatif Peserta Didik Pada Materi Hukum Newton. *Jurnal Ilmiah Pendidikan Fisika*, *6*(1), 87. https://doi.org/10.20527/jipf.v6i1.4743

Muhali, M. (2019). Pembelajaran Inovatif Abad Ke-21. *Jurnal Penelitian Dan Pengkajian Ilmu Pendidikan: E-*

Saintika, *3*(2), 25. https://doi.org/10.36312/e-saintika.v3i2.126

Nurlaila, D., Tawil, M., & Haris, A. (2016). Analisis Keterampilan Berpikir Kreatif Fisika Pada Peserta Didik Kelas XI IPA 1 SMA Negeri 2 Bua Ponrang. *Jurnal Pendidikan Fisika Universitas Muhammadiyah Makassar*, *4*(1), 127–144. https://doi.org/10.26618/jpf.v4i1.304

Peters-burton, E. E., & Stehle, S. M. (2019). Developing student 21 st Century skills in selected exemplary inclusive STEM high schools. *International Journal of STEM Education*, *1*, 1–15. https://doi.org/10.1186/s40594-019-0192-1

Puspitasari, D. H., Listiana, L., & Daesusi, I. R. (2016). *Penerapan Strategi Pembelajaran Berbasis Masalah (Problem Based Learning) Untuk Meningkatkan Kemampuan Berfikir Kreatif Dan Hasil Belajar Siswa* Universitas Muhammadiyah Surabaya. Retrieved from https://repository.um-surabaya.ac.id/834/

Sagita, S. G. N., & Aminatun, T. (2019). Combination of CPS and SAVI on Biology Learning Media to Improve Student's Understanding and Creativity on Environmental Change Topic. *Journal of Physics: Conference Series*, *1397*(1), 12057. https://doi.org/10.1088/1742-6596/1397/1/012057

Sarnita, F., Fitriani, A., & Widia. (2019). Pengembangan Perangkat Pembelajaran Model PBL Berbasis STEM untuk Melatih Keterampilan Berfikir Kreatif Siswa Tuna Netra. *Jurnal Pendidikan Mipa*, *9*(1), 38–44. https://doi.org/10.37630/jpm.v9i1.180

Siregar, F. A. (2019). *Teknologi Pendidikan Peran Teknologi Pendidikan Dalam Mengembangkan Dan Meningkatkan Keprofesionalan Pendidik Di Era Revolusi Industri 4.0.* Universitas Negeri Medan. Retrieved from http://digilib.unimed.ac.id/38872/

Sudaryati, A. (2016). *Pengembangan Modul Fisika Berbasis Masalah Pada Materi Listrik Dinamis Untuk Meningkatkan Kemampuan Berpikir Kreatif Siswa Kelas X Sma/Ma*. UNS (Sebelas Maret University). Retrieved from https://digilib.uns.ac.id/dokumen/detail/53037

Sugiyono. (2019). *Metode Penelitian Dan Pengembangan, (Research and Development R&D*. Alfabeta.

Susanti, N., Yennita, Y., & Azhar, A. (2020). Development of contextual based electronic global warming modules using flipbook applications as physics learning media in high schools. *Journal of Educational Sciences*, *4*(3), 541. https://doi.org/10.31258/jes.4.3.p.541-559

Swestyani, S., Rinanto, Y., & Widoretno, S. (2016). Peningkatan Kemampuan Berpikir Logis Melalui Penerapan Discovery Learning Pada Materi Sistem Reproduksidi Kelas Xi Mia 1 Sma Batik 2 Surakarta Tahun Pelajaran 2014/2015. *Bio-Pedagogi*, *5*(1), 20. https://doi.org/10.20961/bio-pedagogi.v5i1.5398

Umamah, C., & Andi, H. J. (2019). Pengaruh model Project Based Learning terhadap keterampilan berpikir kreatif dalam pembelajaran fisika terapan. *Jurnal Pendidikan Fisika Dan Keilmuan (JPFK)*, *5*(1), 7. https://doi.org/10.25273/jpfk.v5i1.3033

Warsita, B. (2017). Peran dan tantangan profesi pengembang teknologi pembelajaran pada pembelajaran abad 21. *Kwangsan: Jurnal Teknologi Pendidikan*, *5*(2), 77–90. https://doi.org/10.31800/jtp.kw.v5n2.p77--90

Yolanda, Y. (2021). Pengembangan Modul Ajar Fisika Termodinamika Berbasis Kontekstual. *Jurnal Jendela Pendidikan*, *1*(3), 80–95. https://doi.org/10.57008/jjp.v1i03.12

Zubaidah, S. (2016). Keterampilan abad ke-21: Keterampilan yang diajarkan melalui pembelajaran. *Seminar Nasional Pendidikan*, *2*(2), 1–17.

Zulirfan, Rosiyana, V., Rahmad, M., & Yennita. (2022). Junior High School Students' Creative Thinking Skills in The Context of Global Warming: A Preliminary Study on The Implementation of a STEM at Home Approach on Science Learning. *AIP Conference Proceedings*, *2600*. https://doi.org/10.1063/5.0116107

Zulkifli, Z., Azhar, A., & Syaflita, D. (2022). Application Effect of PhET Virtual Laboratory and Real Laboratory on the Learning Outcomes of Class XI Students on Elasticity and Hooke's Law. *Jurnal Penelitian Pendidikan IPA*, *8*(1), 401–407. https://doi.org/10.29303/jppipa.v8i1.1274