Available online
http://journal.um.ac.id/index.php/jptpp/
EISSN: 2502-471X
DOAJ-SHERPA/RoMEO-Google Scholar-IPI

Jurnal Pendidikan:
Teori, Penelitian, dan Pengembangan
Volume: 8 Number 5, May, 2023
Page: 315—320

Development of Local Wisdom-Based Physics E-Modules to Improve Students Critical Thinking and Scientific Argumentation Skills on Newtonian Mechanics Topics

[1]Briliantama Akbar Taufiq, [2]Hidayatullah Hana Putra, [3]Trisya Afidah Sukma
[1,2] Department of Physics-Universitas Negeri Malang, Semarang St, Number 5, East Java, Indonesia
[3]Department of Physics-Universitas Negeri Yogyakarta, Colombo Yogyakarta St, Number 1, Yogyakarta, Indonesia

ARTICLE INFORMATION

Article History:

Accepted: 02-09-2022
Approved: 15-05-2023

Keywords:

e-module physics;
local wisdom;
critical thinking skills;
scientific argumentation skills;
newtonian mechanics

ABSTRACT

The results of the identification of the objective conditions of learning in schools show problems, including students who memorize the material, but do not understand and are unable to connect physics material with the application of local wisdom in everyday life. This study aims to develop a local wisdom-based physics e-module product that was developed in terms of the components of illustration presentation, language, and material suitability for students' critical thinking and scientific argumentation skills on the Newtonian mechanics topics. Product development refers to the ADDIE research model (Analysis, Design, Develop, Implementation, Evaluation). The results of validation by material experts show that the local wisdom-based physics e-module developed has an average percentage of 93.83% (very valid), from media experts at 84.72% (quite valid), and learning experts at 97.22 % (very valid). Therefore, the overall average of the results of the local wisdom-based physics e-module media assessment by the experts is 92.59% with a very valid category. The developed e-module learning media received very good responses from students. This can be seen from the average student response of 90.61% (very good). Based on the validation results from the experts, the product in the form of a physics e-module local wisdom-based is very valid to be used in the learning process.

Correspondence Address:

Briliantama Akbar Taufiq
Department of Physics
Universitas Negeri Malang
Semarang St, Number 5, East Java, Indonesia
E-mail: briliantamaakbartaufiq@gmail.com

Based on the Framework for 21st Century Learning, to face the 4.0 revolution era, one of the competencies that must be developed in students is literacy skills (Meliantina, 2019; Subekt et al., 2017) critical thinking skills (Giri & Paily, 2020) and scientific argumentation skills (Khishfe et al., 2012). McKinsey's digital research (2016) suggests that every student must prepare mentally and skills well to improve self-competence to face the era of the industrial revolution 4.0. In learning physics, there are four important elements that students need to understand and know, including material and its interactions, forces and interactions, energy, waves and their application (NRC, 2012). Newtonian mechanics is one of the materials included in the important elements of force and its interactions, so the concept of Newtonian mechanics is very important to be developed in learning and become the main focus for students to learn (Muna, 2015).

Critical thinking and scientific argumentation in Newtonian mechanics are important skills for students. Scientific arguments are applied so that students not only gain knowledge, but also can organize their knowledge of Newtonian mechanics and can develop their mental activities (Guler & Dogru, 2017). Students will understand various points of view based on evidence when involved in scientific arguments (Khishfe et al., 2012). Scientific argumentation serves as a means for students to discover, verify, and evaluate the principles or concepts of Newtonian mechanics. Students who are able to argue well will be able to give correct claims and be supported by justifications that are in accordance with the correct concepts. Research on scientific argumentation skills is very important because these skills lead students to think critically, analytically and able to solve problems (Sari et al., 2019). Therefore, a research is needed on students' scientific argumentation and critical thinking skills through verbal scientific argumentation.

Research related to critical thinking and scientific argumentation skills in students needs to be done considering that it is often found when providing explanations related to a phenomenon in everyday life, there are still many students who do not consistently use the concept of style (Steinberg & Sabella, 1997) when solving a problem presented in a different context (Savinainen et al., 2013). In addition, based on research by Taufiq & Purwaningsih (2022), it is stated that teachers or educators are still lacking in linking physics learning with local wisdom. These data indicate that Newtonian mechanics is a physics topic that has complex, complicated, and abstract characteristics, and also requires competence and integration of local wisdom to be

able to solve problems in everyday life (Taqwa et al., 2013). To be able to connect local wisdom with physics material in learning, we need a media that can bridge it. Learning media that are deemed appropriate to connect local wisdom with physics material are in the form of modules (Ongowo & Indoshi, 2013; Ting & Siew, 2014). The module not only serves to help students learn independently (Direktorat Pembinaan Sekolah Menengah Atas, 2008), but can also be used to improve literacy skills that are used to hone critical thinking and scientific argumentation skills. Based on the analysis of modules circulating in the field, some modules only contain material summaries and practice questions. In fact, 88.9% of students feel more helpful in solving physics problems if through practical activities (Wulansari et al., 2020). The use of modules can help students to improve critical thinking skills and scientific argumentation in solving physics problems.

The results of the identification of the objective conditions of learning in schools showed problems, including, students memorized the material, but did not understand and were unable to connect concepts with the application of local wisdom in everyday life, as well as difficulties in understanding abstract concepts of material through the lecture method. In addition, based on the results of observations and interviews with three physics teachers in Magetan, it showed that 53% of learning from three high schools in Magetan still used book media, 38% used website media, and the rest had used online media such as PhET, e-learning, and even in the form of educational games (Taufiq & Purwaningsih, 2022).

Based on the conditions described above, this article will discuss the development of local wisdom-based physics e-modules on the topic of Newtonian mechanics, which so far the program used by teachers in delivering Newtonian mechanics material is still very limited. The results of increasing students' critical thinking and scientific argumentation skills against the use of local wisdom-based physics e-modules are also presented in graphical form. The use of this e-module program is expected to replace the role of the teacher, and is presented through electronic media so that it can be accessed anywhere and anytime.

METHODS

This research is a development research, namely developing local wisdom-based physics e-module media on the topic of Newtonian mechanics. The development of this media was carried out at the Physics Department campus, State University of Malang, while the trial was carried out at SMAN 1, 2, and 3 of Magetan. The research design for the development of local widom-based physics e-module media on the topic of Newtonian mechanics is in accordance with the ADDIE model (Mellisa & Yanda, 2019). The ADDIE model consists of five stages, namely Analysis, Design, Development, Implementation, and Evaluation.

In this study, quantitative and qualitative data analysis was carried out. The analyzed data is viewed from the components of illustration presentation, language, and material suitability. Qualitative data were obtained in the form of an analysis of the needs of teachers and students, suggestions and comments from material experts, media experts, learning experts, and students, through observation and interviews. Quantitative data were obtained from the results of the validation experts' assessment and student response questionnaires. The data obtained from the results of this product development are used as a basis for determining the feasibility and attractiveness of the resulting product to the local wisdom-based physics e-module media on the topic of Newtonian mechanics that has been produced. Data collection techniques used in this study were in the form of validation sheets and student response questionnaires. The local wisdom-based physics e-module media validation sheet is an assessment sheet used by material experts, media experts, and learning experts to validate the local wisdom-based physics e-modules developed. The data from this study are the results of responses and input from experts on the quality of local wisdom-based physics e-module product on the topic of Newtonian mechanics in the form of scores, which are then converted into a Likert scale. Moreover, the student response questionnaire aimed to determine student responses to the product being developed.

The data analysis technique used a scale with a modified Likert scale. Likert scale is used in the questionnaire to reveal a person's attitudes and opinions towards a phenomenon. Responses of respondents, in the form of quantitative data, expressed in the form of a range of answers ranging from strongly disagree (1), disagree (2), agree (3), and strongly agree (4). The eligibility criteria according to the validator's assessment can be seen in table 1.

Table 1. Eligibility Criteria According to Validator Assessment

Validity Criteria	Validity Level
85.01% - 100%	Very valid, or can be used without revision.
70.01% - 85%	Quite valid, or usable but need minor revision.
50.01% - 70%	Less valid, it is recommended not to use it because it needs major revision.
01.00% - 50%	Invalid, or should not be used.

The data obtained from the calculation of student responses were analyzed using categories based on rules (Purwanto, 2010) as presented in table 2.

Table 2. Student Response Analysis Criteria

Validity Criteria	Validity Level
86% - 100%	Very good
76% - 85%	Good
60% - 75%	Average
55% - 59%	Deficient
≤ 54%	Very deficient

RESULT AND DISCUSSION

The development of local wisdom-based physics e-module products in terms of illustration presentation components, language, and material suitability for students' critical thinking and scientific arguments skills on the topic of Newtonian mechanics.

Media Validation Results by Material Experts

The assessment of the product by the material validator includes two aspects, namely the learning aspect and the material aspect. The results of the validation of local wisdom-based e-module media are presented in Table 3, in which the validation results of this material expert are carried out only once because the results of the media assessment are included in the very valid category. It is because the percentage score obtained in the learning aspect is 100% and the material aspect is 91.67%. This also means that the learning media does not need to be revised to be tested. In addition, the validation results also state that the local wisdom-based physics e-module media on the topic of Newtonian mechanics has met the standards of learning media in terms of the suitability of the material with the learning objectives, clarity of learning instructions, coherence of the material, suitability of the material with the truth of the concept, and the use of easy-to-understand language.

Table 3. Quantitative Data Validation Results by Material Experts

Validator	Rated Aspect	Validity Percentage (%)	Validity Level
Validator 1	Learning	100%	Very Valid
	Material	91.67%	Very Valid
The average assessment of material experts on all aspects		95.83%	Very Valid

Media Validation Results By Media Experts

Media expert validation focuses the assessment on aspects of the appearance and aspects of the program being developed. The results of the media expert's validation are presented in Table 4. Based on the validation results, it can be concluded that the media is quite valid because the percentage achieved is 84.72%. Thus, the media has met the criteria of validity according to Akbar (2013), which is expected to help increase the stimulation of students in learning activities, and can make it easier for students to understand the material.

Table 4. Quantitative Data Validation Results by Media Experts

Validator	Rated Aspect	Validity Percentage (%)	Validity Level
Validator 2	Appearance	77.78%	Quite Valid
	Program	91.67%	Very Valid
The average assessment of media experts on all aspects		84.72%	Quite Valid

Media Validation Results by Learning Experts

Table 5 shows the results of the validation of learning experts about the local wisdom-based physics e-module learning media that was developed. It can be seen that the results of the assessment carried out by learning experts have reached an average percentage of 97.22% from 100%, which means that the media is categorized as very valid. In the learning aspect and the material aspect, the percentage is 100%, while the display aspect is 91.67%. This also implies that the local wisdom-based physics e-module media that was developed is feasible to be used as an alternative learning media.

Table 5. Quantitative Data Validation Results by Learning Experts

Validator	Rated Aspect	Validity Percentage (%)	Validity Level
Validator 3	Learning	100%	Very Valid
	Material	100%	Very Valid
	Appearance	91.67%	Very Valid
The average assessment of learning experts on all aspects		97,22%	Very Valid

Media Validation Results by Material Experts, Media Experts, and Learning Experts

Based on the validation of local wisdom-based physics e-module media on the topic of Newtonian mechanics by material experts, media experts, and learning experts, the overall media validation results are shown in table 6.

Table 6. Validation Results of Isomorphic-Based Physics E-Module Media by All Validators

Validator	Rated Aspect	Validity Percentage (%)	Validity Level	Validity Average (%)	Validity Level
Validator 1	Learning	100%	Very Valid	95.83%	Very Valid
	Material	91.67%	Very Valid		
Validator 2	Appearance	77.78%	Quite Valid	84.72%	Quite Valid
	Program	91.67%	Very Valid		
Validator 3	Learning	100%	Very Valid	97.22%	Very Valid
	Material	100%	Very Valid		
	Appearance	91.67%	Very Valid		
The overall average of the assessment of material experts on all aspects				92.59%	Very Valid

Table 6 shows the results of the overall validation by experts regarding the local wisdom-based physics e-module media that was developed. It can be seen that material experts get an average percentage of 95.83%, media experts 84.72%, and learning experts 97.22%, so that the overall average results of the assessment of local wisdom-based e-module physics learning media in Newton's mechanics topics by experts amounted to 92.59% with a very valid category.

Student Response Results Data

The data from the feasibility test of the developed media were obtained from the results of the questionnaire response analysis of 30 students. This trial aims to obtain an overview of student responses to local wisdom-based physics e-module learning media through student comments and suggestions as well as student assessments of the product. The instrument used in this trial was the student response sheet or questionnaire. The results of the limited feasibility trial can be seen in the following table 7.

Table 7. Results of Analysis of Student Responses to Isomorphic-Based Physics E-Module Media

Aspects	Response Percentage			Average (%)	Qualification
	Students (1-10)	Students (11-20)	Students (21-30)		
Appearance	88.21%	90.71%	87.85%	88.92%	Very good
Learning	90.00%	92.50%	88.75%	90.41%	Very good
Material	92.50%	95.00%	90.00%	92.50%	Very good
Average (%)	90.23%	92.73%	88.87%	90.61%	Very good

Based on the table above, the highest percentage of test results is 92.50% (very good) in the material aspect, 90.41% (very good) in the learning aspect, while the lowest percentage is 88.92% (very good) in the appearance aspect. The results of the student's limited trial of the developed media obtained an average percentage of 90.61% with a very good category. Based on the results of student responses, it can be concluded that the local wisdom-based physics e-module media that was developed was very feasible to use and received a positive response from students. This can be seen from the average student response, which is 90.61% with a very good category.

Descriptive Results of Students' Critical Thinking Skills

Based on the results of the analysis of students' critical thinking skills on the topic of Newtonian mechanics before and after using the local wisdom-based physics e-module product, it is presented in Figure 1 as a whole.

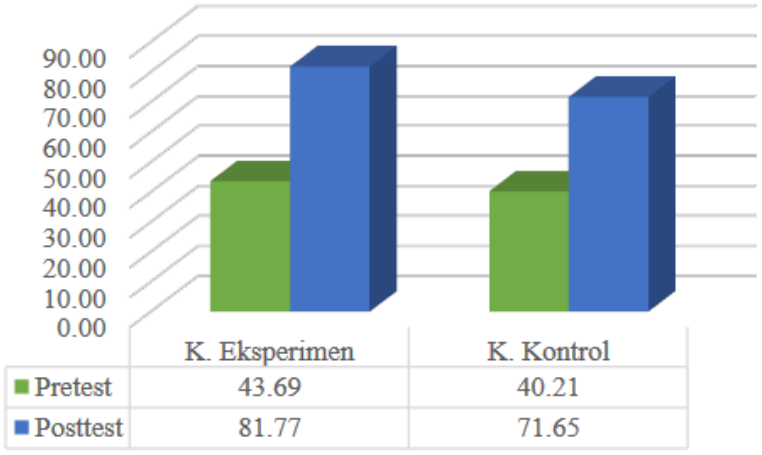

Figure 1. Description of the Average Score of Students' Critical Thinking Skills

Figure 1 describes that the students' initial critical thinking skills seen based on the pretest scores have not reached the school's minimum passing criteria score. Both from the control class (40.21) and the experimental class (43.69) show their initial abilities are at the same value, there is no significant difference between the initial ability of the control class and the experimental class.

The students' posttest results showed an increase in critical thinking skills. However, the increase in the experimental class was greater than the increase in the control class. This provides information that the use of local wisdom-based physics e-modules is more effective in improving students' critical thinking skills than conventional learning.

Descriptive Results of Students' Scientific Argumentation Skills

Based on the results of the analysis of students' scientific argumentation skills on the topic of Newtonian mechanics, it is presented as in Figure 2 as a whole.

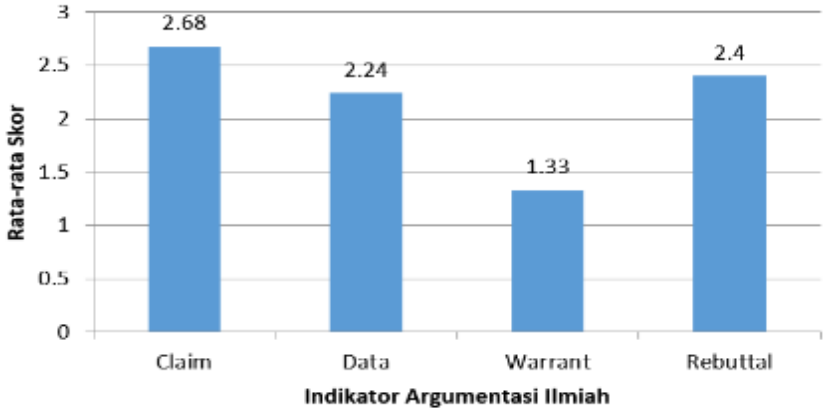

Figure 2. Description of the Average Score of Students' Scientific Argumentation Skills

Based on the data from the students' answers, the highest average score was obtained in the aspect of the ability to make claims, with an average score of 2.68 (very good). This shows that students are able to conclude the explanation given during learning. It appears that students have been able to make a statement correctly after analyzing the phenomenon of changes in the direction of motion of objects in two children who give each other a certain force (tug of war). Students can make statements and draw conclusions that a change in the direction of motion of objects indicates a difference in the frictional force acting on the two children. Then when students are asked to analyze the lines of force acting on an object, students can conclude that there are several types of forces acting on the child against the reference point.

CONCLUSIONS

Research on the development of local wisdom-based physics e-module media on the topic of Newtonian mechanics is very valid based on the validity criteria according to the validator's assessment. Based on the results of the validation of material experts 95.83% (very valid), media experts 84.72% (quite valid), and learning experts 97.22% (very valid), so that the overall average of the assessment results of the local wisdom-based physics e-module media by experts is 92.59% with a very valid category. Local wisdom-based physics e-module learning media on the topic of Newtonian mechanics received very good responses from students. This can be seen from the average student response of 90.61% (very good). After validating and limited trials, the development of learning media in the form of local wisdom-based physics e-modules is very valid/feasible to use.

REFERENCES

Bauer, H. B. (2016). *Industry 4.0 After The Initial Hype-Where Manufacturers Are Finding Value and How They Can Best Capture It*. McKinsey Digital.

Direktorat Pembinaan Sekolah Menengah Atas. (2008). *Panduan Pengembangan Bahan Ajar*. Kementerian Pendidikan dan Kebudayaan.

Giri, V., & Paily, M. U. (2020). Effect of Scientific Argumentation on The Development of Critical Thinking, *Science & Education*, *29*(3), 673—690.

Guler, C., & Dogru, M. (2017). The Effect of Argument-Based Science Inquiry Approach on Science Teacher Candidates' Academic Achievements. *International Online Journal of Education and Teaching*, *4*(3), 229—244.

Khishfe, R., Alshaya, F. S., BouJaoude, S., Mansour, N., & Alrudiyan, K. I. 2012. Students' Understandings of Nature of Science and Their Arguments in The Context of Four Socio-Scientific Issues. *International Journal of Science and Education*, 39(3), 299-334.

Meliantina. (2019). Menerapkan Budaya Literasi Guru Sekolah dalam Upaya Meningkatkan Pendidikan di Era Industri 4.0. *Jurnal Ilmu Pendidikan*, *3*(2), 120—139.

Mellisa, M., & Yanda, Y. D. (2019). Developing Audio-Visual Learning Media Based on Video Documentary on Tissue Culture Explant of Dendrobium Bigibbum. *Jurnal Pendidikan Biologi Indonesia*, 5(3), 379-386.

Muna, I. A. (2015). Identifikasi Miskonsepsi Mahasiswa PGMI Pada Konsep Hukum Newton menggunakan Certainly of Response Index (CRI). *Cendekia*, 13(2), 309-322.

National Research Council. (2012). *A Framework for K-12 Science Education: Practices, Crosscutting Concept, and Core Ideas*. Academies Press.

Ongowo, R. O., & Indoshi, F. C. (2013). Science Process Skills in The Kenya Certificate of Secondary Education Biology Practical Examinations. *Creative Edu*, *4*(11), 713—717.

Purwanto, M. N. (2010). *Prinsip-Prinsip dan Teknik Evaluasi Pengajaran*. Bandung: PT Rosdakarya.

Sari, L. A., Diantoro, M., & Muhardjito. (2019). Pola Perubahan Kemampuan Argumentasi Ilmiah Melalui Model Pembelajaran Kontekstual Multirepresentasi. *Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan*, *4*(9), 1162—1167.

Savinainen, A., Makynen, A., Nieminen, P., & Viiri, J. (2013). Does Using a Visual-Representation Tool Foster Students' Ability to Identify Forces and Construct Free-Body Diagrams?. *Phys. Rev. Phys. Educ. Res*, 9.

Steinberg, R. N., & Sabella, M. S. (1997). Performance on Multiple-Choice Diagnostics and Complementary Exam Problems. *The Physics Teacher*, *35*, 150-155.

Subekt, H., Taufiq, M., Susilo, H., Ibrohim, I., & Suwono, H. (2017). Mengembangkan Literasi Informasi Melalui Belajar Berbasis Kehidupan Terintegrasi STEM untuk Menyiapkan Calon Guru Sains dalam Menghadapi Era Revolusi Industri 4.0. *Education and Human Development Journal*, 3(1), 81—90.

Taqwa, M. R. A., Hidayat, A., & Sutopo, S. (2013). Deskripsi Penggunaan Program Resitasi dalam Meningkatkan Kemampuan Membangun Free-Body Diagrams (FBDs). *Jurnal Pendidikan Fisika Tadulako Online*, *5*(1), 52—58.

Taufiq, B. A., & Purwaningsih, E. (2022). Multi-Representation-Based Recitation Program with Local Wisdom Loads to Improve Students' Concept Mastery on Newtonian Mechanics Topics. *Jurnal Riset Pendidikan Fisika*, *7*(1), 22—28.

Ting, K. L., & Siew, N. M. (2014). Effects of Outdoor School Ground Lessons on Students' Science Process Skills and Scientific Curiosity. *Journal Education and Learning*, *3*(4), 96—107.

Wulansari, W. D., Handayanto, S. K., & Sumarjono, S. (2020). Pengembangan Modul Fisika Berbasis Guided Inquiry pada Materi Suhu dan Kalor untuk Meningkatkan Keterampilan Proses Sains Siswa SMA Kelas X. *Jurnal Riset Pendidikan Fisika*, *5*(1), 65—68.