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The Development of Learning E-Modules Based on Contextual Teaching and Learning on the Material of Changing the Form of Energy to Improve Students' Science Literacy

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Abstract: The low science literacy of students is caused by the lack of utilization of technology in learning activities such as the use of teaching materials. One way to improve students' science literacy is to develop innovative learning materials such as learning e-modules. This study aims to produce contextual teaching and learning-based learning e-modules on IPAS Phase B learning, material for changing the form of energy to improve the science literacy of students in elementary school. This research is a type of Research and Development (R&D) research, the development was carried out referring to the Borg & Gall theory. Data collection tools use valid and reliable test instruments. Based on the results of the material, media and language expert validation test of the validity of the contextual teaching and learning-based learning e-module product obtained an average value of 0.813 with decent criteria. Furthermore, the results of the educator's response test to the contextual teaching and learning-based learning e-module users obtained 86.88 with very practical criteria, while the response of students obtained an average value of 97.59 with very practical criteria. Then the results of the data effectiveness test using the paired t-test with the calculation result of 0.000 < 005 means that there is a significant difference between before being given treatment with contextual teaching and learning-based learning e-modules and after being given the treatment. Based on the data obtained from the results of the study, it can be concluded that the contextual teaching and learning-based learning e-module on the material of changing the form of energy is valid, practical, and effective to improve the science literacy of students in elementary schools.

Keywords: Contextual teaching and learning; Learning e-module; Science literacy

Introduction

The Industrial Revolution 4.0 has a significant impact on the education sector. One of the impacts is the implementation of digital learning that allows students and educators to conduct learning without having to meet face-to-face (Dito & Pujiastuti, 2021). The implementation of 21st century learning, scientific and contextual approaches are used to develop various learner skills, such as critical thinking, creative, communication, and collaboration skills (Pribadi et al, 2022). This opinion is in line with research conducted by Zubaidah (2016) which states that 21st century learning integrates literacy, critical thinking skills, creativity, and collaboration in the learning process. The development of education in the industrial revolution 4.0 is in accordance with the development of 21st century learning, including the development of many digital-based learning modules in the form of electronic modules or e-modules (Elvarita et al, 2020).

E-modules are one of the products of developing digital-based non-print teaching materials that are made to be used by students in learning through computers, laptops, and Android (Asmiyunda et al., 2018; Razzaq, 2018). E-modules can be used as learning media equipped with video, audio, and image displays that

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help students to increase their knowledge and understanding in learning (Nurhidayati et al., 2018). The lack of creativity and understanding of teachers in making interesting and interactive e-modules makes the learning process monotonous and boring (Astari, 2022).

According to Harahap et al. (2017), learning is a process of activities carried out by teachers to educate, train, guide, foster, and direct students to have better behavior. Teachers must be able to develop students' knowledge, attitudes and skills by linking the real world that exists in the daily lives of students into learning (Harahap et al., 2019). In carrying out learning activities, of course, educators use learning models that are in accordance with the characteristics and needs of students. One of the effective learning models to be applied to IPAS learning is the Contextual Teaching and learning model.

Contextual Teaching and learning model is a learning model that links the real world that exists in the daily lives of students to the subject matter to develop students' knowledge, attitudes and skills (Zakiyah et al., 2019). Contextual teaching and learning or contextual learning model was first proposed by John Dewey, an American education expert, around 1916. According to Dewey (1916) the contextual learning model emphasizes the development of students' interests and experiences. Contextual learning teaches learners to work on meaningful tasks and experiences carried out through group activities, discussions using teaching materials (Suhartono, 2018). The learning process organized today is based on the curriculum. The curriculum is the most important element in developing student potential (Anagun, 2018). Fatirul et al. (2022) state that the curriculum is a learning plan, meaning that an educational program is designed to teach students. The designed program contains various activities that can support the learning process of students, so that changes and developments arise both from the behavior and skills of students in accordance with educational objectives. The development of the education curriculum in Indonesia has reached the development of the Independent Curriculum. Currently, the independent curriculum has been integrated at every level of education.

The concept of independent learning is part of an educational institution that aims to improve the quality of education which has elements of freedom and independence that can contribute to educating the nation's next generation in the era of the industrial revolution 4.0 (Alfath, 2022.). The implementation of an independent curriculum gives students the freedom to develop their potential. Through an independent curriculum, teachers can develop students' competencies which will have a positive impact on improving students' science literacy skills (Aransyah, 2023).

Science literacy is one of the keys to facing various challenges in the 21st century. Mastery and possession of basic concepts of science and technology which include the ability to read, understand, evaluate, use scientific information and knowledge to make informed decisions and think critically, so that it will greatly help solve problems in life (Wahyuningsih, 2021). The low scientific literacy skills of students are influenced by many things, including the curriculum, education system, method selection, facilities, and so on (Febrianti et al., 2021).

Based on the results of research that has been carried out on May 23, 2023 at SD Negeri 1 Srikuncoro, Semaka District, Tanggamus Regency through interviews and questionnaires with fourth grade homeroom teachers totaling 2 educators and 22 students. The results of the interview obtained learning resources used only educators' books, students' books and bupena, the number of books is insufficient so that there are students who share books using one book, learning resources that educators use are less interesting and monotonous because they only learn from educators' books, students' books and bupena, modules that are already available are still very rarely used especially e-modules based on Contextual learning teaches learners to improve students' science literacy skills.

Analysis of the needs questionnaire given to students regarding e-modules shows that 100% of educators only use student books, bupena, 100% of educators have never used e-modules, learning methods are not innovative, learning activities are not related to everyday life, besides that 70% of educators are less able to direct students to relate learning to everyday life, explore students' critical ideas and ideas, some of the above make students unable to implement science literacy skills..

Analysis of the needs questionnaire given to fourth grade educators of SD Negeri 1 Srikuncoro, Semaka District, Tanggamus Regency, shows that the learning process uses the same method, 100% of the teaching materials used are only educator books, so far the references used by teachers use textual language that is difficult to understand, so it is hoped that the module is packaged with learning language that is easily understood by students, so it is important that the module as a reference makes it easier for children to learn. Educators do not apply the material to the real world or daily life that can explore ideas to improve students' science literacy skills.

The results of the pretest analysis test of students' science literacy skills are low, because of 27 students 15% of moderate criteria, 44% low and 41% very low

indicating that the learning applied has not fully familiarized students to apply science literacy skills. So the solution to develop students' science literacy skills is through innovative teaching materials.

The results of other supporting interviews prove that students' science literacy skills are influenced by several aspects such as; the use of learning resources has not been functioned optimally, educators also only use the lecture method, learning is still centered on educators as a learning resource, students do not pay attention to the learning process and educators do not relate material to everyday life so that it can affect students' science literacy skills which results in learning objectives not being achieved (Febrianti, 2021). Efforts to realize the learning objectives of an educator are required to master the models and learning resources that are implemented can provide reinforcement to students. However, in reality what happens is the low creativity of educators in planning and implementing learning models, so that the model is not implemented properly. Based on the results of the needs analysis given to educators and students, it is necessary to have learning resources based on Contextual Teaching and learning, so that the potential possessed by students can develop optimally. One alternative that can be used by educators to be able to improve science literacy skills is to develop Contextual Teaching and learning based e-modules. This is supported by research Hasanah (2019) the results of his research show that CTL-based modules with the components in them can improve science literacy skills.

Method

This research is an R&D (Research and Development) development research. Research and development (R&D) is research that aims to produce certain products. This research refers to the design model of Borg & Gall. The product developed in this study is a contextual theaching and learning (CTL)-based learning e-module on IPAS Phase B material changing the form of energy to improve the science literacy of grade IV students in elementary schools. Borg & Gall model development research (1983) has steps including. 1) research and data collection, 2) planning, 3) product draft development, 4) initial field trial, 5) revision of initial field trial, 6) main field trial, 7) product revision, 8) field implementation test, 9) refinement of product results, 10) dissemination and implementation. Systematically the research steps described by Borg & Gall (1983) can be seen in Figure 1.

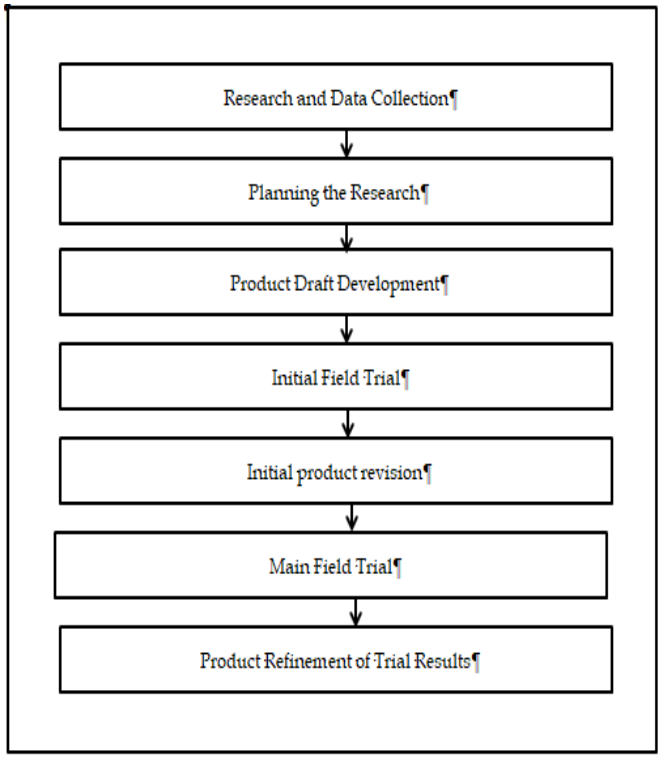

Figure 1. Borg and Gall procedure

Research and Data Collection

At the initial data collection stage, researchers made initial observations to conduct a needs analysis, and literature studies, to find out the conditions, potential, and problems that occur in the field. Researchers conducted an analysis by interviewing, analyzing the needs of students and fourth grade educators at SD Negeri 1 Srikuncoro, Semaka District, Tanggamus Regency. Interviews and analysis aim to find out how learning activities at school, the characteristics of students and learning resources, analyze tasks in teaching and learning activities on material changing the form of energy. Furthermore, at this stage an analysis is carried out by analyzing the educator's handbook and the learner's book used as a reference for learning by educators in the classroom, analyzing learning resources and analyzing needs in accordance with the problem. After obtaining data from the results of the needs analysis and analysis of the science literacy abilities of students, the next thing to do is to take solutions related to existing problems, namely the need for a contextual theaching and learning-based learning e-module development on the material of changing the form of energy to improve the science literacy of students in elementary school. A literature study was conducted for a temporary introduction to the product to be developed. This literature study aims to collect research findings and information related to the development of e-modules.

Planning the Research

The planning stage aims to prepare materials in making product designs. This stage begins with determining the content framework of the material in the learning e-module and preparing the outline of the learning e-module.

a) Preparation of material content, the preparation of material content in the learning e-module is the initial stage to determine learning outcomes, subject matter to be used, and formulation of the flow of learning objectives and assignments that will be used as learning evaluation materials.
b) Preparation of learning e-module outline, preparation of CTL-based learning e-module outline contains an initial plan of what will be written in the e-module. The learning e-module will be created using the canva application with online use. E-modules that will be made consist of a cover page, preface, table of contents, instructions for using e-modules, concept maps, learning content, activity sheets, summaries, quiz sheet evaluation sheets and evaluation key sheets and e-module learning content design, namely the presentation of material, visualizations and illustrations that will be made in accordance with the real life of students.

Product Draft Development

The product developed in this study is a learning e-module based on contextual theaching and learning. The initial product development in this study includes the preparation of the cover, table of contents, CP mapping, TP, preparation of module content (learning material) development of the initial form in the form of a draft product of e-modules based on Contextual Teaching and learning in IPAS learning in Phase B. Chapter 4 about changing the form of energy.

Initial Field Trial

Initial trials were carried out to determine the readability of the products developed before being implemented in learning activities. This initial trial aims to test whether the product developed is suitable for use and in accordance with the abilities to be measured. Product validation conducted by researchers in this study includes validation of material experts, media experts, and linguists. The results of validation from several experts in the form of comments and suggestions will mark whether or not the product developed in the Contextual Teaching and learning based learning e-module is valid and then revised according to the validators' suggestions. Furthermore, the researcher also conducted a practitioner test (educators of class IV SD Negeri 1 Karang Agung Semaka District, Tanggamus Regency) and user test (21 students). The results of this limited trial will be revised according to the suggestions obtained.

Initial Product Revision

Initial product revisions were carried out based on suggestions and input from expert validation and practitioners. This activity is carried out as a step to improve e-module products based on Contextual Teaching and learning. After being revised, the Contextual Teaching and learning-based e-module product can be used in the main field trial activities.

Main Field Trial

Initial product revisions were made based on suggestions and input from expert validation and practitioners. This activity is carried out as a step to improve e-module products based on Contextual Teaching and learning. After being revised, the Contextual Teaching and learning-based e-module product can be used in the main field trial activities.

Table 1. Nonequivalent Control Group Design

Group	Pre-test	Post Test
Experiment	O_1	X_1
Control	O_2	X_2

Product Refinement of Trial Results

After the main field trial is conducted, then the data is analyzed to make improvements to the contextual theaching and learning-based e-module. This stage is intended as a refinement of the e-module that has been developed to the real conditions in schools based on trials conducted by researchers.

Result and Discussion

Product development with the Borg & Gall model can be completed well. The results of the initial stage of research are preliminary studies through field studies and literature studies show that there are problems that are often encountered in IPAS learning. These problems are the absence of contextual teaching and learning-based learning e-modules on the material of changing the form of energy, educators have not implemented contextual teaching and learning learning models and educators have not been optimal in developing contextual teaching and learning-based learning e-modules. In previous lessons, teachers used commonly used teaching materials such as teacher and student handbooks. Therefore, a technology-based learning innovation is needed such as the IPAS Phase B learning e-module that can improve students' science literacy.

Research and Data Collection

Based on the needs analysis conducted by researchers, the problem was found that there is a need to develop contextual teaching and learning-based learning e-modules on the material of changing the form of energy to improve students' science literacy. The purpose of developing e-modules based on contextual teaching and learning on the material of changing the form of energy in this study is for educators to analyze the right learning strategy to improve students' science literacy skills.

Planning the Research

Furthermore, the planning stage of e-module products based on contextual teaching and learning is carried out. The planning stage carried out by researchers is to compile a learning e-module framework based on contextual teaching and learning on the material of changing the form of energy arranged systematically in the following order, (1) title page, (2) preface, (3) table of contents, (4) instructions for using learning e-modules, (5) concept map, (6) learning content, (7) summary, quiz sheet evaluation sheet and (8) answer key sheet. Finding the systematic presentation of material in the development of learning e-modules based on contextual teaching and learning on the material of changing the form of energy is based on the learning outcomes (CP) and learning objectives (TP) that have been determined. The presentation of the material is adjusted to the components of the contextual teaching and learning approach, namely linking learning with the real life of students. Students work on evaluation questions on the e-module, this activity encourages students to think by reviewing learning material. Planning evaluation tools, which are used include competency tests. The evaluation in this study is in the form of a test in the form of multiple choice questions. Developing a learning e-module assessment instrument based on contextual teaching and learning on the material of changing the form of energy is prepared based on the theoretical studies that have been put forward in the form of a questionnaire. The questionnaire used consists of answer options 1 to state very invalid, 2 states invalid, 3 states doubtful, 4 states valid and 5 states very valid which is used to assess the quality of validity and suitability of the learning e-module.

Product Draft Development

The development of learning e-modules is organized based on the goals and objectives that have been planned previously. Product development is carried out in accordance with the e-module framework that has been prepared with the initial product draft. The contextual teaching and learning-based e-module products developed in this study can be seen in Figure 2.

Figure 2. Screenshot of contextual teaching and learning-based learning e-module on the subject of changing the form of energy

Initial Field Trial

Initial field trials were conducted after the product was compiled by reviewing the contextual teaching and learning-based learning e-module product by validating material experts, media experts, and linguists. Product validation is carried out to determine the validity and practicality of the learning e-modules developed before being tested in the field and as a basis for revising and improving the prototype.

Table 2. Results of Material, Language and Media Expert Validation of E-Modules Based on Contextual Teaching and Learning

Validator	Value
Material	0.767
Media	0.929
Language	0.742
Average	0.813
Criteria	Valid

Based on table 2, it can be seen that the results of expert validation assessment of the design of e-module development based on contextual teaching and learning to improve the science literacy of elementary school students, have met the criteria with an average score of 0.813 with valid criteria.

The product development of learning e-modules based on contextual teaching and learning that has been validated by material, language and media expert advice, then the next step is to conduct an initial field trial to educators and grade IV students at SD Negeri 1 Karang Agung to determine the practicality of learning e-modules based on contextual teaching and learning on the material of changing the form of energy to increase the science literacy of students in elementary school.

Table 3. Educator Practicality Test Results

Aspects assessed	Percentage per aspect	Criteria
Use of learning e-modules	87.5%	Very Practical
Efficiency of using learning e-modules	85%	Very Practical
Learning e-module display	85%	Very Practical
Ease of implementation of learning e-modules	90%	Very Practical
Average Percentage		86.88
Criteria		Very Practical

Based on Table 3, the results of the educator response test obtained an average percentage of 86.88% which is included in the very practical criteria.

Initial Product Revision

Based on Table 4, the results of the learner response test obtained an average percentage of 97.59% which is included in the very practical criteria.

Table 4. Results of Practicality Test for Students

Aspects assessed	Percentage per aspect	Criteria
Use of learning e-modules	96.07%	Very Practical
Efficiency of using learning e-modules	94.29%	Very Practical
Learning e-module display	100%%	Very Practical
Ease of implementation of learning e-modules	100%%	Very Practical
Average Percentage		97.59
Criteria		Very Practical

Revision of the Initial Product

Before the main field trial was carried out, the researcher first conducted an instrument prerequisite test consisting of validity test, reliability test, differentiator analysis, and question difficulty level.

a) Validity test

Validity testing is done to determine whether a question item is valid or not in this study. The validity test in this study used the Product Moment formula with the help of the Microsoft Office excel 2013 program.

Table 5. Validity Test Results

Question Number	r_{count}	r_{table}	Criteria	Description
1	0.470	0.423	Medium	Valid
2	0.424	0.423	Medium	Valid
3	0.605	0.423	High	Valid
4	0.524	0.423	Medium	Valid
5	0.516	0.423	Medium	Valid
6	0.522	0.423	Medium	Valid
7	0.619	0.423	High	Valid
8	0.715	0.423	High	Valid
9	0.516	0.423	Medium	Valid
10	0.432	0.423	Medium	Valid

Based on table 5, the results of the validity calculation in the table with the help of Microsoft Office excel 2013 with the test criteria if r count> r table with a significance level of 1% or α = 0.01 obtained r table is 0.478. So it can be concluded that out of 10 question items there are 10 valid items that can be used in research.

b) Reliability test

The reliability test is carried out to determine the level of accuracy or consistency of a question in the instrument. This test was taken from 22 respondents with 10 items and was carried out using Cronbach's Alpha assisted by the Microsoft Office excel 2013 program.

Table 6. Reliability Test Results

Cronbach's Alpha	N	Category
0.672	10	Strong

Based on Table 6, it can be obtained the results of the Cronbach's Alpha value reliability test of 0.709. This shows that the reliability of the test items is categorized as strong and can be used.

c) Differentiator analysis

The test of the level of difficulty in this study aims to determine whether the item is categorized as easy, medium or difficult. The testing of the level of difficulty in this study was assisted by the Microsoft Office excel 2013 program.

Based on Table 7, it can be obtained that the level of difficulty of question items with difficult criteria is 3 items consisting of question items number 5, 8, and 10. Easy category questions are contained in question items number 4, 6, 7, and 9.

Table 7. Problem Difficulty Test Results

Question Item	Difficulty Index Value	Criteria
1	0.60	Medium
2	0.55	Medium
3	0.50	Medium
4	0.70	Easy
5	0.25	Difficult
6	0.85	Easy
7	0.85	Easy
8	0.30	Difficult
9	0.80	Easy
10	0.25	Difficult

d) Question difficulty level

The distinguishing power of the item is a question item that is used to categorize between students who are the upper group, namely students with high abilities and the lower group, namely the group of students with low abilities. This differentiation test was carried out with the help of the Microsoft Office excel 2013 program.

Table 8. Distinguishing Power Test Results

Question Item	Distinguishing Power Index	Criteria
1	0.55	Very good
2	0.27	Good Enough
3	0.36	Good
4	0.36	Good
5	0.27	Good Enough
6	0.29	Good Enough
7	0.29	Good Enough
8	0.36	Good
9	0.28	Good Enough
10	0.27	Good Enough

Based on Table 8, information can be obtained that there are 3 items categorized as "Good", 6 items categorized as "Good Enough" and 1 item categorized as "Very Good". In total there are 10 items that can be used in research

Main Field Trial

This main field trial was conducted to determine the effectiveness of using a product with a development product said to be effective if all indicators of the effectiveness of the development were met according to the target to be achieved beforehand.

The Paired Sample T-test is used in hypothesis testing to evaluate whether a finding is statistically significant or not by comparing one mean with a hypothesized value. The requirements for conducting the Paired Sample T-test test. First, descriptive data, normality and homogeneity tests are carried out.

a) Descriptive Data

Descriptive analysis is analyzing data by describing or describing the data that has been collected as it is without intending to make general conclusions or generalizations. Data processing using the SPSS version 26 program.

Table 9. Data Descriptive Test Results

Descriptive Data	Experiment Pre-Test	Experiment Post-Test
N	22	22
KKM	75	75
Range	30	30
Minimum	50	60
Maximum	80	90
Mean	65.45	75.00
S Deviation	11.010	11.443

Based on table 9, it can be obtained the results of descriptive statistical test analysis in the experimental class that in the pree test of the experimental class students obtained the lowest score of 60 with an average score of 65.42, and in the post test of the experimental class students obtained the lowest score of 60 with an average score of 75.00.

Table 10. Data Descriptive Test Results

Descriptive Data	Experiment Pre-Test	Experiment Post-Test
N	22	22
KKM	75	75
Range	30	30
Minimum	50	60
Maximum	80	90
Mean	65,45	75,00
S Deviation	11.010	11.443

Based on table 10, it can be obtained the results of descriptive statistical test analysis on the control class pree test, students obtained the lowest score of 60 with an average score of 69.55, and on the control class post test, students obtained the lowest score of 70 with an average score of 79.55.

This means that there are differences in the science literacy skills of students in the experimental class who are given treatment by using e-modules based on Contextual Teaching Learning with the control class which is given treatment with conventional methods.

b) Normality Tests

The normality test is carried out to determine whether the data obtained comes from a normally distributed population or not, the normality test in this study uses the one-sample kolmogorov-smirnov formula using the help of the SPSS version 26 program.

Based on table 11, it can be interpreted that the significance value (p) in the experimental class pre-test obtained a significance value of 0.016, the experimental class posttest obtained a significance value of 0.010, and in the control class pre-test obtained a significance value of 0.016, the control class posttest obtained a significance value of 0.010. The significance value obtained is greater

than α = 0.016 and 0.10> 0.05, meaning that the data distribution in the experimental class and control class is normally distributed.

Table 11. Normality Test Results

Treatment Group	Kolmogorov-Smirnov[a]		
	Statistic	df	Sig.
Pre-Test Experiment	.206	22	.016
Post-Test Experiment	.214	22	.010
Pre-Test Control	.206	22	.016
Post-Test Control	.206	22	.016

c) Homogeneity Tests

The homogeneity test is a test conducted to determine that two or more groups of data come from populations that have the same variance. The homogeneity test in this study used one way anova with the help of the SPSS 26 program.

Table 12. Homogeneity Test Results

Class Group	Value Based on Mean	Description
Post-Test Experiment and Post-Test Control	0.12	Homogeneous

Based on table 12, it can be obtained that the significance value (p) in the experimental class and control class obtained a value of 0.12. The significance value obtained is greater than 0.05 (0.12> 0.05), meaning that the data is homogeneously distributed.

d) Paired Sample T-Test

The paired t-test was used by researchers to see the improvement of students' science literacy skills before and after using contextual teaching and learning-based e-modules.

Table 13. Paired Sample T-Test Results

Class Group	Sig. (2-tailed)	Description
Pre Test Experimental Class-Post Test Experimental Class	0.000	H_0 Rejected

Based on table 13, it can be obtained that in the pree test post test of the experimental class, the sig value is obtained. (2 tailed) of 0.000 <0.05, it can be concluded that there is a significant difference between the acquisition of the average value of students' science literacy in the pree test and post test of the experimental class before using the Contextual Teaching and Learning-based learning e-module and after using the Contextual Teaching and Learning-based learning e-module.

Conclusion

Based on the results of research and discussion regarding the product development of e-modules based on contextual teaching and learning in IPAS Phase B learning, the material of changing the form of energy to improve the science literacy of students in elementary schools, it can be concluded that e-modules based on contextual teaching and learning in IPAS Phase B learning, the material of changing the form of energy to improve the science literacy of students in elementary schools developed are valid. The learning e-module based on contextual teaching and learning in Phase B IPAS learning, the material of changing the form of energy to improve the science literacy of students in elementary schools developed is practical. The learning e-module based on contextual teaching and learning in Phase B IPAS learning, the material of changing the form of energy to improve the science literacy of students in elementary schools developed is effective.

Author Contributions

Finding problems related to student achievement, drafting research instruments, developing e-modules based on contextual teaching and learning, writing initial drafts, providing concept ideas, writing-reviewing and editing, monitoring research progress and providing feedback on research. All authors contributed to the content and every part of this article. We have read and approved the published version of the manuscript.

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Conflicts of Interest

The authors state that there is no conflict of interest.

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