JPPIPA 9(12) (2023)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Design Interactive Multimedia Based on Problem Solving Using Articulate Storyline on Dynamic Fluid Material

Ranti Addriani[1], Wahyuni Satria Dewi[1*], Akmam[1], Putri Dwi Sundari[1]

[1] Department of Physics Education, Faculty of Mathematics and Natural Science, Padang State University, Padang, Indonesia

Received: October 30, 2023
Revised: November 29, 2023
Accepted: December 20, 2023
Published: December 31, 2023

Corresponding Author:
Wahyuni Satria Dewi
wahyunisatria@fmipa.ac.id

DOI: 10.29303/jppipa.v9i12.5894

Abstract: This study aims to develop interactive multimedia based on problem solving using articulate storyline on fluid material in class XI Phase F. The research wants to test the validity and practicality of interactive multimedia using articulate storyline. The research method used R&D with Plomp's model. Plomp's model consist of three phases, there are preliminary phase, prototyping phase, assesment phase. The subjects of this research were the physics lecturer of physics department, physics teacher and students in class XII IPA 9 MAN 2 Padang. The instruments used to collect data consisted of interview sheets with teacher, observation sheets, self-evalution questionnaire, expert review, one to one and small group questionnaire sheets. The data obtained were analyzed using validity index proposed by Aiken and practicality data using category interval. The result of this study show that the development of interactive multimedia using Articulate Storyline was valid with score 0.91, practical by students with score 95.25% and practical by teachers with score 95.83. Conclusion of this study explains that the interactive multimedia based on problem solving using articulate storyline is valid and practical toward learning process.

Keywords: Articulate Storyline; Interactive Multimedia; Problem Solving.

Introduction

Education is a fundamental aspect that shows the progress of a nation. According to Law No. 20 of 2003 states that education is about making students active, evolving their potential, religious and spiritual strength, self-discipline, self-identity, intelligence, noble character, and the ability of themselves, society, the nation and other people to need the nation. Education is the need of every human being in order to be able to become quality resources. Problem solving is the ability to find solutions through the process of acquiring and organizing information. Problem solving is finding a practicable way to achieve a goal (Santrock, 2011). In improving students' problem solving skills, teachers can act as facilitators in guiding and directing students in the learning process (Dewi & Afrizon, 2018).

There are several factors that influence the learning process, namely learning materials, students, teaching materials, assessments and media used. The factors that influence the learning process will help teachers in improving students' problem solving skills and can provide effective time for a teacher to be able to achieve the learning competencies that have been compiled. From several factors that influence the learning process to be able to improve students' problem solving skills, learning media is needed. Learning media as physical equipment to present learning to learners. Learning media can facilitate learning and can improve understanding of learning materials. Along with the times, many changes have occurred, especially in technology. One of the media that utilizes technology is interactive multimedia (Reiser & Dempsey, 2012).

Interactive multimedia is a medium used to convey teacher messages to students through communication using technology with systems and infrastructure in the form of application programs and by utilizing electronic media as part of the educational method (Arsyad, 2013). Interactive learning media can be used anytime and anywhere. Using interactive multimedia content as long

How to Cite:
Addriani, R., Dewi, W. S., Akmam, & Sundari, P. D. (2023). Design Interactive Multimedia Based on Problem Solving Using Articulate Storyline on Dynamic Fluid Material. *Jurnal Penelitian Pendidikan IPA*, *9*(12), 11528–11537. https://doi.org/10.29303/jppipa.v9i12.5894

as learning increases effectiveness and motivation, and promotes functional, experiential, and consistent student-centered learning (Eilks, 2013). One of the applications that can be used as interactive multimedia is Articulate Storyline.

Articulate Storyline is a software that has the ability to combine slides, flash, videos, and animated characters into one. Articulate Storyline offers some very attractive templates that can shorten the creation time. Its simple appearance will make it easier for teachers to operate. The advantages of Articulate Storyline as revealed by (Hadza et al., 2020). Articulate Storyline software form can be used to create attractive presentation documents. The advantage of Articulate Storyline is that it can create creative and comprehensive presentations (Ananda et al., 2023).

The Articulate Storyline application is an interactive multimedia application that can be used by teachers and students. Articulate Storyline is available for public use as you wish. This application supports HTML5 format, so it can be accessed over the Internet, as well as from a computer or smartphone. Using learning media as the implementation of learning as same as the use of learning models in learning process. This learning model is useful for producing directed and enjoyable learning so that students can be interested in learning and can be more enthusiastic. Problem Solving model is the one solution that can improve problem solving skills.

Problem Solving is a model of learning centered on teaching and strengthening problem solving abilities (Shoimin, 2014) And according to As'ari in (Shoimin, 2014) problem solving-based learning can train students to think critically. Students are expected to develop their problem-solving skills by applying the Problem Solving approach, particularly in physics instruction.

One of the concepts in physics subjects that is often encountered in everyday life is fluid (Saputra et al., 2017). There are several physics materials that are difficult for students to understand, including dynamic fluids. This challenge arises because the learning method of dynamic fluid ideas in schools is still instructional and does not give students real-world experience (Fathiah & Kaniawati, 2015).

According to the results of preliminary observations that have been done with Physics teachers MAN 2 Padang found several problems related to learning Physics, including first, the learning process teachers are still rarely in utilizing technology in making interactive learning media. The media used by teachers is only limited to the blackboard. The amount of time spent on making learning media is also a factor in the lack of utilization of technology in making learning media. Not only that, teachers also have difficulty in making media that is in accordance with learning. The second, furthermore, teachers still do not use learning models that can improve students' problem solving skills. Teachers only know the inquiry, authentic assessment, and questioning models. However, in its application the teacher has not implemented the entire syntax so that it is still not optimal in the implementation process. So that students' problem solving skills are still low. The third, in dynamic fluid material, students view fluid concepts as difficult and abstract concepts. This is because in teaching at school, students receive this lesson only by listening or recording the applicable laws given by the teacher without really understanding the fluid concepts they are learning.

Based on these circumstances, efforts should be made to create learning media that can help students enhance their problem-solving skills. As a result, pupils require engaging learning media that is not monotonous. Interactive multimedia is one type of alternative learning material (Rampho, 2017). Interactive multimedia can be created using Articulate Storyline. Articulate Storyline is software that is still rarely used by teachers. The use of software makes it easy to design an interactive media because it does not require a programming or coding process. Learning media created with Articulate Storyline has various advantages, including the following. First, programs that can be published to the PlayStore, second, interactive displays; third, allows students to learn anywhere and at any time; fourth can be accessible offline, and fifth learning media that can be utilized at home (Rohmah & Bukhori, 2020).

Method

The type of research used is R&D (Research and Development). The aim is to develop new products and improve existing products. Argues that research and development method is method used to test the validity, practicality and effectiveness of the products that have made before. The product in this study is Problem Solving-based interactive multimedia using Articulate Storyline 3 (Sugiyono, 2018).

The model of research employed is the Plomp's Model, which explains that in designing and developing intervention such as programmes, training tools and strategy, products and systems to solve scientific problems and advance science there is a need for development research (Plomp, 2013). Plomp's advancement model has three sections, in particular: first, the primer exploration process, which comprises of leading a necessities examination and record investigation; second, the turn of prototyping process is essential for the plan to further develop the substance perpetually. supported in the starter research, which

comprises of model plan, process examination and model correction, and third, the assessment cycle is a task pointed toward assessing the qualities of the genuine person, to guarantee that it is essential and in light of the constant and meet the particulars determined before (Susanti, 2021).

The instruments used to collect data consisted of preliminary research stage instruments (i.e. interview sheets with teachers and observation sheets) and prototype phase instruments (i.e. self-evalution questionnaire sheets, expert review questionnaire sheets and one to one questionnaire sheets). In the making stage, the prototype design process is carried out, evaluating and revising it. Before the product assessment is carried out, the researcher first checks the completeness and errors of the initial product. Then the product assessment was carried out by validating the product by experts consisting of 6 lecturers of the physics department of FMIPA, Padang State University and product practicality testing by 2 physics teachers of class XII MAN 2 Padang and 9 students of class XII MAN 2 Padang with different abilities.

In this study, the method of data analysis is used, that is, the analysis at each level is carried out from the first analysis through the analysis of the literature through the use of descriptive analysis through the analysis of the available articles (Dewi et al., 2023). Importance then at the development stage, that is the evaluation of effectiveness and value. Validity test questionnaires were obtained from validated questionnaire data collected using a Likert scale (Dewi & Afrizon, 2020). A Likert scale is used to measure the attitudes, opinions and opinions of an individual or group (Weksi, 2013).

The data obtained were analyzed using the validation index proposed by Aiken. The data obtained from the validity test results were analyzed by Aiken's V index which was written as follows on Equation 1 and 2. After obtaining the agreement from the stakeholders, the type of index value is determined. The results of group decision based on Aiken's V index as shown in Table 2.

Table 1. Likert Scale

Likert Scale	Category	Percentage of Indicator Achievement (%)
1	Strongly disagree	76%-100%
2	Disagree	51%-75%
3	Agree	25%-50%
4	Strongly agree	0%-25%

(Sugiyono, 2018)

$$V = sn\,(c-1) \quad (1)$$

$$s = r - 10 \quad (2)$$

Information:

V : Rater agreement index

10 : The most reduced legitimacy evaluation number (for this situation = 1)

c : The most noteworthy legitimacy evaluation number (for this situation = 4)

r : The number given by a expert

n : Number of experts

Table 2. Index Aiken's V Category

Interval	Category
V < 0.78	Invalid
V ≥ 0.78	Valid

(Aiken, 1985)

Learning media is said to be practical if it meets the practicality criteria of each indicator assessed. The practicality instrument is a questionnaire consisting of student responses to learning media, the aspects assessed in the practicality instrument consist of ease of use, attractiveness, efficiency and benefits. This instrument is used at the one to one stage (Sukariasih, 2020). The practicality of interactive media based on problem solving learning using Articulate Storyline 3 on Dynamic Fluid material can be seen from the results sheet of Physics teacher and student responses in the form of a questionnaire. Weighting is done based on a Likert scale as in table 1. Mathematically it can be written as the Equation 3. The practicality evaluation is resolved in view of the standards for deciphering the score got as in Table 3.

This research is limited to the prototype stage (development or prototyping phase). The making of interactive multimedia based on Problem Solving using Articulate Storyline on dynamic fluid material is carried out until the one to one practicality stage only, while the effectiveness test or small group is not carried out due to limited time, energy, and costs. The following is an explanation of the stages that will be passed during the research:

The preliminary research stage is also known as needs analysis or problem analysis. Through this analysis, it can define a problem to be given a solution. The analysis stage includes two things, namely needs analysis and literature review.The prototype stage aims to design several prototypes, evaluate the prototypes and revise them, which is done repeatedly to produce a good result. Prototype is a temporarily developed product that requires a series of tests before making the desired product. In the prototype design stage, it is used as a guide in making the product.

$$value = score\ obtained\ maximum\ score \times 100\% \quad (3)$$

Table 3. Practicality Category

Pecentage (%)	Category
86-100	Very practical
76-85	Practical
60-75	Practical enough
55-59	Less practical
0-54	Impractical

(Purwanto, 2010)

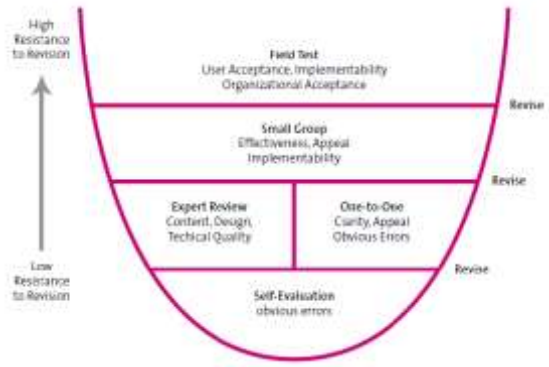

Figure 1. Plomp Model Development Research Flow

The prototype stage aims to design several prototypes, evaluate the prototypes and revise them, which is done repeatedly to produce a good result. Prototype is a temporarily developed product that requires a series of tests before making the desired product. In the prototype design stage, it is used as a guide in making the product.

Formative evaluation aims to refine or improve the product being made, while prototype revision aims to meet the needs of the end users. This activity is carried out to test the validity and practicality of the prototype that has been made in the previous stage. Formative evaluation was carried out starting from self-evaluation by the researchers themselves. Furthermore, the prototype was validated through a team of experts (expert review) and a practical one to one evaluation of the product was carried out by teachers and students. This evaluation refers to the Tessemer diagram in Figure 1.

Result and Discussion

Based on Plomp's development model, the research was carried out through three stages: the initial research phase, the phase of designing the prototype, and the phase of evaluating and revising the prototype. The research focused on assessing the validity and practicality of creating interactive multimedia through Articulate Storyline on Dynamic Fluid material. It reached the practicality phase, involving a small group, to determine the validity and practicality of this approach to problem-solving. The research findings are derived from the initial research phase to the practicality stage (small group), as established by the conducted research.

Preliminary Research Result

Information obtained from MAN 2 Padang based on teacher interview sheets is that schools use the 2013 curriculum in learning, teachers use learning media. The media used by teachers is power point, but the media is not yet interactive. Other information obtained about learning is that teachers rarely use learning models, teachers have used problem-based learning in practicum activities, and teachers feel that the learning media used is not interactive and the material presented is incomplete and too brief.

In addition, information obtained based on student questionnaires based on indicators of student interest in physics learning is 81.105%, 46.18% on the indicator of the step model used by the teacher which means that the teacher has not used the problem solving learning model in class, and 75% on the learning resource indicator where students are interested in using interactive multimedia in learning. The results of this analysis evaluation are, the need for the development of problem solving-based interactive multimedia using Articulate Storyline on dynamic fluid material so that it can improve students' problem solving skills.

In view of the issues got from the necessities examination that educators seldom use media in learning, educators all the more frequently utilize addressing learning models in learning, the inaccessibility of intelligent sight and sound, and the low critical ability to think of understudies on unique liquid material (Takacs, 2015). The arrangement that can be given from the requirements examination that has been completed is by making intuitive media in view of critical thinking utilizing Articulate Storyline on dynamic fluid material. In the learning process, students are encouraged to be able to develop problem-solving skills (Djamas, 2018). The physics learning process will be of quality if there is mutual interaction between students and teachers. One of the factors that influence the learning process is the use of media in the learning process.

Prototyping Phase

The prototype was designed based on results of the analysis at the preliminary research stage, namely through needs analysis and literature review (Wiana, 2018). In this study, prototype design was carried out to produce products of interactive multimedia product based on problem solving using Articulate Storyline on dynamic fluid material. Interactive multimedia design based on problem solving using Articulate Storyline on dynamic fluid material that has been made by researchers.

Figure 2. Display of Product

Self-evaluation is an evaluation performed by the researchers themselves, which checks the completeness and feasibility of the products produced by the researchers. This self-assessment step is performed before the product is sent to the validator for the validation process (Ceberio, 2016). At this stage, the researcher reads, checks for completeness, corrects errors and adds if parts are still missing. This form of self-assessment is in the form of a checklist (√). The results obtained at this stage are as follows: first, the problem solving-based physics interactive multimedia using Articulate Storyline already contains an interactive multimedia structure based on depdiknas 2008, namely the title, competencies to be achieved, learning objectives, learning instructions, material descriptions, practice questions, answer keys, feedback on student work and portfolio assessment as an assessment; second, the appearance of physics interactive multimedia has been made attractive; third, there are errors in the use of language, typing letters, and punctuation that have been corrected; fourth, the use of writing fonts in interactive multimedia is too monotonous and has been corrected; and fifth, the color composition of the display on interactive multimedia already looks contrasting and attractive. The results of the analysis of the self-evaluation sheet were obtained in a very good category.

Six specialists, comprising six FMIPA UNP physics lecturers, validated interactive multimedia focused on problem solving utilizing Articulate Storyline on dynamic fluid material. The validation's outcomes serve as a reference for both assessing the viability of the created product and making necessary changes. The five components of the product validation instrument are the following: software utilization, problem solving evaluation, instructional design, visual communication, and material substance. The validation tool has multiple indicators for each of its aspects (Malkawi, 2019).

Substance of the material is the first indicator of validity test. In the validation of the substance of the material obtained valid results. These results indicate that the substance contained in the teaching materials has met existing media standards. The validation results on the second indicator, namely the appearance of visual communication, are classified as valid. Navigation buttons and commands on Articulate Storyline run well. This result is in accordance with previous research which states that the appearance of the media will make users interested in using it. The third indicator is learning design. In this section, a problem solving-based learning model is implemented, valid category classified by result of learning design indicators. The fourth indicator is software utilization. (Ananda et al., 2023). The making of this teaching material involves a variety of software in making it an android application. The results of the validation of this stage are in the valid category. The fifth indicator is the assessment of problem solving skills. The results of this stage of validation are in the valid category.

Based on the assessment tool used, the results of the validity of the five aspects of the interactive multimedia assessment of problem solving can be analyzed using Articulate Storyline with dynamic flowing material. Validity test result data based on evaluation aspects are analyzed using Aikens V-formula in each interactive multimedia structure. And the feasibility of interactive multimedia in physics can be determined (Pandiangan, 2017). The mean value of each component of Articulate Storyline and dynamic fluid problem-solving interactive multimedia assessment can be determined from the mean of the five component validity ratings of the problem-solving interactive multimedia assessment using Articulate Storyline in dynamic fluid material analyzed by experts is shown in the following table 4.

From table 4, using a valid category, the average interactive multimedia validation score provided by the six experts (validators) is 0.91. There are a number of modification suggestions and comments from validators based on the outcomes of the validation of interactive multimedia based on problem solving using Articulate Storyline on dynamic fluid material. Suggestions from validators for interactive multimedia based on problem solving using Articulate Storyline on dynamic fluid material are useful for researchers to improve interactive multimedia that has been developed to be better. This is in accordance with the results of research by (Ananda & Usmeldi, 2023) that learning by interactive media is more effective to apply in learning process.

Table 4. Average Analysis of Multimedia Validity

Validity Component	Average valid score	Category
Material Substance	0.91	Valid
Visual Communication	0.91	Valid
Desain Pembelajaran	0.91	Valid
Software Utilization	0.91	Valid

Validity Component	Average valid score	Category
Problem Solving Assessment	0.89	Valid
Average Overall Validity Score	0.91	Valid

Figure 3. Validity Test Instrument by Expert

In the practical test, the researchers conducted a small group practical test conducted at MAN 2 Padang by distributing questionnaires to class XII physics teachers and 9 students with high, middle and low competence. Four evaluation criteria comprise the practice test tool: clarity, accessibility, utility to teachers and students, and attractiveness. There are multiple indicators for every evaluation component. Each indicator has a 1-4 rating. Each assessment section's score is translated into a grade. A Likert scale was used for the practical analysis, and a percentage formula was used for the analysis.

The average value obtained from each component of the problem solving-based interactive multimedia assessment using Articulate Storyline on dynamic fluid material can be determined from the average of the four components of the practicality assessment of problem solving-based interactive multimedia using Articulate Storyline on dynamic fluid material conducted by students who have been analyzed can be seen in the following table 5.

Table 5. Average Analysis of Multimedia Student's Practicality

Practicality Component	Average practical score (%)	Category
Attractiveness	96.30	Very Practical
Clarity	93.98	Very Practical
Usability	94.44	Very Practical
Ease of Access	96.30	Very Practical
Average Overall Practicality Score	95.25	Very Practical

According to the results of the students' practicality assessment for the four aspects, it can be stated that interactive multimedia based on problem solving using Articulate Storyline on dynamic fluid material has a very practical practicality with an average value according to 95.25%.

While the average value of the four components of the practicality assessment of problem solving-based interactive multimedia using Articulate Storyline on dynamic fluid material carried out by the analyzed teacher can be seen in the table 6.

Figure 4. Practicality One to One

Figure 5. Practicality Small Group

According to research by (Zulhelmi et al., 2023) this shows that the learning materials meet the standards necessary for their use in the learning process. Its aim is to train students to think creatively and critically, while also enhancing their metacognitive skills and collaboration capabilities in order to solve problems effectively in the 21St century. So, multimedia interactive as learning media can improve students skills. This is also supported by the finding of (Khairani & Aloysius, 2023) it shows that the solving model gives students the opportunity to increase their independence in thinking and analyzing problems. This ability to analyze problems gives students the ability to solve problems posed by teachers. Problem-solving skills are a set of processes that allow a person to increase their independence of thinking (Putra, 2018).

Table 6. Average Analysis of Multimedia Teacher's Practicality

Practicality Component	Grade Average (%)	Category
Attractiveness	91.67	Very Practical
Clarity	95.83	Very Practical
Usability	97.92	Very Practical
Ease of Access	97.92	Very Practical
Average Overall Practicality Score	95.83	Very Practical

Figure 6. Practicality by Teacher

Problem solving activities can help students construct new knowledge and facilitate learning (Herawati & Wilujeng, 2023). It is possible to conclude that problem-solving-based interactive multimedia utilizing Articulate Storyline on dynamic fluid material has a very practical practicality with an average value according to 95.83% based on the findings of the teacher's practicality assessment for the four areas. That shows that interactive multimedia is very practical to use for students and teachers in learning. Interactive learning can motivate students to learn with high motivation due to their interest in multimedia systems capable of displaying text, images, videos, sounds, and animations (Julia et al., 2023). Additionally, media such as articulation storyline and student activities can be tracked so that student performance can be accurately measured. Articulate Storyline has user-friendly to minimize the teacher's role and maximize the student's role (Prihartina et al., 2023). According to (Muhlisin et al., 2023) the focus of interactive learning media is not only on conveying messages, but also on how students interact with the media.

Problem solving involves learning to solve problems based on some principles or events that have occurred (Kattayat, 2020). In this learning model, students learn to formulate and solve problems. The problem solving learning model aims to present lessons that encourage students in their search for solutions to problems or issues and promote student engagement. This approach is known as problem solving (Fahlevi & Aminatun, 2023). Learning through problem-solving and skill-use techniques can lead to improved proficiency and familiarity with easy learning activities, resulting in more effective information acquisition (Kawuwung & Mamahit, 2023).

In the 21st century, the use of electronic devices for learning still has its pros and cons, and there are gaps in that era (Istiana et al., 2023). Moreover, it exhibits an effective use of resources, a less attractive format and highlights that science education should emphasize the process used by educators, which may result in less independent learning from engaged students (Saputri et al., 2023). According to the result by research of (Sari et al., 2023), it found that student problem solving skills can improve by using interactive media through the problem solving model.

In this research, several limitations and obstacles were found. The obstacles faced can be explained in terms of the causes and best solutions to obtain even better results (Cramer, 2022). The first obstacle is that problem solving-based interactive multimedia using Articulate Storyline on dynamic fluid material developed is still limited to only one class XI material. This is due to the limited time of researchers to design and develop interactive multimedia based on problem solving using Articulate Storyline on dynamic fluid material. An alternative solution is to carry out further development regarding the coverage of KD Class XI SMA / MA in order to produce interactive multimedia based on problem solving using a complete Articulate Storyline. The second obstacle is that the product quality test is still only limited to the small group test. This is due to the limited time of researchers. An alternative solution that can be done is that other researchers can continue to the effectiveness stage.

Conclusion

Problem solving based Interactive multimedia using Articulate Storyline on dynamic fluid material is suitable for use as a learning medium by teachers and learning resources by students. The average overall assessment of aspects of interactive multimedia is 0.91 with a valid category and obtained a score of 95.25% with very practical category by students. Practicality by teachers on 95.83% with very practical category.

Acknowledgments

Thank you to Mrs. Wahyuni Satria Dewi, S.Pd., M.Pd. as the supervisor in this study, thank you to Dr. Akmam, M.Si. and Mrs. Putri Dwi Sundari, S.Pd., M.Pd. as a team of examining lecturers in this study, thank you to all lecturers of the physics department FMIPA Padang State University, thank you to Mr. Hasrul S.Si., M.Pfis and Mr. Jonismen, S.Pd. and thank you to the XII class students of MAN 2 Padang as the subject of research data on the practicality of the research product.

Hopefully the help of all parties will be a blessing and a deed of worship for each, Aamiin.

Author Contributions

Conceptualization, W. S. D., R. A.; methodology, R. A..; validation, W. S. D., A. A., P. D. S.; formal analysis, W. S. D., A. A., P. D. S.; investigation, R.A..; resources, R. A.; data curation, W. S. D., R. A.: writing—original draft preparation, W. S. D., R. A.; writing—review and editing, R. A., W. S. D., A. A., P. D. S.: visualization, and R. A., W. S. D. All authors have read and agreed to the published version of the manuscript.

Funding

This study was funded by Ranti Addriani and Mrs. Wahyuni Satria Dewi, S.Pd., M.Pd.

Conflicts of Interest

The authors affirm that there is no conflict of interest associated with this paper's publication.

References

Aiken, Lewis. R. (1985). Three Coefficients for Analyzing the Reliability and Validity of Ratings. *Educational and Psychological Measurement*, *45*(1), 131–142. https://doi.org/10.1177/0013164485451012

Ananda, P. N., & Usmeldi, U. (2023). Validity and Practicality of E-Module Model Inquiry Based Online Learning to Improve Student Competence. *Jurnal Penelitian Pendidikan IPA*, *9*(4), 2010–2017. https://doi.org/10.29303/jppipa.v9i4.3563

Ananda, R., Hadiyanto, H., Erita, Y., & Karneli, Y. (2023). Development of Android-Based Interactive Media Articulate Storyline 3 in the Merdeka Curriculum. *Jurnal Penelitian Pendidikan IPA*, *9*(9), 6819–6827. https://doi.org/10.29303/jppipa.v9i9.5393

Arsyad, A. (2013). *Media Pembelajaran*. Jakarta: Rajawali Press.

Cramer, C. (2022). Problem-Solving A Lesson From Relativity In Physics Education. *Physics Education*, *57*(4). https://doi.org/10.1088/1361-6552/ac5641

Djamas, D. (2018). Development of interactive multimedia learning materials for improving critical thinking skills. *International Journal of Information and Communication Technology Education*, *14*(4), 66–84. https://doi.org/10.4018/IJICTE.2018100105

Dewi, W. S., & Afrizon, R. (2018). Analisis Kondisi Awal Perkuliahan Mahasiswa Pendidikan Fisika Dalam Rangka Mengembangkan Bahan Ajar Statistika Pendidikan Fisika Menggunakan Model Problem Solving. *Jurnal Eksakta Pendidikan (JEP)*, *2*(1), 93. https://doi.org/10.24036/jep/vol2-iss1/140

Dewi, W. S., & Afrizon, R. (2020). Validity of handout development of physics education statistics course using a cooperative problem solving (CPS) model. *Journal of Physics: Conference Series*, *1481*(1). https://doi.org/10.1088/1742-6596/1481/1/012108

Dewi, W. S., Safitri, G., & Mairizwan. (2023). The Practicality of the Physics Module Based on the PjBL Model with a Portfolio Assessment to Improve Students' Critical Thinking Skills. *Journal of Physics: Conference Series*, *2582*(1), 012054. https://doi.org/10.1088/1742-6596/2582/1/012054

Djamas, D. (2018). Development Of Interactive Multimedia Learning Materials For Improving Critical Thinking Skills. *International Journal of Information and Communication Technology Education*, *14*(4), 66–84. https://doi.org/10.4018/IJICTE.2018100105

Eilks, I. (2013). *Teaching Physics*. Rotterdam: Sense Publisher.

Fahlevi, R., & Aminatun, T. (2023). Development of Smart Apps Creator Learning Media Using Problem-Solving Learning Models on Global Warming Materials to Improve Critical Thinking and Problem-Solving Ability. *Jurnal Penelitan Pendidikan IPA*, *9*(9), 7221–7230. https://doi.org/10.29303/jppipa.v9i9.4311

Fathiah, F., & Kaniawati, I. (2015). Analisis Didaktik Pembelajaran yang Dapat Meningkatkan Korelasi antara Pemahaman Konsep dan Kemampuan Pemecahan Masalah Siswa SMA pada Materi Fluida Dinamis. *Jurnal Penelitian & Pengembangan Pendidikan Fisika*, *01*(1), 111–118. https://doi.org/10.21009/1.01116

Hadza, C., Sesrita, A., & Suherman, I. (2020). Development of Learning Media Based on Articulate Storyline. Indonesian Journal of Applied Research (IJAR), 1(2), 80-85. https://doi.org/10.30997/ijar.v1i2.54

Herawati, N. I., & Wilujeng, I. (2023). Improving Problem Solving Ability Through Problem Based Learning E-Modules. *Jurnal Penelitian Pendidikan IPA*, *9*(9), 6787–6794. https://doi.org/10.29303/jppipa.v9i9.4622

Istiana, R., Herawati, D., Herninngtyas, F., Ichsan, I. Z., & Ali, A. (2023). STEM Learning to Improve Problem Solving Ability on the Topic of Environmental Education. *Jurnal Penelitian Pendidikan IPA*, *9*(3), 1202–1208. https://doi.org/10.29303/jppipa.v9i3.2979

Julia, R. I., Nellitawati, Bentri, A., & Desyandri. (2023). Development of Learning Media Using Articulate Storylines to Increase Student Motivation in Mathematics Subjects in Elementary Schools. *Jurnal Penelitian Pendidikan IPA*, *9*(8), 6345–6352. https://doi.org/10.29303/jppipa.v9i8.4558

Kattayat, S. (2020). An investigation of application of mathematics review to improve problem solving skills and active learning of engineering students in physics applied to engineering education. In *2020 Advances in Science and Engineering Technology International Conferences, ASET 2020*. https://doi.org/10.1109/ASET48392.2020.9118172

Kawuwung, F. R., & Mamahit, J. A. (2023). Analysis of Classroom Action Research Studies: The Effectiveness of Inquiry Learning Models on Biology Education Undergraduate Students Problem Solving Ability. *Jurnal Penelitian Pendidikan IPA*, *9*(8), 6136–6146. https://doi.org/10.29303/jppipa.v9i8.4258

Khairani, R., & Aloysius, S. (2023). How does PBL Brainwriting Method Supplemented with Concept Mapping Effective to Improve Critical Thinking and Problem-Solving Ability? *Jurnal Penelitian Pendidikan IPA*, *9*(3), 1030–1038. https://doi.org/10.29303/jppipa.v9i3.3212

Malkawi, E. (2019). Building an interactive mobile application to enhance students' problem solving skills in higher education physics. *CSEDU 2019 - Proceedings of the 11th International Conference on Computer Supported Education* (Vol. 2, pp. 550–555). https://doi.org/10.5220/0007780105500555

Muhlisin, A., Hidayani, L., & Juliyanto, E. (2023). E-Comic Science Integrated with PBL Model to Improve Problem Solving Skills. *Jurnal Penelitian Pendidikan IPA*, *9*(1), 360–368. https://doi.org/10.29303/jppipa.v9i1.1676

Pandiangan, P. (2017). The validity and effectiveness of Physics Independent Learning Model To Improve Physics Problem Solving And Selfdirected Learning Skills Of Students In Open And Distance Education Systems. *Journal of Baltic Science Education*, *16*(5), 651–665. Retrieved from https://api.elsevier.com/content/abstract/scopus_id/85032581675

Plomp, T., & Nieveen, N. (2013). *Educational Design Research: An Introduction*. Netherland: SLO.

Prihartina, Y., Salirawati, D., & Wiyarsi, A. (2023). Measuring Student Learning Activities Through Articulate Storyline 3-Based Mobile Learning. *Jurnal Penelitian Pendidikan IPA*, *9*(4), 2252–2258. https://doi.org/10.29303/jppipa.v9i4.3113

Purwanto. (2010). *Evaluasi Hasil Belajar*. Yogyakarta: Pustaka Pelajar.

Putra, A. (2018). Planning Model of Physics Learning in Senior High School to Develop Problem Solving Creativity Based on National Standard of Education. In *IOP Conference Series: Materials Science and Engineering*, 35(1). https://doi.org/10.1088/1757-899X/335/1/012073

Rampho, G. (2017). Learning problem-solving skills in a distance education physics course. In *Journal of Physics: Conference Series*. 905 (1). https://doi.org/10.1088/1742-6596/905/1/012019

Reiser, R. A., & Dempsey, J. V. (2012). *Trends and Issues in Instructional Design and Technology*. USA: Pearson.

Rohmah, F. N., & Bukhori, I. (2020). Pengembangan Media Pembelajaran Interaktif Mata Pelajaran Korespondensi Berbasis Android Menggunakan Articulate Storyline 3. *Ecoducation: Economic and Education Journal*, 169–182. Retrieved from http://ejurnal.budiutomomalang.ac.id/index.php/ecoducation/article/download/892/523/

Santrock, J. W. (2011). *Educational Psychology*. New York: McGraw-Hill.

Saputra, O., Setiawan, A., Rusdiana, D., & Muslim, D. (2017). Identifikasi Miskonsepsi Siswa Sekolah Menengah Atas (SMA) pada Topik Fluida Dinamis. *Jurnal Kreatif Online*, *7*(3), 22–33. Retrieved from http://jurnal.untad.ac.id/jurnal/index.php/JKTO/article/view/13647

Saputri, R., Wilujeng, I., Jumadi, J., Nurohman, S., & Purnama, A. Y. (2023). Development of PBL Modul-El to Improve Problem Solving Students of Physics Education Program. *Jurnal Penelitian Pendidikan IPA*, *9*(10), 8376–8382. https://doi.org/10.29303/jppipa.v9i10.4092

Sari, I. P. M., Jatmiko, B., & Suprapto, N. (2023). Students' Physics Problem-Solving Skills in Daily Life Context: Between Confession and Fact. *Jurnal Penelitian Pendidikan IPA*, *9*(1), 231–241. https://doi.org/10.29303/jppipa.v9i1.2561

Shoimin, A. (2014). *68 Model Pembelajaran INOVATIF dalam Kurikulum 2013*. Yogyakarta: AR-Russ Media.

Sukariasih, L. (2020). Description of physics problem-solving in the topic of static fluid: Case study of physics education in Halu Oleo University. *Universal Journal of Educational Research*, *8*(10), 4568–4579. https://doi.org/10.13189/ujer.2020.081025

Sugiyono. (2018). *Metode Penelitian Kuantitatif, Kualitatif dan R&D*. Bandung: Alfabeta.

Susanti, E. (2021). Analysis of problem-solving ability of physics education students in STEM-based project based learning. In *Journal of Physics: Conference Series*, *2104*(1). https://doi.org/10.1088/1742-6596/2104/1/012005

Takacs, Z. K. (2015). Benefits and Pitfalls of Multimedia and Interactive Features in Technology-Enhanced Storybooks: A Meta-Analysis. *Review of Educational*

Research, *85*(4), 698–739. https://doi.org/10.3102/0034654314566989

Weksi, B. (2013). Skala Pengukuran Dan Jumlah Respon Skala Likert. *Jurnal Ilmu Pertanian Dan Perikanan*, *2*, 127–133. http://dx.doi.org/10.31227/osf.io/k7bgy

Wiana, W. (2018). The Effectiveness Of Using Interactive Multimedia Based On Motion Graphic In Concept Mastering Enhancement And Fashion Designing Skill In Digital Format. *International Journal of Emerging Technologies in Learning*, *13*(2), 4–20. https://doi.org/10.3991/ijet.v13i02.7830

Zulhelmi, Z., Fauza, N., Syaflita, D., Pratiwi, J., Wijaya, T. T., & Hermita, N. (2023). Development of Learning Media to Improve Students' Higher Order Thinking Skills in Circular Motion Material. *Jurnal Penelitian Pendidikan IPA*, *9*(4), 1734–1740. https://doi.org/10.29303/jppipa.v9i4.3536