JURNAL INOVASI

Teknologi Pendidikan

Volume 10, No 1, March 2023

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JURNAL INOVASI Teknologi Pendidikan

Volume 10, No. 1, March 2023

Volume 10, No 1, March 2023

ISSN 2407-0963 (print)
ISSN 2460-7177 (onlne)

JURNAL INOVASI

TEKNOLOGI PENDIDIKAN

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JURNAL INOVASI
Teknologi Pendidikan

Publisher:
Ikatan Profesi Teknologi Pendidikan Indonesia (IPTPI) & Asosiasi Program Studi Teknologi Pendidikan Indonesia (APS-TPI)
in Cooperation with
Faculty of Education and Psychology, Yogyakarta State University

Jurnal Inovasi Teknologi Pendidikan published in March, August and December

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Email: teknodik@uny.ac.id
Website: http://journal.uny.ac.id/index.php/jitp

Volume 10, No 1, March 2023

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Jurnal Inovasi Teknologi Pendidikan
Volume 10, No. 1, March 2023 (1-9)
Online: http://journal.uny.ac.id/index.php/jitp

Development of integrated STEM education learning units to access students' systems thinking abilities

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ARTICLE INFO

Article History
Received:
16 December 2022;
Revised:
14 February 2023;
Accepted:
21 February 2023;
Available online:
09 March 2023.

Keywords
Instructional unit; Integrated STEM Education; system thinking.

ABSTRACT

This research aims to develop a Biology Science learning unit based on Science, Technology, Engineering, and Mathematics (STEM) that is valid, practical and effective in accessing students' system thinking skills. The topic ,of the Biology Science learning unit is the water cycle. The development used the ADDIE model research and development for the research method. The research subjects were 32 grade VII students from State Junior High School in Jember. The research findings showed that the average validation result of STEM-based learning units was 95.3%. These can be considered valid. The Paired Sample Test result is <0.001 or less than 0.05, so there is a significant difference between the pretest and post-test results. The average effectiveness test score is 0.73, higher than the typical gain test score, and the results include the high criteria. Finally, the average percentage of practicality tests is in the high category of 89%. System thinking skills are needed in learning activities to describe and solve a problem using integrated STEM education. Therefore, the STEM-based learning unit on the water cycle topic could be applied in the learning process to acquire students' system thinking abilities in the Biology Science learning unit. Finally, assessing student responses during the learning using this learning unit is pivotal for future research.

How to cite:
Wahono, B., Husna, A., Hariyadi, S., Anwar, Y., & Meilinda, M. (2023). Development of integrated STEM education learning units to access students' systems thinking abilities. *Jurnal Inovasi Teknologi Pendidikan*, 10(1), 1-9. doi: https://doi.org/10.21831/jitp.v10i1.52886

INTRODUCTION

STEM education is a learning innovation as needed skills in the 21st century. Farwati et al. (2017) stated that implementing STEM education in learning activities can encourage students to use technology in designing, developing, and improving cognitive operations and applying knowledge. One of the applications of STEM education in learning is an integrated STEM education approach. Suratno et al. (2020) state that an integrated STEM education potentially helps students gain good academic abilities, such as problem-solving, collaboration, innovation, and creativity. The expansion of integrated STEM education comes after being implemented in learning activities believed to improve knowledge skills, apply knowledge in problem-solving, and inspire students to create new

things. One of the learning supports to achieve good academic abilities is to use quality learning units.

According to Nurdiana et al. (2021), learning units are teaching materials that can make it easier for teachers to learn the materials and how to teach them to students. Developing the sections of the learning units will help teachers facilitate students' understanding of the material, conduct analysis, and encourage students to acquire higher-order thinking skills. Research that develops integrated STEM education-based learning units on specific topics in junior high schools still needs to be completed. Wahono et al. (2018) have developed teaching materials based on a STEM approach encouraging students to engage with the world through activities such as identifying problems, gathering information to solve problems, considering solutions, and examining findings from an interdisciplinary perspective. Simarmata et al. (2020), in their book reveal that applying STEM for learning empowers students to design, develop and use technology to develop cognitive, manipulative, and affective skills and apply knowledge. On the other hand, other research states that developing system thinking skills through a logical approach and mastery of concepts can be an alternative strategy to maximize student performance in physiology learning (Nursani, 2014). However, these studies have yet to develop integrated STEM education learning units to access students' system thinking skills.

Systems thinking is holistic thinking about a problem. The ability to think of systems plays a crucial role in education (Kholil, 2018). The ability to think of systems becomes part of sustainable development efforts and STEM literacy and is one of the competencies needed in the 21st century (Rustaman, 2020; Wahono, Hariyadi, & Chang, 2022). Learning activities to describe and solve problems require a systematic mindset. One of the problems that can affect the current social and economic situation and require appropriate solutions is floods. Floods are one of the natural disasters that frequently occur almost every year in Indonesia. There are many causative factors. The phenomenon of floods at this time is one of the constant global changes that can affect the food market in the world. Flood disasters in Indonesia are a recurrent phenomenon and become a routine problem whenever there is high rainfall. Flooding can occur due to rainwater infiltration into watersheds and rainfall different from the river's ability to drain it into the sea.

Biology learning in natural sciences is a learning activity that interrelates science, technology, engineering, and mathematics. It is necessary for the learning devices with an appropriate approach. Education is supposed to facilitate students to be able to acquire student systems thinking. Therefore, innovations are needed in the form of learning units with a STEM approach. Based on this, researchers researched developing integrated STEM education learning units to access students' system thinking skills in flood phenomena.

METHOD

The type of research carried out here is development research (R&D) which aims to produce an integrated STEM education learning unit. This study used the ADDIE development model. This model has several stages (Analysis, Design, Development, Implementation, and Evaluation). This research was conducted in the Biology Education Study Program at the University of Jember with the participation of some grade VII students of a State Junior High School (SMPN 4) in Jember District in 2021/2022 as a product trial. This research involved two lecturers with minimum qualifications of master of education and one teacher of Biology Science from the same school as validators.

The data analysis technique selects data by sorting, grouping, and presenting information from qualitative data based on the ADDIE stage. Data analysis is also presented here with quantitative descriptive analysis based on validation tests using face and content validity with a 5-point Likert scale and construct validity based on literature studies. The assessment criteria for the learning units developed in this study can be seen in Table 1.

The researchers measured the effectiveness of learning units using pretest and posttest instruments. Then, the researchers measured the practicality of the learning units by providing a questionnaire instrument as feedback to find out whether the learning units developed here could

work practically or not. The following is an example of a pretest/posttest problem *"What is the water cycle process that occurs if an area undergoes continuous deforestation?"*

Table 1. Criteria of Product Validity Assessment Score

Scores	Validity Criteria
85.01-100.00 %	Very valid
70.01-85.00 %	Quite valid
50.01-70.00 %	Less valid
01.00-50.00 %	Invalid

(Source: Fatmawati, 2016).

Before analyzing the effectiveness test in the integrated STEM education learning units, the researchers conducted a Paired Sample Test and a normal gain or N (gain) test. The quantitative criteria for the effectiveness of the learning units developed in this research can be seen in Table 2

Table 2. Product Effectiveness of N (gain) Score and Criteria

N-gain score	N-gain criteria
normalized gain ≥ 0,70	High
0,30 ≤ normalized gain < 0,70	Medium
normalized gain < 0,30	Low

(Source: Yulyatno *et al*., 2019).

Analysis of the practicality test of integrated STEM education learning units uses a 5-point Likert scale. The assessment criteria for learning units developed here can be seen in Table 3.

Table 3. Product Practical Assessment Score Criteria

Scores	Practicality criteria
76-100 %	High
56-75 %	Medium
40-55 %	Low
<40 %	Very Low

(Source: Fatmawati, 2016).

RESULTS AND DISCUSSION

Results

They are developing the education learning unit through five phases: analysis, design, development, implementation, and evaluation. The analysis stage contains material analysis activities, learning goals and learning objectives analysis, and task analysis. The materials selected for developing this learning unit is water cycle material using an integrated STEM approach (integrated STEM education). The analyzed water cycle materials include several subsections. These consist of the concept of the water cycle, various water cycles, problems in the water cycle (factors and impacts of the water cycle), flood disasters, and technology that can reduce disasters using an integrated STEM education approach. STEM education is a four-discipline approach (Science, Technology, Engineering, and Mathematics). It can train students to think at a higher level, one of which is the ability to think systems.

The design stage contains activities to compose a learning unit using integrated STEM education, research instruments, and learning tools. This water cycle material's integrated STEM education learning unit is intended for grade 7 junior high school. The learning unit consists of a learning unit cover, a preface, a table of contents, an introduction, material concepts, summaries, worksheets, RPP, and a bibliography. The development design results of integrated STEM education learning units are presented in Figure 1.

The development stage in this study contains product manufacturing activities, namely integrated STEM education learning units and product validation. This validation test aims to

determine the validity of integrated STEM education learning units through a score obtained from experts of 95.3%. However, to achieve the perfection of the learning unit, the researchers made several minor revisions based on the suggestions of validators.

The implementation phase is the phase of conducting product trials. This phase determines whether the learning unit is effective and practical for accessing the student's system thinking skills. The researchers submitted a product trial with a limited-scale test of 32 students. The results in the implementation phase include pretest and posttest assessments and questionnaires of student responses to using learning units. The researchers analyze the obtained data to determine the effectiveness and practicality of the learning units developed.

The researchers carried out the evaluation stage at each phase of development. This stage is carried out from the analysis phase to the implementation phase by refining the learning unit products, learning tools, and learning activities in the classroom. The evaluation phase is the final stage of the learning unit development process. This phase aims to know that the learning unit product has been declared valid.

Figure 1. Integrated STEM Education Learning Units

Validity of The Integrated STEM Education Learning Units

The researchers validate three aspects of the product, including construct, face, and content validity. This study's construct validity results come from various literature. Table 4 describes the buildings or constructs that must appear on the instructional units developed. The researchers developed the items based on existing theories and literature starting from the cover page to the list of references. Table 5 shows the detailed result of the face and content validity from the experts.

Table 4. Results of Construct Validity

Elements of Learning Units	Remarks
Cover page (Azka *et al*., 2019)	Contains in cover page provide context for use in product development. The title is "Integrated STEM-based learning unit (honing students' systems thinking skills)," and the topic of the water cycle and flood solutions.
Preface page (Azka *et al*., 2019)	This preface page is a form of the author's gratitude for the preparation of the product and a thank you to the parties who have aided in making the product.
Introduction (Samsuddin, 2019)	The introduction page contains a general overview of aspects of the study in a paper.
Concepts of the material/content of the material (Syaifullah, 2019)	The breadth and depth of the content of a development product demonstrate the correctness of the content's scope. It seeks to be comprehended by students as users.
Summaries (Gunawan, 2017)	Summaries in the book generally contain the essence of learning materials.
Students' worksheets (Azka *et al*., 2019).	Test questions are necessary to aid in student to comprehend the subject matter and to enable students to apply the knowledge to problems about the subject taught.
List of reference (Azka *et al*., 2019).	The list of references shows the sources of material used in the product.

Table 5. Results of Face and Content Validity

No	Criteria	Expert (E) Validation Score		
		E 1	E 2	E 3
1.	Clarity of learning objectives	5	5	5
2.	Relevance of learning objectives to KI/KD/Curriculum	5	5	5
3.	Accuracy of making learning objectives from the reference of Basic Competencies	5	5	5
4.	Learning units used following the needs of teaching materials	5	4	5
5.	Visibility of STEM approach aspects (Science, Technology, Engineering, and Mathematics)	5	4	5
	a. Science inquiry			
	b. Mathematical thinking	5	4	4
	c. Technology literacy	5	5	5
	d. Engineering design	5	4	5
6.	Consistency of the systematics of the material description	5	4	5
7.	Contextuality and actuality of media in learning activities	4	5	4
8.	Learning unit framework:	4	5	5
	a. Description of the table of content			
	b. Description of instructions for the use of learning units	4	5	5
	c. Description of prerequisites in the introductory section of the learning unit	4	4	4
	d. Description of learning goals and learning objectives	5	5	5
	e. Description of the material	5	4	5
	f. Assignment	5	5	5
	g. List of reference	5	4	5
9.	Consistency in the use of fonts, spacing, and layouts.	5	4	5
10.	Proportional layout cover (text and image layout)	5	4	5
11.	Conformity of color proportions (color balance)	5	5	5
12.	Image display (image selection)	5	4	5
13.	Clarity of STEM learning unit titles	5	4	5
14.	The attractiveness of the cover design	5	5	5
15.	Synchronization between graphic, visual, and verbal illustrations	5	5	5
16.	Variations in the delivery of data information types	5	5	5
17.	Accuracy in the explanation of the material	5	4	5
18.	The attractiveness of the material in motivating users	5	5	5
19.	(breadth and depth) of the content of the material	5	5	5
20.	Coherent content of the material	5	4	5
21.	Factualization and actualization of the content of the material	4	4	4
22.	Clarity and adequacy of examples relating to the material	5	5	5
23.	Clarity and appropriateness of the relevance of the language used	5	4	5
24.	A comprehensive sequence of test questions presented to access systems thinking skills	5	5	5
25.	The level of difficulty of test questions according to the indicators of the ability to think systems	5	5	5
26.	A balance between the proportion of test questions and the content of the material	5	4	5
27.	Clarity of evaluation in providing problem-solving	5	5	5
28.	Clarity and accuracy of the learning unit summary	5	5	5
Total		180	168	181
Inter-rater agreement			95.3%	

Limited effectivity test

Figure 2 shows that students were learning with education learning units. The students fill out the pretest and posttest. Pretest and post-test results come from 32 students. These aim to

determine the effectiveness of the learning units developed. The pretest and post-test results were analyzed using the paired sample t-test test presented in Table 6.

Table 6. Limited Scale Results of Systems Thinking Skills

	Paired Differences					t	df	Sig.(2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 PRETEST - POSTTEST	-33.062	7.079	1.251	-35.615	-30.509	-26.417	31	<0.001

Based on the results of the paired sample T-Test, it shows the value of Sig. (2-tailed) is equal to <0.001 or less than 0.05, so there is a significant difference between the pretest and post-test results. Meanwhile, the results of the N (gain) test on a limited scale test had a score of 0.73 which showed that it was highly effective for acquiring students' systems thinking skills.

Figure 2. Students in learning activities

Limited practicality test

The practicality test of the learning unit is measured based on the value of the student's response to the use of the learning unit. This questionnaire aims to know the practicality of the learning unit developed after the students read and learn it. The questionnaire results of student responses to the learning unit show the results of 89% with a high category. It shows that using the learning unit to access students' systems thinking skills throughout learning activities can be claimed to be practical.

Discussion

The type of development research used in this study is the ADDIE development model. This development model comprises 5 phases (Analysis, Design, Development, Implementation and Evaluation). This development research resulted in a product in the form of an integrated STEM education learning unit to access students' system thinking skills on water cycle materials. Material analysis activities aim to achieve the competencies desired by students through developed learning units. Cahyadi (2019) stated that analyzing material in terms of facts, concepts, principles, and procedures is a form of identifying material, and it is relevant to develop teaching materials in learning activities. The analysis is carried out through a literature study method and aims to identify and systematically organize the main parts of the material taught in the classroom. The existence of learning units can provide concrete explanations for abstract material.

A validity test is a test to determine whether a measuring instrument is valid (valid) or not (Janna, 2021). Islamy (2022) stated that the validation test data were results after calculating the

scores obtained and making improvements from experts' criticism and suggestions. The researchers used experts' criticism and suggestions to revise and improve the product for a better product according to the actual needs. The scores show the results of the inter-rater agreement from 3 expert validators totaling 95.3% with valid criteria. According to Fatmawati (2016), if the experts' agreement value has a minimum value of 70.01%, we can say that a product is valid and we can use it. We can say that this integrated STEM education learning unit is also valid. Using an integrated STEM education approach on the water cycle topic, we can use it in biology science learning activities to access students' system thinking skills. Construct validity in learning units is measured based on literature studies. The construct validity test aims to determine what aspects of the developed learning unit.

The researchers conducted effectiveness tests on 32 students. It aims to determine students' understanding of water cycle material with an integrated STEM education approach. The results of the paired sample t-test show that the value of Sig. (2-tailed) is equal to <0.001 or it is less than 0.05. Therefore, there is a significant difference between the pretest and post-test results. On the limited scale test, the N (gain) test result is 0.73. It shows that it is highly effective for accessing students' system thinking skills. According to Yulyatno et al. (2019), the N (gain) score has high criteria if it has a minimum score of 0.70. The data show that the average post-test value is higher than the pretest value, meaning that overall there is a difference in the average pretest and post-test results.

STEM education refers to the teaching, learning, and integration between natural science disciplines and science, technology, mathematics, and engineering skills in STEM topics by focusing on solving real-world problems (Wahono et al., 2020). STEM education focuses on hands-on activities to prepare students for the development of a new era of competition. Learning activities using a STEM approach can improve soft skills of problem-solving, higher-order thinking skills, and collaborative work. System thinking skills are closely related to higher-order thinking skills when juxtaposed with STEM. It is because systems thinking skills can improve students' retention of material and problem-solving skills with an integrated STEM approach (York et al., 2019). This research can access students' systems thinking abilities proven by real-world results. Therefore, the learning units developed effectively access students' systems thinking skills in biology science learning activities using an integrated STEM education approach on the water cycle topic.

The questionnaire results of student responses to the learning unit obtained 89% with high categories. According to Fatmawati (2016), the percentage of respondents can be mentioned as a high criterion if they have a minimum score of 76%. From the data obtained, a high percentage of respondents met the criteria. Therefore, the learning units developed in this research are practical to get students' systems thinking skills in learning activities through an integrated STEM education approach. According to Destiana et al. (2020), practical value is a factor to consider when developing a product. Practical value provides convenience in every development process carried out. We use the practicality of the learning unit under development as a benchmark for its feasibility.

The benefits of learning using integrated STEM education can provide the potential to develop the ability to argue and make decisions (Wahono et al., 2021). Integrated STEM education positively influences the student's thought development process because it involves multiple disciplinary perspectives. Students are familiar with convergent and divergent thinking in learning environments governed by integrated STEM education. Therefore, integrated STEM education is critical for increasing students' interest in learning and improving learning outcomes.

CONCLUSION

This research developed integrated STEM education learning units to access students' system thinking skills systematically and scientifically. The validity of integrated STEM education learning units to access system thinking skills has a very high value of inter-rater agreement from experts. Therefore, this learning unit is valid for use in learning activities. Based on the literature, the construction of the learning unit is also accurate. The results of the limited scale test of integrated STEM education learning units to access students' system thinking skills in the effectiveness test using the Paired Sample Test were significant. Therefore, thinking of systems is necessary for

education to understand the multilevel structure of several concepts and their interrelationships. This research is expected to innovate integrated STEM education learning units on the water cycle material through relevant literature. It can utilize learning hours to create meaningful learning for students.

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Jurnal Inovasi Teknologi Pendidikan
Volume 10, No. 1, March 2023 (10-21)
Online: http://journal.uny.ac.id/index.php/jitp

How STEAM is a Chemistry textbook for class XI of a public high school in Surakarta

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ARTICLE INFO

Article History
Received:
19 July 2022;
Revised:
7 January 2023;
Accepted:
13 January 2023
Available online:
09 March 2023.

Keywords
HOTS; textbook; science; STEAM.

ABSTRACT

This study aims to analyze the content of the STEAM aspect in the chemistry textbook for class XI. The research method used is descriptive qualitative. Data collection in this study used content analysis techniques. The sampling technique used is purposive sampling. The data sources used are the Chemistry Book for SMA/MA Class XI Specialization in Mathematics and Natural Sciences published by Erlangga in 2016 as book A, Experiment-based Chemistry Student Book published by Tiga Serangkai in 2014 as book B, and Chemistry Student Books for SMA/MA Class XI publisher Intan Pariwara in 2016 as book C. Basic Competencies analyzed in the three books, namely Hydrocarbon Compounds and Petroleum represent KD which are conceptual-theoretical, Reaction Rate represents KD which is mathematical, and Chemical Equilibrium represents KD which is abstract-complex. The results showed that books A, B, and C already contained all aspects of STEAM in various basic competencies. The contents of STEAM aspects in book A are 80 statements, book B are 85 statements, and book C are 121 statements. In Books A and C, the aspects of STEAM that are mostly covered are the mathematical aspects, while the aspects that are mostly published in Book B are the science aspects. The aspects of STEAM that are least contained in books A and B are the artistic aspects, while in book C are the technical and artistic aspects. Thus, in books A, B, and C, the artistic aspect has a low amount of load. Research on the content of STEAM and HOTS aspects needs to be carried out in more depth with a different approach regarding the integration of STEAM and HOTS aspects, especially in textbooks and other learning resources.

How to cite:
Rahma, D. F., Ariani, S. R. D., Masykuri, M. (2023). How STEAM is a Chemistry textbook for Class XI of a public high school in Surakarta. *Jurnal Inovasi Teknologi Pendidikan*, 10(1), 10-21. doi: https://doi.org/10.21831/jitp.v10i1.52018

INTRODUCTION

The world is currently entering the 21st century which is characterized by the rapid development of science and technology. The very rapid development of technology apart from facilitating access to unlimited information apparently also raises various complex problems that require a variety of knowledge and skills to solve them. The world of education is one aspect of life that is closely related to the development of science and technology. Learning in the 21st century is required to be able to develop the quality and competitiveness of students both from the aspects of

knowledge, attitudes and skills (Usman, Asrizal, & Kamus, 2017). Educational institutions are one of the institutions that play an important role in preparing individuals to master the skills of acquiring knowledge and innovation, skills in utilizing technology and information, and other skills that can be applied to work and survive (Wijaya, Sudjimat, & Nyoto, 2016).

The 21st century learning can be a medium to equip students with knowledge and skills that can be applied primarily in the process of solving problems that arise in life. The skills that are the demands of 21st century learning have been formulated by Partnership for 21th Century Learning the so-called 4C skills include Creativity and Innovation, Critical Thinking and Problem Solving, Communication, and Collaboration (Nuraeni, Feronika, & Yunita, 2019). Critical thinking is included in the realm of higher order thinking (HOTS) which is one of the skills that must be mastered as a response to the rapid development of science and technology so that students can be wiser in responding to the information they receive. In addition, these skills will also be very useful in the process of solving problems in life. Brookhart (2010) has defined HOTS into 3 (three) aspects, namely HOTS as transfer of knowledge, HOTS as critical thinking skills, and HOTS as problem solving skills. All aspects of HOTS need to be mastered and accustomed to in school learning so that students are able to practice their skills in solving difficult problems in their lives.

PISA is a global scope research to determine students' mastery of HOTS in a country, including Indonesia. The PISA results on 2018 show that Indonesia is ranked 74th out of 79 countries for the reading category. Meanwhile, for the category of mathematics and science, Indonesia ranks 73rd and 71st respectively out of a total of 79 participating countries. In addition to PISA, students' HOTS abilities on a national scale can be identified through the results of the National Examination (UN), because the questions in the current National Exam already contain questions in the HOTS category as one of the steps to improve the quality of education. The national exam results on 2019 show that the average national exam result for high school level (IPA) throughout Indonesia is 46.79 with an average chemistry subject of only 50.87. The average value of chemistry scores shows that low national exam results in chemistry occur in almost all schools in Indonesia, one of which is Surakarta City. The average National Examination for chemistry subjects for the high school level of the Science study program in Surakarta in 2019 shows a value of 69.95.

The low results of Indonesia's PISA and the average UN scores indicate that students' mastery of HOTS in Indonesia is still low, so that the quality of Indonesian education is still far behind other countries. Students in Indonesia still have difficulties when solving questions that require them to apply several concepts and stages of completion, non-routine questions that require reasoning, and contextual questions. Students also often encounter difficulties when there are questions that require them to apply a concept in an unfamiliar context, questions that require them to infer or predict data from several variables, and questions of understanding abstract concepts. The students' low mastery of HOTS certainly must be addressed as soon as possible. Research conducted by Putri, Ahda, & D. (2018) found that the learning process that has been taking place so far has not been directed effectively to hone students' higher-order thinking skills.

Higher-order thinking skills can be developed through contextual learning so as to stimulate students' curiosity and high-order thinking skills, one of which is through STEAM integrated learning. STEAM learning is learning that integrates science, technology, engineering, art, and mathematics. Through STEAM learning, students can be trained to apply the knowledge they have acquired to solve the problems they face and develop their skills in using technology so that their creativity and critical thinking skills can develop (Permanasari, 2016; Sa'ida, 2021). STEAM learning is a form of learning that can be applied to answer the demands of learning in the 21st century. STEAM integration in learning can develop various knowledge and skills in students. This is because in STEAM learning, students are stimulated to be curious so that higher-order thinking skills, problem solving, and the ability to work together can be developed (Purnamasari, Handayani, & Formen, 2020).

The application of the STEAM approach in learning can offer opportunities for students to develop the skills needed in the 21st century, for example communication skills, critical thinking, leadership, teamwork, creativity, and various other skills without compromising the breadth of

insight in the sciences and humanities. This is because learning with the STEAM approach is in the form of contextual learning, so that it is able to direct students to explore their abilities with a method that suits them. Through STEAM learning the ability of students to collaborate, work together, and communicate will be honed. Learning will also reveal the diverse works of students both individually and in groups (Mu'minah & Suryaningsih, 2020).

Arts in STEAM is able to develop student creativity which is useful for bringing out various innovations. It is known that art learning is able to develop a variety of student skills such as creativity, critical thinking, innovation, collaboration, interpersonal communication, and cognitive skills (spatial reasoning, abstract and divergent thinking, self-creativity, openness to experience, and curiosity) (NEA, 2016; Swaminathan & Schellenberg, 2015). In line with that, Katz (2018) has defined STEAM as the interaction of art with curriculum and learning in the scope of science, technology, engineering, and mathematics. As an approach to learning, STEAM can accommodate students to generate ideas or ideas based on science and technology through thinking and exploring activities in solving problems based on five integrated scientific disciplines so as to produce solutions that are very precise, attractive, effective and efficient (Nurhikmayati, 2019).

STEAM consists of 5 (five) aspects, namely science, technology, engineering, art, and mathematics. The scientific aspect is defined as a concept related to natural phenomena and the changes that occur due to human activities (Asrizal & Dewi, 2018). According to Revee (2015) science is the study of the universe including natural laws related to physics, chemistry and biology. Technological aspects cover various fields that involve the application of human knowledge, skills and abilities in producing something that can facilitate life activities (Bruton, 2017). The technical aspect is the design process in making a product or work step (Bruton, 2017). The aspect of art is knowledge related to aesthetic value or beauty. Art can make learning more interesting because it involves elements of aesthetics or beauty in it (Apriliana et al., 2018). The mathematical aspect is the science of numbers, operations, relationships, and shapes (Revee, 2015). Mathematics helps in interpreting, analyzing information, simplifying and solving problems, assessing risks, making decisions, making models, and explaining abstract and concrete concept problems (Bruton, 2017). STEAM aspect analysis in this study was based on indicators of 5 (five) STEAM aspects, namely science, technology, engineering, art, and mathematics which were analyzed using a silo approach, namely analyzing the content of 5 (five) STEAM in textbooks separately.

The learning process still uses books as learning resources used by students. In Bonnie B. Ambutser, the results of EPIE's research stated that the use of textbooks in the learning process in class was 75%, while the use of textbooks for homework was 90% (Awaliyah, Feronika, & Agung, 2015). A study conducted by Prakoso (2021) suggested that of the 3 (three) class X chemistry textbooks analyzed, only 1 (one) book contained 5 (five) aspects of STEAM, although the composition was not balanced, while 2 (two) books others have not yet included all aspects of STEAM. Based on these facts, an analysis of STEAM content in chemistry textbooks for class XI also needs to be done. This is in line with the statement made by Wahyu, Fathurohman, & Makos, (2016) that analysis of textbooks is very important as an evaluation to improve the quality of learning in Indonesia. Through the analysis of textbooks, textbooks can also be developed so that teachers can choose and adjust textbooks according to the learning objectives that have been set.

METHOD

This study used descriptive qualitative method. Descriptive research is a research method in which a researcher collects data, then analyzes the data critically and draws conclusions based on the facts at the time the research took place. This study examines the 3 (three) textbooks that are most widely circulated in several public high schools in Surakarta because the indicators of the Science, Technology, Engineering, Arts, and Mathematics (STEAM) in chemistry textbooks for class XI is very important to study to find out aspect indicators Science, Technology, Engineering, Arts, and Mathematics (STEAM) in the chemistry textbook for class XI has been loaded to support the fulfillment of the objectives of the applied curriculum. The three books are book A used by 2 schools, book B used by 3 schools, and book C used by 3 schools. The research was conducted from October 2021 to March 2022.

Research Objectives

The data in this study are in the form of STEAM aspect indicator content in XI grade chemistry textbooks. The data sources in this study were the 3 (three) textbooks for chemistry class XI that were most widely used in SMA Negeri in Surakarta.

Research Object Retrieval Techniques

The research object taking technique used was purposive sampling. Purposive sampling is a sampling technique with certain considerations (Sugiyono, 2018). In this study, the researcher considered several criteria in selecting research objects, namely (1) meeting the eligibility standards for books used in learning according to the applicable Regulations of the Minister of Education and Culture of the Republic of Indonesia includes content feasibility, presentation feasibility, language feasibility, and graphics feasibility; (2) based on the 2013 curriculum; (3) is a chemistry text book for class XI with different authors and publishers; (4) chemistry textbooks used in public high schools in Surakarta.as a result, 3 (three) textbooks were used in the study, namely the Chemistry Book for SMA/MA Class XI Specialization in Mathematics and Natural Sciences, published by Erlangga as book A, Experiment-based Chemistry Student Book, published by Tiga Serangkai as book C, and Student's Book. Chemistry for Class XI SMA/MA published by Intan Pariwara as book C.

Research Procedure

The research began by determining three types of chemistry textbooks for class XI which would be analyzed based on predetermined criteria. Furthermore, from each of the three textbooks, Basic Competencies (KD) were selected to be analyzed. Selection of Basic Competency (KD) is carried out based on the characteristics of learning materials, namely conceptual-theoretical, mathematical, and abstract-complex. Furthermore, the selected XI class chemistry textbooks were analyzed for STEAM aspect content using validated STEAM aspect load analysis instrument sheets. The research data from the three raters were then tested for reliability using the inter-rater reliability test or ICC. Then an analysis of the research data was carried out to describe the content of the STEAM aspect in the XI class chemistry text book.

Research Data Collection Techniques and Instruments

The data collection technique used is content analysis technique. The research data in the form of STEAM aspect indicator content was obtained by analyzing the selected KD from each of the analyzed textbooks. The analysis was carried out by reading and understanding the elements of the text on each page in the book and then matching them with the STEAM aspect indicators listed on the validated STEAM aspect analysis instrument sheet. Analysis of STEAM aspects in research based on indicators of 5 (five) STEAM aspects, namely science, technology, engineering, art, and mathematics which were analyzed using the silo approach, namely analyzing the content of 5 (five) STEAM in the textbooks separately. Prior to use, the research instrument was validated first using a research instrument validity test with expert validation techniques. The validation results were then analyzed using content validity with the Gregory formula, in Formula 1.

$$Cooeficient\ of\ content\ validity = \frac{D}{(A + B + C + D)} \quad (1)$$

Where:
A: both panelists disagree
B: panelist I agrees, panelist II disagrees
C: panelist I disagree, panelist II agrees
D: both panelists agree

Data analysis in this study begins with calculating the reliability between raters. The inter-rater reliability test is determined using the inter-rater reliability test or *Interclass Correlation Coefficient* (ICC). This reliability test was developed by Pearson (Widhiarso, 2011) which can be

applied if a study involves many raters and the results of the assessment scores are continuum or measurement data. Next, count the number of occurrences of each STEAM aspect indicator in the XI grade chemistry text books being analyzed. The amount of STEAM aspect indicator content is grouped based on the characteristics of the Basic Competences analyzed in each book.

RESULT AND DISCUSSION

Result

Class XI high school chemistry textbooks were analyzed based on the STEAM aspect content (*Science, Technology, Engineering, Arts, and Mathematics*) with content analysis techniques. STEAM aspect content analysis was carried out using a silo approach, namely analyzing the content of the five STEAM aspects in the textbooks separately. This study involved three raters, namely rater 1 was a researcher, rater 2 was a student, and rater 3 was a chemistry teacher. The results of the calculation of the intra-class correlation coefficient or ICC for the STEAM aspect load analysis in books A, B, and C are presented in Table 1.

Table 1. Inter-Rater Reliability Test Results for STEAM Aspect Load Analysis

Books	R. *alpha*	ICC		
	Marks	*Single Measures*	*Average Measures*	Category
A	0.999	0.998	0.999	*Excellent agreement*
B	0.999	0.998	0.999	*Excellent agreement*
C	0.999	0.998	0.999	*Excellent agreement*
Average	0.999	0.998	0.999	*Excellent agreement*

Based on Table 1, information can be obtained that books A, B, and C have value*average measures* ≥0.999, meaning that the average agreement among raters for STEAM analysis in the three books is very good, so that the analysis of the STEAM aspects in the three books can be continued. The results of the STEAM aspect load analysis in books A, B, and C according to the three raters are as shown in Table 2.

Table 2. Results of STEAM Aspect Load Analysis in Books A, B, and C

STEAM Aspect	STEAM Aspect Load Amount				
	Rater 1	Rater 2	Rater 3	Average	% Average
Book A					
Science	24	22	23	23	28.75
Technology	9	9	7	8	10.38
Engineering	9	9	8	9	10.88
Art	1	1	1	1	1.25
Mathematics	41	38	38	39	48.75
Total	84	79	77	80	100
Book B					
Science	27	26	25	26	30.59
Technology	13	12	11	12	14.12
Engineering	18	16	17	17	20.00
Art	8	7	7	7	8.59
Mathematics	24	22	22	23	26.71
Total	90	83	82	85	100
Book C					
Science	34	33	30	32	26.76
Technology	24	24	23	24	19.64
Engineering	15	15	14	15	12.18
Art	15	14	15	15	12.18
Mathematics	36	35	35	35	29.25
Total	124	121	117	121	100

Based on Table 2, the average number of STEAM aspects in book A is 80 statements, book B is 85 statements, and book C is 121 statements. In books A and C, the aspect of STEAM that is most widely covered is the mathematical aspect, while the aspect most published in book B is the aspect of science. The STEAM aspect that is at least covered in books A and B is the artistic aspect, while in book C are the technical and artistic aspects. Thus, in books A, B, and C, the artistic aspect has a low amount of content.

STEAM aspect content analysis in chemistry textbooks for class XI in terms of 5 (five) aspects, namely aspects of science, aspects of technology, aspects of engineering, aspects of art, and aspects of mathematics. the description of the results of the content analysis of each aspect of STEAM in books A, B, and C is as follows in Figure 1.

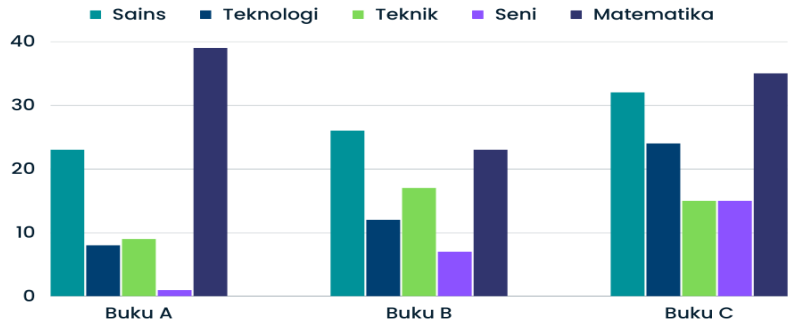

Figure 1. Results of STEAM Aspect Analysis in Books A, B, and C

Discussion

Science

The content of science aspects in textbooks is indicated by the presence of text elements which contain one of the indicators which includes stimulation that relates surrounding phenomena to material (S1), describes phenomena that occur around (S2), asks questions after making observations (S3), makes decisions related to phenomena that occur around (S4), explain the macro and sub-micro relationships of phenomena that occur around (S5), and evaluate and design scientific evidence (S6). The content of science aspects in textbooks plays a role in training students to understand and associate problems with natural phenomena and changes that occur due to human activities so that students do not only memorize concepts (Asrizal & Dewi, 2018; Pratiwi & Ramli, 2019).

The results of the analysis of science aspects in the XI class chemistry textbooks show that this aspect has been included in the three textbooks analyzed on KD of hydrocarbon and petroleum compounds, reaction rates, and chemical equilibrium. Based on Figure 1, the science aspect is the aspect that is most widely contained in book B. Meanwhile, in books A and C this aspect is the aspect that has the second highest amount of content after the mathematical aspect. These results indicate that the textbooks in circulation are still dominated by scientific content. This is also explained in the results of research conducted by Yuanita & Kurnia (2019) which shows that the scientific aspect is the aspect that is most widely included in the themes being analyzed. Following are the results of the content analysis for each indicator of the scientific aspect in books A, B, and C, can be shown in Figure 2.

Based on Figure 2, it is known that there are 2 (two) indicators that dominate the content of scientific aspects in the chemistry textbooks for class XI SMA being analyzed, namely the S1 indicator (stimulation that links surrounding phenomena to the material) and the S6 indicator (evaluating and designing scientific evidence). The content of the two indicators is the reason for the large number of scientific aspects in the three textbooks analyzed.

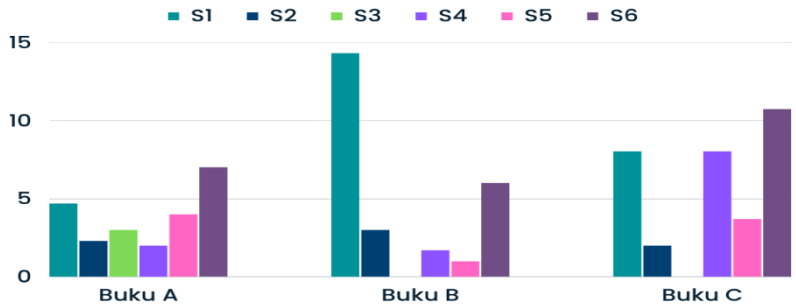

Figure 2. Results of Analysis of Indicators of the Science Aspect in Books A, B, and C

Most of the S1 indicators in books A, B and C are displayed in the format of pictures of the surrounding phenomena along with their descriptions. The amount of stimulating content that associates surrounding phenomena with learning material can make it easier for students to build an understanding of the concepts of the material being studied. While the S6 indicator is mostly contained in the format of practical activities or experiments in the laboratory. The existence of practicum activities is able to direct students to be active and independent in building understanding based on observations so that the learning experienced becomes more meaningful. In addition, the implementation of practicum activities can hone various skills of students, one of which is higher-order thinking skills.

Technology

The content of technological aspects in textbooks can be demonstrated by the existence of text elements that inform an innovation as a result of human thought processes in the form of hardware and software that are created to facilitate human work in order to create a higher quality life (Yuanita & Kurnia, 2019). This information can be in the form of statements regarding the development of new technology (T1), the use of new technology (T2), the application of technology in everyday life (T3), the use of software in learning (T4), and the use of internet networks in learning (T5).

The results of the analysis of technological aspects in chemistry textbooks for class XI show that books A, B, and C already contain these aspects. Based on Figure 1, this aspect is the aspect that has the third largest amount of content in book C, while in books A and B this aspect has the fourth highest amount of content. This aspect is contained in the KD of hydrocarbons and petroleum, reaction rates, and chemical equilibrium in the three books analyzed. Following are the results of the analysis of each indicator of the technological aspect in books A, B, and C, as follows in Figure 3.

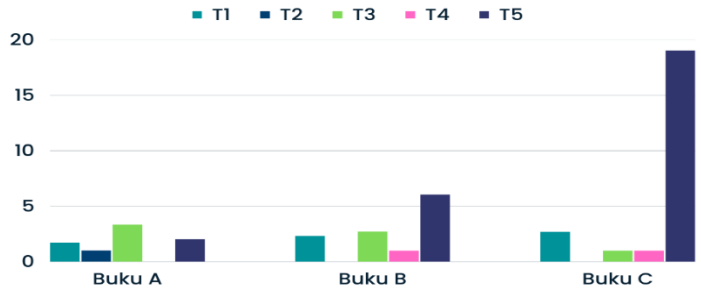

Figure 3. Results of Analysis of Technology Aspect Indicators in Books A, B, and C

Based on Figure 3, the content of technological aspects in book A is dominated by information on the application of technology in life related to learning materials (indicator T3), such as oil platforms for taking petroleum, petroleum multilevel distillation columns for petroleum processing, gas station machines for distributing gasoline used as fuel, and *catalytic converter* to prevent air pollution in vehicle exhaust. The use of some of these technologies makes technology a

medium to make it easier for humans to solve problems they face in life. While the contents of the technological aspects in books B and C are dominated by information or activities that invite students to take advantage of the internet network (indicator T5). Students are invited to access the listed website link which contains learning materials. This shows that books B and C have made technology a support for student activities to find and obtain explanations related to learning materials and related natural phenomena. In addition, the use of technology in books B and C is also shown by its use *software* (T4 indicator), such as consumption *Microsoft Power Point* or the like to make *slide* presentation. There is 1 statement excerpt in book B and 1 statement excerpt in book C. The content should be increased because the use of software can increase the effectiveness of the implementation of the learning process which has an impact on increasing understanding, learning outcomes, and students' skills.

Engineering

The content of technical aspects in textbooks is closely related to the knowledge and skills to design, apply, replicate and engineer a work in the form of equipment, systems and machines that can be used by humans to speed up and facilitate the production process of goods and services (Yuanita & Kurnia, 2019). The results of the analysis of technical aspects in the chemistry textbooks for class XI high school in Figure 1 show that this aspect has been included in the three books analyzed, although the number is still small. This aspect load is contained in the KD of hydrocarbons and petroleum, reaction rates, and chemical equilibrium. The results of the analysis are based on 4 (four) indicators, namely completing project assignments (E1), integrating chemistry with other sciences (E2), applying learning materials in the process of solving a problem (E3), and informing solutions to various problems in everyday life. day (E4). Following are the results of the analysis of each technical aspect indicator in books A, B, and C, can be shown in Figure 4.

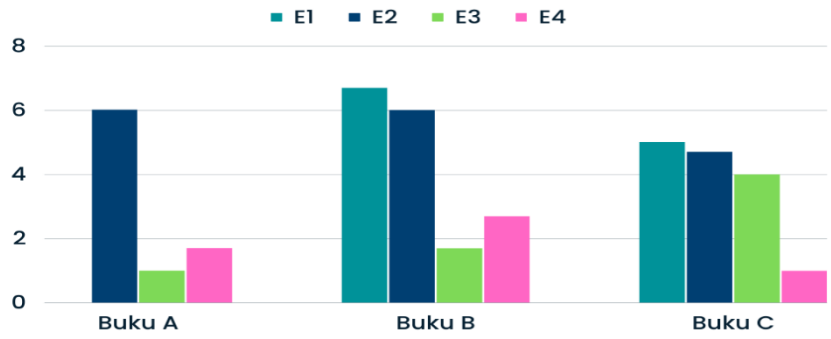

Figure 4. Results of Analysis of Technical Aspect Indicators in Books A, B, and C

There are 9 citations for the technical aspects in book A, 18 citations for book B, and 15 citations for book C. Based on Figure 4, in general the content of the technical aspects in books A, B, and C is dominated by activities that encourage students to combine chemistry with other sciences to solve a problem (E2). In book A there are 6 quotes that encourage students to combine chemistry with mathematics to solve problems. In book B there are 6 quotes that encourage students to combine chemistry with several other sciences such as mathematics, art, and technology. Whereas in book C there are 5 quotes that encourage students to combine chemistry with mathematics or technology. The quotations are many in number and most of them are contained in the work steps in practicum activities or experiments in the laboratory. As previously mentioned, the scientific aspects in books A, B, and C are dominated by practical activities or experiments in the laboratory, so there are also many work steps that encourage students to integrate chemistry with other sciences.

In books B and C there are indicators of technical aspects which show the most amount of content, namely activities that encourage students to complete project assignments (indicator E1), 7 citations in book B and 5 citations in book C. Most of the content is packaged in a column entitled “Project Tasks”, including: 1) Project Task “Cramping Fruit with Carbide” (Book B, p. 31); 2)

Project Task: design and conduct experiments on factors affecting shifts in the direction of equilibrium (Book B, p. 138); 3) Project Task "Creating a Framework for Hydrocarbon Compounds" (Book C, p. 26), and 4) Project Task "Making Biogas" (Book C, p. 46)

Project assignments contain complex problems that require students to be able to design, solve problems, make decisions, investigate, and be independent in solving the problems they face so as to develop students' scientific skills and attitudes. Therefore, the content in book A should also be equipped with project assignments so that students' skills can also develop along with their mastery of knowledge. The three books analyzed did not contain many activities that develop students' skills for defining problems, designing, assembling, or operating something. There are only a few design and fabrication activities included in the project assignment. The information content related to solutions to problems in everyday life is also only about 1-3 quotes in each book. The limited amount of content can hinder the development of students' problem-solving skills in everyday life.

Art

The content of artistic aspects in textbooks is closely related to design, creativity and innovation. Therefore, the integration of aspects of the arts in learning is expected to be able to reduce the pressure felt by students and increase learning motivation, activeness, cognitive abilities, and creativity of students (Purnamasari, Handayani, & Formen, 2020). The results of the analysis of the art aspect in the XI class chemistry textbook in Figure 1 show that this aspect has been included in books A, B, and C, but in small quantities. This aspect is the least covered in the three books analyzed. The fulfillment of artistic aspects in the books analyzed varies. The art aspect is found in book A only in KD of hydrocarbons and petroleum. In book B, artistic aspects are contained in KD of hydrocarbons and petroleum and reaction rates. Meanwhile, book C contains art aspects in KD of hydrocarbons and petroleum, reaction rates, and chemical equilibrium. The following is the result of the analysis of the content of the artistic aspect indicators in books A, B, and C, can be shown in Figure 5.

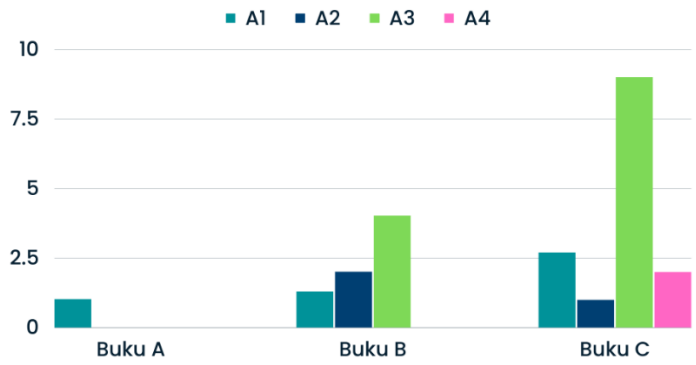

Figure 5. Results of the Analysis of Art Aspect Indicators in Books A, B, and C

Based on Figure 5, the indicators that appear in all the books analyzed are only indicator A1. This indicator is also the only indicator of the artistic aspect that appears in book A, namely activities that encourage students to produce creative and innovative products or works. In book A KD hydrocarbons and petroleum, page 29 contains assignments that encourage students to make posters about the process of forming petroleum, refining, and the use of each fraction in a systematic way. In book B, students are directed to color the arrangement of molecules and make presentation slides. Whereas in book C, students are directed to make posters, molimod, and activated charcoal from tools and materials around them. These activities develop the creativity of students to produce interesting products or works as a solution to the problems they face. In addition, the learning process that takes place can also be more interesting and fun so that it is expected to increase students' understanding of the concept of learning material.

In books B and C, there are indicators loaded with the largest number, namely communicating ideas effectively (indicator A3). This skill includes aspects of art in terms of communication that really need to be mastered by students. Much of this content is contained in books B and C because there are many discussion activities accompanied by the activity of conveying the results of the discussions in front of the class. In book B there are 4 discussion activities while in book C there are 9 discussion activities. However, these three books have not properly facilitated students to develop their abilities to socialize their products or works to the public. Only book C contains 2 excerpts containing activities to socialize his products and works to the public. The limited content in textbooks can make students' creativity to introduce their products or work to the public less fully developed. In fact, such ability is one of the important abilities that must be owned by every individual in this century.

Mathematic

The content of mathematical aspects in textbooks with numeration, patterns of change and relationships, space and form, skills for thinking rationally and logically and reasoning, and using them in a systematic and structured manner (Yuanita & Kurnia, 2019). Analysis of the content of the mathematical aspects of textbooks is based on 4 (four) indicators, namely applying mathematical symbols (M1), applying numeracy skills to solve problems (M2), interpreting experimental data and results (M3), and formulating conditions or problems mathematically (M4).).

The results of the analysis of the mathematical aspects in the XI class textbooks show that these aspects have been included in the 3 (three) books analyzed. Based on Figure 1, it is known that this aspect is the aspect that appears the most in books A and C, while in book B this aspect is the second most appearing aspect after the science aspect. In general, the results of the research show that the content of the scientific aspects and the mathematical aspects has an almost equal amount. These results are similar to research on the analysis of STEM content in high school physics textbooks for class X semester 1 which shows that the presentation of the number of aspects of science and aspects of mathematics in the five books analyzed is almost the same (Agnezi, Khair, & Yolanda, 2019). Mathematical aspects are known to appear in KD of hydrocarbons and petroleum, reaction rates, and chemical equilibrium in both books A, B, and C. The results of the analysis of the load on the mathematical aspect indicators in books A, B, and C are shown in Figure 6 as follows:

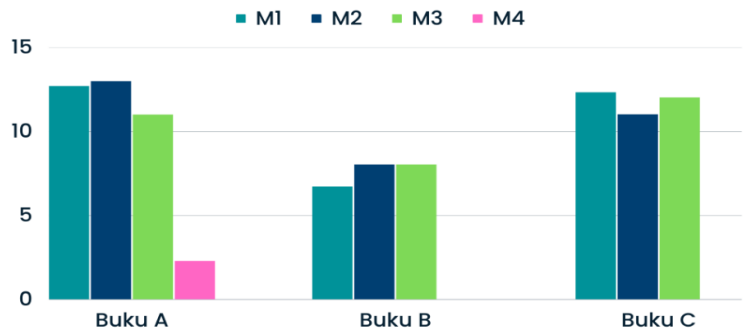

Figure 6. Results of the Analysis of Mathematical Aspect Indicators in Books A, B, and C

The contents of many mathematical aspects are found in books A, B, and C because there are many elements of the text that apply mathematical symbols to facilitate students' understanding (indicator M1). Apart from that, in the three books there are also many activities that require students to apply numeracy skills (indicator M2) and interpretation of data and research results (indicator M3). It is very important to integrate these contents in textbooks because the results of PISA show that the ability of Indonesian students to relate mathematical concepts to everyday problems is still low (Akmal & Asikin 2022). The mathematical aspects in books A, B, and C are mostly covered in

KD reaction rates compared to KD in hydrocarbons and petroleum and chemical equilibrium, because these KD contain a lot of activities that require students' numeracy skills and interpretation.

CONCLUSION

The STEAM aspect content in book A is 80 statements, book B is 85 statements, and book C is 121 statements. The STEAM aspect is contained in 3 (three) various Basic Competencies. In book A, aspects of science, technology, engineering, and mathematics are included in the KD, which are hydrocarbons and petroleum, reaction rates, and chemical equilibrium. Meanwhile, the art aspect is only contained in KD of hydrocarbons and petroleum. In book B, the aspects of science, technology, engineering, and mathematics are contained in the KD of hydrocarbons and petroleum, reaction rates, and chemical equilibrium. While the artistic aspects are contained in KD of hydrocarbons and petroleum and reaction rates. In book C, aspects of science, technology, engineering, art, and mathematics are included in KD of hydrocarbons and petroleum, reaction rates, and chemical equilibrium. The results of this study indicate that the STEAM aspect content is still presented partially. Therefore, researchers expect the development of textbooks that integrate STEAM aspects of content in a complete and proportionate manner into textbooks and other learning resources to improve the quality of Indonesian student resources to be able to solve problems faced and compete in the international world of work. Thus it will make it easier for educators to apply it in learning so that it makes it easier for students to master it. Research on the content of STEAM and HOTS aspects needs to be carried out in more depth with a different approach regarding the integration of STEAM and HOTS aspects, especially in textbooks and other learning resources.

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Jurnal Inovasi Teknologi Pendidikan
Volume 10, No. 1, March 2023 (22-32)
Online: http://journal.uny.ac.id/index.php/jitp

Effect of Zoom fatigue on health and learning loss in students during the COVID-19 pandemic

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ARTICLE INFO

Article History
Received:
06 November 2022;
Revised:
20 January 2023;
Accepted:
02 February 2023;
Available online:
09 March 2023.

Keywords
Online learning;
students;
video conference;
zoom fatigue.

ABSTRACT

Covid-19 pandemic causes all face-to-face activities converted to distance or virtual meetings, including educational learning system. These days, the majority educational institutions in Indonesia still implement distance learning via video conference platforms. This primary research aims to discover how Zoom Fatigue affects health and causes learning loss in university students across Java. The methodologies used in this research are qualitative and quantitative. To specify this research, the population is set to students who study at several universities in Java, with 50 samples being Multimedia Nusantara University students and the other 50 sample are being students from other universities in Java. The techniques used to collect data are observation and questionnaire via Google Forms. After analyzing responses, the result shows that most students experience health issues such as eyesight issues, exhaustion, and saturation. Moreover, most students also go through some issues when it comes to the learning process, they experience a decrease of learning motivation and have trouble concentrating. Nevertheless, their academic records are stable and some even stated that their grades are increasing when compared to face-to-face learning systems, this fact shows that in-class learning is not the only source of information used by students to support their academic performance, but there are other sources of information such as internet where students can look up information from online article and scientific journals.

How to cite:
Permana, A. A., Kusnadi, A., Marpaung, A. N., Marcela, D. A., Yuasan, N., & Fauziyah, S. (2023). Effect of Zoom fatigue on health and learning loss in students during the COVID-19 pandemic. *Jurnal Inovasi Teknologi Pendidikan*, 10(1), 22-32. doi: https://doi.org/10.21831/jitp.v10i1.52930

INTRODUCTION

Pandemic Covid-19 situations force school or university to arrange learning online. Online learning is an education program that is done without having to meet directly but using an education application platform or an available social network that can distribute the learning materials online. One from many video conference platforms that is often used for online learning is Zoom (Salim et al., 2022). Based on 2020 data, Zoom has been downloaded about 477 million times from all around the world (Curry, 2021; Hidayatullah et al., 2020; Rezki et al., 2020). By using Zoom, it will make

online learning and communication between lecturers and students become easier (Hidayatullah et al., 2020). On the other hand, students feel uncomfortable in study with online learning (Alexandra & Choirisa, 2021). According to UNESCO in March 2021, more than 888 million students around the world have experienced education disturbance because of school closure (Shoshan & Wehrt, 2022; UNICEF, 2021). Disturbances experienced can affect students' physical and mental health (Fauville et al., 2021a). One of the phenomena that happen a lot due to the use of video conference platforms as a replacement for direct learning is Zoom Fatigue, i.e., excessive fatigue because of continuous video conferencing via laptop or smartphone (Duffy, 2020; Nadler, 2020).

The Zoom Fatigue phenomenon can have a destructive impact on students' mental and physical health. To previous research, about 83,7% of students experience light stress, and 59,7% of students experience fatigue during online learning (Hidayati & Irwansyah, 2021; Pustikasai & Fitriyanti, 2021; Rump & Brandt, 2020). Some of the health problems that happen a lot because of Zoom fatigue are hard to focus, feeling dizzy, back problems, and insomnia. Besides influencing students' health, Zoom Fatigue has a possibility of emergence learning loss (de Oliveira Kubrusly Sobral et al., 2022). It will be hard for students to understand the material that is delivered by lectures when they are physically and mentally not in good condition (Peper et al., 2021; Peper & Yang, 2021).

In some of the previous studies, Zoom Fatigue solution has been discussed. Fatigue can be overcome by changing the interface following user comfort, i.e., if the user feels more comfortable without seeing their video, then the user can activate the hide self-window feature (Bailenson, 2021; Cranford, 2020). There are also some solutions from similar studies, such as avoiding multitasking, enough rest, and using the speaker view feature to keep the focus on the person that is talking (Peper et al., 2021). Even though some solutions have already been discovered for the problems before, previous studies tend to discuss only the cause and effect of Zoom Fatigue on students' health (Fauville et al., 2021b). Therefore, this study discusses the aspect that hasn't been discussed in the previous study, which is about the impact of Zoom Fatigue on health, such as physical and mental health, including exhaustion, saturation, inconvenience and anxiety moreover, eyesight issues, spine problems, also headache and learning loss with the decrease of productivity, motivation, understanding, concentration, also academic value as an indicator in student.

This study uses quantitative and qualitative methods. Google Forms will be used in collecting data as questionnaires, with the target respondents being students from Multimedia Nusantara University and other universities. The Target of respondents is set to 100 students to optimize the survey result for the highest accuracy.

With this study, hopefully, can discover how Zoom Fatigue phenomenon impacts health and student achievement, especially in the academic field. After collecting the data, there will be a comparison between the impact of Zoom Fatigue on health and academic achievement, then conclude whether the impact on health and academic achievement is directly proportional or vice versa. The result of this study is expected can be a measurements form of the effectiveness of online learning, specifically in universities.

In life, many things are caused by causality or causal relationships. Causal is a condition where an event happens because of an event before that becomes the impact factor. An impact is power from things, people, or inside symptoms that make a difference in any life aspect. Based on information on the official website of PBB, an impact can be positive or negative and can also happen in the long or short term. Moreover, the effect can be intentional and unintentional, as well as direct and indirect. Generally, the level of impact accuration can be measured by numeric and quantitative data.

Learning is a process of knowledge transfer that involves student as the recipient of knowledge and instructor as source of knowledge (Chatib & Said, 2012; Tjokrodinata et al., 2022). Basically, the learning process has been known since the beginning of human civilization, but the concept of a new formal school was created in the early 500 AD in Ancient Greece, Ancient Rome, and Ancient Egypt. As time passed, the education system and school also evolved, until first university in the world was formed, Bologna University in 1088.

So far, there have been more than 20.000 universities spread around the world and according to Mark In Style UK data, around 250.000.000 students are studying at universities. From the data, it can be concluded that the level of education awareness is very high. Besides awareness of education, other motivational factors of someone studying at university is competition in a competitive professional environment.

In early 2020, most countries in the world was forced to close formal school and college to prevent the spread of Covid-19 virus. School closures have impact in the change of learning system from initially face-to-face become online learning. Online learning is media set in many formats such as text, picture, and video, that can be accessed by internet (Romli, 2018). From the definition, online learning can be interpreted as a learning system that arrange a meeting between student and instructor via media that is connected to the internet.

The most used media in online learning is Zoom Cloud Meeting. Zoom Cloud Meeting is a platform for video conference cloud base. Zoom Cloud Meeting provides a virtual room that enable participant to interact both ways supported with visual feature, video, and sound. These features, used by most of the education institutes, are the one that help education institutes to arrange learning during the pandemic.

Even though features that provided by Zoom Cloud Meeting can meet most of the needs in learning during pandemic, there are still some shortcomings from online learning system via Zoom Meeting. One of the phenomena that arise from the use of Zoom Cloud Meeting is Zoom Fatigue. Zoom Fatigue is excessive tiredness because of doing virtual meeting via video conferencing media continuously.

Researcher from Stanford University has study about causative factor of Zoom Fatigue that consists of 4 main points. First cause is intense eye contact with strangers, for some people this can make them feel uncomfortable or even anxious. Furthermore, one of the research has proven when someone is talking and the other person is looking at them intensely, that can affect their psychology (Fauville et al., 2021). Second cause is cognitive load, this happens because of communication via video conferencing platform nonverbal so that user needs more effort in understanding and sending communication message. Third cause is user stare at their mirrored self, this can provoke tendency in evaluating them self. Fourth cause is low mobility. Communication via Zoom will limit user range of motion especially when they activate their camera, with this habit user will try to stay in camera view area unconsciously which means they will stay at the same position in a long time and that will make them exhausted faster and less comfortable because of limited movement.

Zoom Fatigue phenomenon is very likely experienced by students that do online learning via video conferencing platform in their daily life. This has a negative impact to student's psychological and physical health. In previous study, it was said that students in Eritrea Institute of Technology tend to experience moderate stress (71%) (Yikealo et al., 2018). In the same study, it was found that physical problem that happen during online learning are exhausted (24,4%).

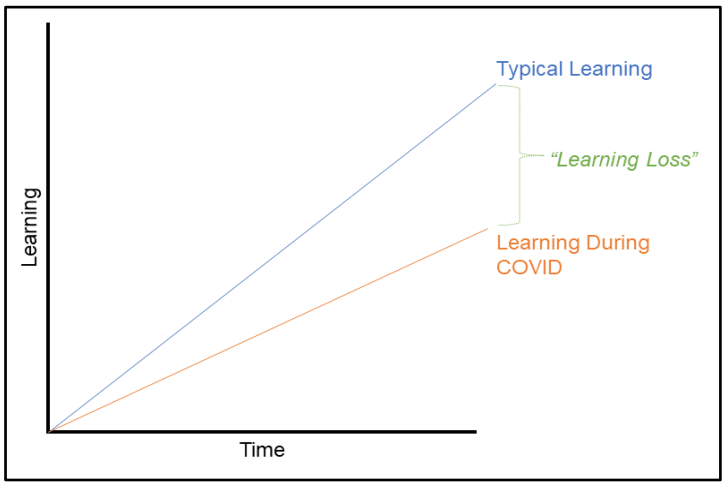

Figure 1. Graph of Comparison of Understanding Levels of Online and Face-to-Face Learning (Pier et al., 2021)

Beside psychologist and physical problems, Zoom Fatigue can also affect in decrease of understanding material in students or called as learning loss. According to The Education and Development Forum in 2020, learning loss can be described as a condition where a student experience in level of understanding and skills also affect in academic performance of the student. Learning loss can be caused by gap or failure in education system.

In relation to Covid-19 pandemic, learning loss caused by online learning can be visualized as a student concern that cannot understand and master learning materials as well as direct learning. Visualization of different levels of understanding online learning and direct learning can be seen in Figure 1.

Emergence of learning loss certainly will create long and short term impact especially in education quality and human resources in the future, even several experts state the impact of this phenomenon will mostly be seen in the next 10 years. Short term impact for students are decrease of study motivation, lose confidence, moreover in some cases can cause depression. For long term impact of learning loss is still predicted by the expert, the quality of human resources that born from online learning won't be able to compete with human resources that born from direct learning. That is caused by lack of practical activity during online learning, thus resulting in students only understand theoretical material.

Indonesia is certainly not spared from the learning loss phenomenon. Based on the observation, not a few students have complained about the online learning situation, this matter is often expressed by students via social media, particularly in Twitter, Instagram, and TikTok. Some of them also worrying about career prospects in the future due to believe they are not having enough skills to compete in working life. It can be concluded that online learning system can affect students' psychology, but in this study will also discuss how online learning affects students' academic value. This is an interesting thing to be studied because in fact online learning gives students more freedom in exploring resources while doing homework or exam.

There are questions in the questionnaire, in the first segment containing questions about zoom fatigue impact to mental and physical health. The second segment containing questions about zoom fatigue impact to academic achievement. To optimize the survey results in reaching the best accuration, this study targets 100 respondents.

METHOD

Research method is obtaining data with specific object and usage in a scientific way (Sugiyono, 2017). There are four keywords that have to be noticed, namely the scientific method, data, objectives, and usability. This study using primary data resource with quantitative and qualitative methods. Qualitative method is types of research that aim for understanding the objectives of the study deeply, describes the reality related to basic theory and elaborate understanding of one or more way towards experienced phenomenon (Moleong, 2007). Quantitative method is research that involves theory, design, hypothesis, and determine the subject. Both of the methods supported with collecting data, data processing, and data analysis before conclusion was made.

Population is the whole object of research (Arikunto, 2010). Research can only be done with limited population and subjects. Population in this research are students in Java island. Java island is chosen as the location of the population because the researcher is domiciled in Java and has connection with students from universities around Java island.

Sample is part of the total and characteristics of the population (Sugiyono, 2008). In this research, we spread the questionnaire to 100 respondents, which consists of Multimedia Nusantara University students and other universities around Java. The sampling technique used is random sampling, where the sample is taken somewhat from each individual or group of the population. Total the population in the research is 50 students from Multimedia Nusantara University and 50 students from various universities in Java.

The research focuses on several parts or domains that are defined as the primary situation in a study (Sugiyono, 2016). The details will be used to limit the topic to discuss and process in collecting data. Some research focus that has been appointed are (1) Respondent intensity in the

usage of video conference platform; (2) Zoom Fatigue impact on mental and physical health; (3) Zoom Fatigue impact on learning loss.

Information or data collecting techniques are done by observation and questionnaire. Observing students' behavior when attending online learning and outside of online learning we do the observation. Questionnaires are data-collecting technique which is conducted by giving questions for respondents to answer. Questionnaires will be spread to 100 respondents that are active students from several universities around November 2021.

A research instrument is a written guideline about an interview, observation, or even questions that will be used for obtaining information. Research instruments are also called observation guidelines, interview guidelines, questionnaire guidelines, or documenters depending on the method used (Ismayani, 2020). Questions and statements from the questionnaire be the focus of the research based on the previous research entitled "*Nonverbal Mechanisms Predict Zoom Fatigue and Explain Why Women Experience Higher Levels than Men*" where in the study, there is a theory that states Zoom and *Exhaustion Fatigue* (ZEF) scale influenced by gender, the intensity factor of video conference usage, nonverbal mechanism like anxiety, stare at the monitor in a long time, and limited physical movement. Moreover, several questions and statements are also based on observations and personal experiences of researchers that happen during online learning.

Table 1. Questionnaire Structure

No	Segment	Answer Type	Total Question
1	Respondent identity	Short answer, multiple choice	7
2	Usage intensity of video conferencing platform	Multiple-choice, checkboxes	6
3	Impact of Zoom Fatigue on health	Linear scale (1 = strongly disagree, 5 = strongly agree)	7
4	Impact of Zoom Fatigue towards Learning Loss	Linear scale (1 = strongly disagree, 5 = strongly agree), multiple choice	5

In this research, data collecting will be done by using Google Forms to create the questionnaire that will be spread to the respondents according to the criteria. Table 1 shows a questionnaire structure.

RESULTS AND DISCUSSION

Results

In Figure 1, we look for students from generations 2018-2021 as respondents because students in that year experience online learning via video conference platform due to the Covid-19 virus. So that every student does learning and graduation via video conference. Therefore in the diagram, there are 72% of students from generation 2019, 14% of students from generation 2020, 13% of students from generation 2021, and 1% of students from generation 2018.

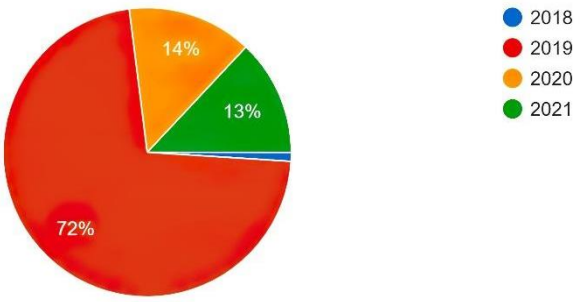

Figure 1. Respondent Batch Year

Zoom Fatigue is excessive fatigue because of video conferencing. From Figure 2 above can be seen that 56% of respondents know about *the Zoom Fatigue* phenomenon, and 44% don't know about *Zoom Fatigue*.

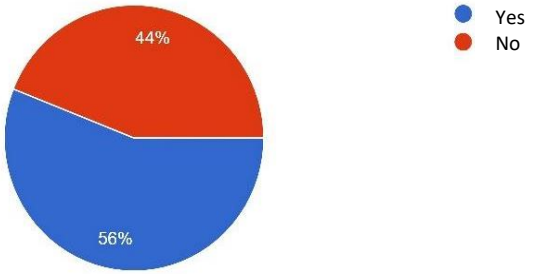

Figure 2. The knowledge of Respondent about Zoom Fatigue

Several platforms provide video conferencing, such as Zoom Meeting, Google Meet, Microsoft Team, etc. In Figure 3, the result based on the questionnaire is that 78% of respondents choose Zoom Meeting as the most used video conference platform. Therefore 14% for Google Meet and 8% for Microsoft Teams.

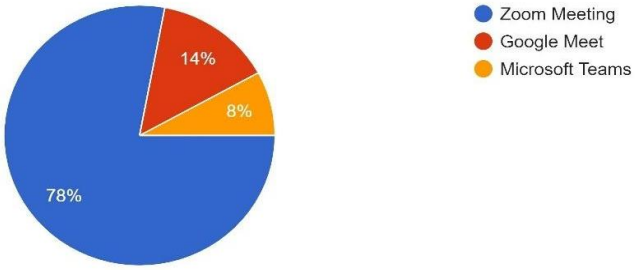

Figure 3. The Most Used Video Conferencing Platform

Figure 4 discusses activities that require to use of a video conference platform, and 99% of respondents state that they use it for the lecture because the questionnaire is spread only to students. Not only that, there are other activities such as organization/committee and communication with friends during online learning that need video conferencing.

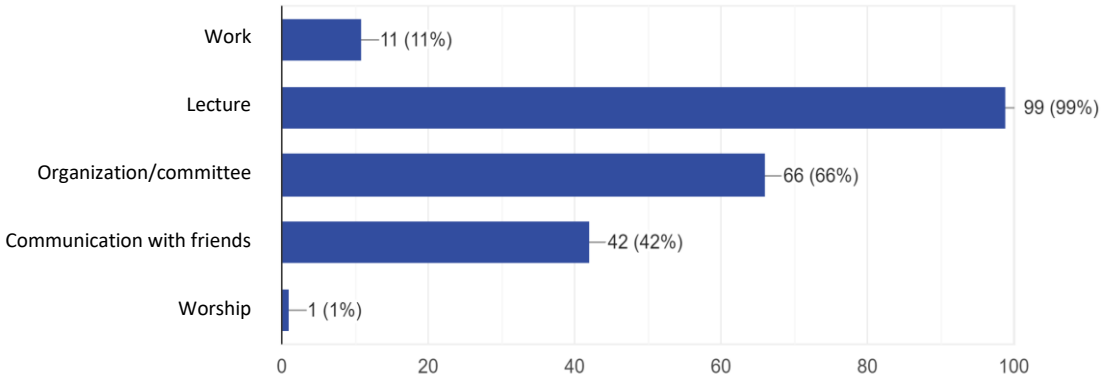

Figure 4. The Needs of Using Video Conferencing Platforms

Most respondents do video conferences for about five days or more a week. The activity which respondents conduct during video conferences are lectures, organization, communication with friends, working, and even worship. 60% of respondents do video conferencing for about 4 hours or more daily to do lectures, organizational meetings, communicate with friends, and even worship.

89% of respondents use a PC / laptop for video conferences. This might be due to the multitasking that they can do while using a PC / laptop. The screen on a PC or laptop tends to be bigger than the screen on a smartphone or tablet, so everything that happens during video conferencing can be seen easily.

Table 2. Video Conference Fatigue Assessment Indicators

No	Aspects	Percentage (%)				
		1	2	3	4	5
1	The fatigue levels during video conferencing	0	0	6.5	43	50.5
2	The saturation levels during video conferencing	0	0	4.3	23.7	72
3	The anxiety levels during video conferencing	2.2	9.7	37.6	28	22.6
4	The effect of turning off the camera on anxiety	2.2	5.4	12.9	25.8	53.8
5	The eye health problems due to video conferencing	0	2.2	7.5	33.3	57
6	The spinal health problems due to video conferencing	1.1	0	8.6	29	61.3
7	The frequency of headaches due to video conferencing	2,2	12.9	28	31.2	25.8
8	The decrease in productivity of respondents after doing video conferencing	5	10	27	27	31
9	The decrease in learning motivation of respondents while using video conferencing platforms	1	13	28	29	29
10	The decrease in understanding of the learning material of respondents while using the video conferencing platform	2	8	28	32	30
11	The difficulty concentrating level of respondents while using the video conferencing platform	1	6	26	31	36

Table 2 shows video conference fatigue assessment indicators. 93% of respondents feel their physical and mental health can be disturbed because of doing video conferencing too often. Most of the respondents (93.5%) feel exhausted after video conferencing, but 6.5% of respondents feel indifferent or neutral even though they are doing video conferencing.

The majority of respondents feel saturated when they are doing a long time of video conferencing. This can be seen by 72% of respondents choosing 5 points, which means they strongly agree, and 23.7% choosing 4 points, which means they agree. Besides, 4.3% of other respondents choose 3 points which means neutral.

The anxiety levels during video conferencing show that 22.6% of respondents chose 5 points, and 28% of respondents chose 4 points which means the majority of respondents feel uncomfortable or uneasy when doing video conferencing. While 37.6% of respondents chose 3 points, they think neutral when doing video conferencing. There 9.7% of respondents chose 2 points, and 2.2% of respondents chose 1 point, which means they feel comfortable when doing video conferencing.

The effect of turning off the camera on anxiety shows 53.8% of respondents chose 5 points, and 35.8% of respondents chose 4 points which means the majority of respondents feel that turning off the camera while doing video conferencing, can decrease their uneasy feeling. 12.9% of respondents choose 3 points which means neutral. While 5.4% of respondents chose 2 points and 2.2% of respondents chose 1 point, that means the respondents consider by turn off the camera when doing video conferencing cannot decrease their uneasy feeling. It can be concluded that activating or non activate the camera during video conferencing can have an impact on the majority of people.

Eye health problems due to video conferencing can be concluded that most respondents agree that eyesight health can be disturbed by video conferencing with high intensity. This conclusion can be seen by 57% of the respondents choosing 5 points and 33.3% choosing 4 points. While 2.2% of respondents choose to disagree that high intensity of video conferencing can disturb eyesight health, and the rest choose neutral.

The spinal health problems due to video conferencing show 61.3% of respondents chose 5 points (strongly agree), and 29% chose 4 points (agree), so it can be concluded that the majority of respondents agree when doing video conferencing with high-intensity can disturb backbone health.

But some respondents choose neutral and disagree that backbone health can be disturbed by doing video conferencing at high intensity.

The frequency of headaches due to video conferencing can be seen in the majority of respondents feeling dizzy or headache while doing video conferencing because 25.8% of respondents chose 5 points (strongly agree) and 31.2% chose 4 points (agree). But not a few respondents choose 3 points (neutral, by 28%), and the rest choose 1 and 2 points, meaning they are not feeling dizzy or headache during video conferencing.

Decreased productivity of respondents after video conferencing can be concluded that most respondents need to be more productive after doing video conferencing. This is shown by 31% of respondents choosing 5 points (strongly agree) and 27% choosing 4 points (agree). But on the other hand, some respondents rarely or even never go through a decrease in productivity after video conferencing.

The decrease in respondents' productivity after video conferencing shows that 28% chose neutral, 29% decided to agree, and 29% chose strongly agree, so two possibilities can be concluded. First is video conference platform user not impacting students' motivation to study. Second, video conference platform users are ineffective for students because they decrease their motivation to learn. Moreover, some students disagree with the statement.

The decrease in understanding of the learning material respondents while using the video conferencing platform can be concluded that students tend to experience a reduced understanding of learning material implemented via video conference platforms. It results in 32% of students agreeing to agree and 30% strongly agreeing. Not a few students chose neutral, indicating that the learning material's level of understanding was not affected by the usage of the video conference platform as a learning platform.

The difficulty concentrating level of respondents while using video conferencing platforms can be seen 67% of respondents agree with the statement that the use of video conference platforms makes students hard to concentrate while studying. This happens because of lots of distractions while learning via video conference platforms. The distraction can be the urge to do other activities or drowsiness because the learning environment tends to be monotonous via video conference platforms and lack of physical communication with friends in class.

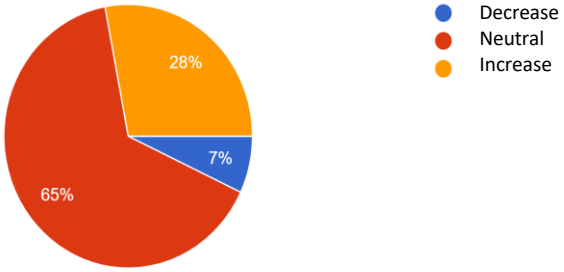

Figure 5. The Academic Score Condition of Respondents While Using Video Conferencing Platform

From Figure 5 can be seen that the academic score of students while online learning tends to be neutral and increasing. It shows that 65% of respondents state their academic scores are neutral, and 28% of respondents experience an increase in academic scores during online learning.

Discussion

The excessive use of video conferencing can have an impact on physical and mental health. The majority of respondents already know what Zoom Fatigue is. Zoom is the most common application used to carry out lecture activities with an intensity of time for more than five days a week, and more than four hours a day. The majority of respondents use a PC or laptop during video conferencing. The impact of Zoom Fatigue that is felt when using video conferencing is feeling tired, feeling bored when doing video conferencing for a long duration, feeling anxious or uncomfortable

during video conferencing, feeling more comfortable and calm when turning off the camera during video conferencing, experiencing eye health problems due to too frequent video conferencing, having back spinal health problems, and having headaches while video conferencing is going on.

The use of video conferencing platforms has resulted in several changes in the academic conditions of students. Based on the data collected, it can be stated that the use of video conferencing platforms as online learning media causes learning loss for students. This learning loss can be in the form of decreased productivity, reduced motivation to learn and understand the material, and difficulty concentrating. Even so, the learning loss that has been faced by the students is inversely proportional to the academic condition during online learning. Based on questionnaire data, most of the students stated that the condition of their academic scores during online learning tended to be neutral and increased. This shows that there are learning supporting factors outside the activity of material given by the lecturers during the lecture hours. Based on observations, one of the supporting factors is the internet. The development of technologies allows students to easily search for sources of information through the internet, where the information can be used to complete the understanding that might not be obtained through online learning so that the students can maintain or improve their academic achievement.

CONCLUSION

The Zoom Fatigue phenomenon can have an impact on students' health conditions during online class learning. This can be concluded from the frequency of respondents who agree that doing video conferencing with high intensity can affect physical and mental health. The results of the questionnaire also showed that the majority of respondents experienced several symptoms of physical and psychological health problems, which have been described in the discussion section. Using the video conferencing platform also causes learning loss for students but doesn't significantly affect the condition of student academic scores. This is an anomaly because the dimensions of student behavior and the results of academic scores are out of sync. Therefore, this finding can be a topic for further research to reveal the factors that cause the asynchronous learning loss experienced by students with the academic conditions achieved during online learning during the pandemic.

ACKNOWLEDGEMENT

This research was carried out properly with the help and support of the parties involved. Therefore, we would like to thank Universitas Multimedia Nusantara, and we would also like to thank all the respondents who took part to fill out the questionnaire for this research.

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Jurnal Inovasi Teknologi Pendidikan
Volume 10, No.1 March 2023 (33-42)
Online: http://journal.uny.ac.id/index.php/jitp

Design of air conditioner (AC) system simulator on cars to improve student competence

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ARTICLE INFO

Article History
Received:
16 December 2022;
Revised:
15 February 2023;
Accepted:
28 February 2023;
Available online:
09 March 2023.

Keywords
Air conditioner;
competency; simulator.

ABSTRACT

The purpose of this study is to design a simulator for a car air conditioning system as a learning medium, so that the learning objectives can be achieved properly and in accordance with the expected competencies. This design uses an electric motor drive to drive the AC system compressor so that it is easier to operate and does not produce air pollution and is made with a design that can be moved easily by having sturdy wheels. The electric motor is also equipped with an inverter that can adjust the rotation of the motor as in the conditions of a real car engine. This research model uses Research and Development, which includes the stages: problem analysis, seeking information, designing a model, validating the design, evaluating the model, testing the model, revising the model, wider testing, finalizing the design. The results obtained are the creation of an AC simulator that has been validated by experts in terms of media and material in the very feasible category, then from the user side with 25 respondents giving a value in the very feasible category for use in learning. The increase in competency occurred by 23.90% with a comparison of the pretest value with the posttest value.

How to cite:
Hidayat, N., Ambiyar , A., Wakhinuddin, W., Muslim, M., Purwanto, W. (2023). Design of air conditioner (AC) system simulator on cars to improve student competence. *Jurnal Inovasi Teknologi Pendidikan, 10*(1), 33-42. doi: https://doi.org/10.21831/jitp.v10i1.55758

INTRODUCTION

The air conditioning system (AC) has the function of adjusting temperature, keeping the air clean, maintaining air humidity and circulating air in the vehicle cabin. On the other hand, the use of the air conditioning system in a car aims to stabilize the temperature in the car so that the cabin conditions are comfortable for passengers and drivers. Furthermore, use also has the function of removing condensation on the windshield when it rains. The working principle of the air conditioning (AC) system in vehicles, especially cars, has several processes, namely the cooling step by reducing the amount of water vapor by going through the process of increasing the temperature and adding the amount of water vapor. However, in areas with hot air, an air conditioner (AC) is only used to lower the temperature and reduce the amount of water vapor. On the other hand, the air conditioning (AC) system also produces conditions where a person is comfortable or uses it, under all circumstances. The air conditioning (AC) system is usually

integrated with the existing car control system, which already uses sensors and systems based on electronic systems and utilizes computer control which is commonly referred to as ECU control and Air Conditioning System (Arif et al., 2017).

The results of research on making air conditioner (AC) simulators for cars can increase motivation in learning practicum (Suranegara et al., 2014). From research, information was obtained that learning achievement using simulators had good learning outcomes compared to learning outcomes using only modules (Syahyuniar et al., 2018). Development of an air conditioner (AC) simulator regarding damage analysis to the electrical system in the simulator (Hafizah, 2017). Development of an air conditioner (AC) simulator for cars with CFD (Computational Fluid Dynamics) analysis, the results obtained by simulation have almost the same value when compared to the simulator, so it is very possible for the simulator to be developed because it has the same information when the results are compared with the experiment (Kitada et al., 2000). Research has been conducted on the manufacture of a car air conditioner (AC) simulator with a straight fin condenser type which is commonly used with single-phase electric motor drives with a series circuit that only produces 2 HP of power and that can be done with a moderate rotation in this simulator, the simulator can work well and the result is that the car's AC system can work properly (Wiharsa, 2018).

The development and manufacture of a 3-phase induction motor and inverter ATV312 electric motor simulator for 3-phase motors will be better because the measurement of the COP (coefficient of performance) of the compressor rotation is between 1500rpm-2000rpm because the power generated is sufficient to operate the car's air conditioning (AC) system (Andrizal and Arif, 2017). Furthermore, it is also easier to operate and understand the concept and calculation of the COP (Coefficient of Performance) because it is equipped with a pressure gauge and thermocouple for every change in refrigerant temperature and pressure which will be developed digitally.

Learning in tertiary institutions is an organization that develops knowledge including cognitive, affective, and psychomotor aspects. In cognitive learning, such as learning based on technology and technological capabilities, this must be synchronized with the industry, which is better known as link and match, so that learning is in line with industry needs (Siregar and Simatupang, 2020).

At this time learning is not running as it should and seems to be ignored and only provides conventional learning. The implementation of learning which is mostly carried out in educational institutions still uses a lot of learning methods with lectures or demonstrations which are then carried out with practical implementation in workshops or workshops. Limitations of learning media, especially in practical learning, are the main obstacles in achieving learning objectives, especially simulator media in learning. Other obstacles in learning are the occurrence of misconceptions about the working principle of the air conditioning system in cars which makes learning objectives difficult to achieve.

Air conditioning technology course, hereinafter abbreviated as TPU, is a compulsory subject for students of the Department of Automotive Engineering, Faculty of Engineering, Padang State University with a load of 2 practical credits and 1 theoretical credit. Air Conditioning Technology is a course that covers learning and skills including: about cooling steps, psychrometric diagrams, COP (coefficient of performance), refrigerant, components and parts contained in a vehicle's air conditioner (AC) also includes periodic maintenance, inspection of components, steps to repair and testing of the air conditioner (UNP, 2017).

This course consists of two methods, namely in theory 1 credit (50 minutes) and in practice 2 credits (200 minutes). During the theory lectures there were no serious obstacles to be encountered because for theory the facilities and infrastructure were sufficient. On the other hand, in practice, there are many obstacles encountered, especially in the equipment for TPU practice, which is very minimal. The condition of the practical equipment for TPU is not in good condition because the practical training for TPU is combined with the Automotive Electronics Electrical Practice (LEO) in one engine stand. The use of this engine stand alternates with different lecture semesters. If the engine stand is used in the LEO recovery, then it is certain that the AC system will be damaged or cannot be used directly during lectures or must be repaired again so that the air conditioning (AC) system can work. Conditions like this take quite a long time on average 60 minutes. Another

problem is that the installed air conditioner (AC) system uses a car engine that is old and difficult to start and barely even starts. If the engine cannot be turned on, it is certain that lectures cannot be continued with the main material because time is taken up to repair the car engine (Hidayat et al., 2017).

The level of understanding considered complete by students can be seen from the achievement of learning objectives, including skills in carrying out practical learning activities. Practice must be carried out on an ongoing basis and can result in comprehensive motor skills. Students can practice by carrying out activities that lead to learning objectives that can make their skills develop and carry out activities in the form of demonstrations and simulations. Implementation of practical activities gives opportunities to students to be better and more effective in carrying out learning activities. In addition to maximizing learning activities that are carried out practically, there are several stages, namely the preparatory steps in practical activities, then the implementation of the practice itself.

Figure 1. The condition of the air conditioner (AC) practicum equipment which was heavily damaged and produced pollution during practical activities

From the problems described above, to see the changes that occur in the car air conditioner (AC) system to increase its efficiency in implementing learning both in terms of competence achievements and in the operation of the air conditioning system, it is necessary to develop a car air conditioner (AC) simulator separately from the car engine to make it easier to understand the concept and how the air conditioner (AC) works.

To drive the compressor in the AC air conditioner system, it is assisted by using an electric motor with an inverter which is easier to operate and easier to maintain. The development of this simulator can help students understand concepts and achieve competency in learning car air conditioning (AC) systems in Air Conditioning Technology (TPU) lectures.

METHOD

In this study using the research and development method, namely research with development. Development research is a process that can be used to develop and validate a product produced in the field of education in accordance with the study (Borg and Gall, 1983). Development research is a process that can be used to develop and validate a product produced in the field of education in accordance with the study (Borg and Gall, 1983). Research implementation is fundamental in research preparation including determining the results of the research to be carried out, designing research implementation procedures, preparing supporting materials such as materials and materials in the implementation of lectures and preparing subject matter related to media and semester learning plans. The stages carried out are: (1) preparing the design of the air conditioner (AC) simulator, by studying the basic principles of the air conditioner (AC) system, to develop including manufacturing plans, assembling from the simulator and the learning model to be used; (2) validating the air conditioner (AC) simulator, validating it by media experts, then validating the testing of the tool by testing it from the perspective of the workings and working principles of the air conditioner (AC), and testing the use of the AC simulator in learning or in the field.

Experts who will be involved in this validation test are: experts in charge of the teaching and learning process, experts in charge of the working principles of air conditioners (AC). The implementation carried out by experts is by carrying out model focused group discussion (FGD) activities. In this study, the object to be studied is the air conditioner (AC) simulator and the model in a learning approach that can be designed and implemented when learning about air conditioners (AC). Namely attitude at work, performance, which is guided by the criteria in learning Air Conditioning Technology Data collection in this study, used measuring instruments including: distribution of questionnaires, interview sheets, and observation sheets.

Data analysis techniques used are qualitative and quantitative. For quantitative, it comes from a questionnaire about whether the resulting simulator is feasible or not, based on the opinions of experts and students. The formula used to calculate the average value is:

$$\bar{x} = 1/n\ (x1+x2+\cdots+xn) \quad (1)$$

Description:

$\bar{x}$ = Average value
xi = the value of the i sample
n = number of samples

From the average value obtained from the instrument then interpreted. From the interpretation of the data, it can be determined the level of failure of the AC simulator that has been made which can be seen in table 1 which is an interpretation of quantitative to qualitative data (Mardapi, 2017).

Table 1. Eligibility categories

No	Score	Eligibility Category
1	$x \geq \bar{x} + 1.SB_x$	Very worth it
2	$x \geq \bar{x} + 1.SB_x > x \geq \bar{x}$	worthy
3	$\bar{x} > x \geq \bar{x} - 1.SB_x$	Not feasible
4	$x < \bar{x} - 1.SB_x$	Very unworthy

Description:

$\bar{x}$ = Average overall score in one class = (1/2). (Maximum score + Minimum score)
SB_x = Standard deviation of the overall score in one class = (1/6) .(Maximum score - Minimum score)
x = score achieved (Mardapi, 2017)

RESULTS AND DISCUSSION

Result

Based on the targets and steps in the research, there are several steps that must be taken, namely the first step is to design a simulator by making a frame design and layout and the position of placing components that are right and proportional (Aditya, 2020). The second step is to proceed to the process of preparing materials and making simulators that refer to the learning objectives and competencies that must be achieved after learning. After making it, it is continued with designing learning which includes modules and usage procedures and steps in learning.

The design of the air conditioner (AC) simulator, has dimensions of Length x Width x Height which is 0.8 m x 1.2 m x 1.2 m using hollow steel 40mm x 40mm with a thickness of 2mm as the main frame. And supported by hollow iron 20mm x 20mm 1.2mm thick as a supporting bone. Place for mounting components using 5mm thick acrylic. The design looks like in Figure 2.

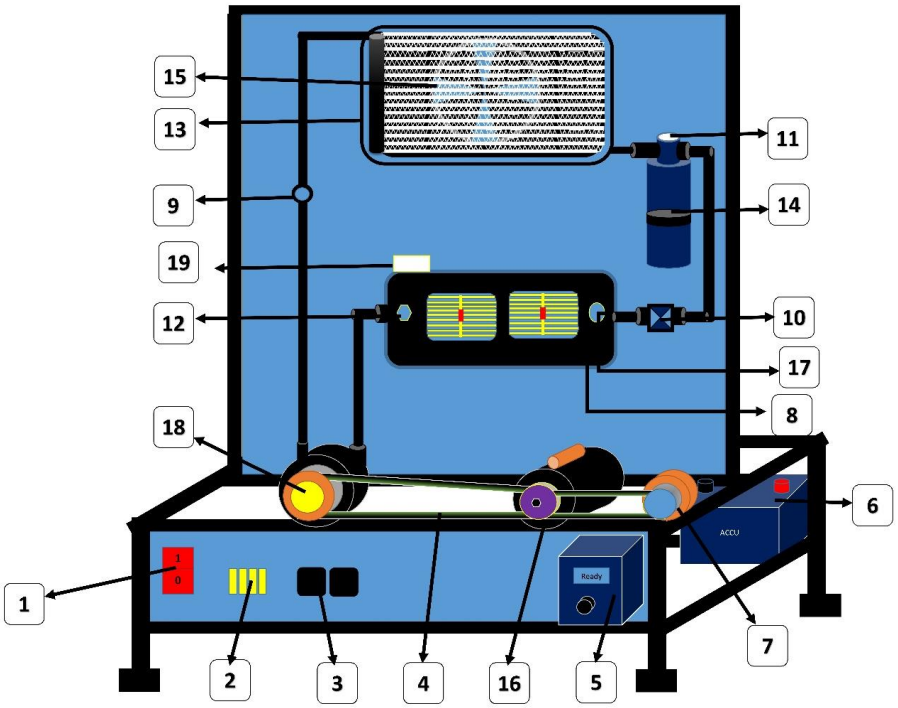

Figure 2. Design of an air conditioner (AC) simulator with an electric motor drive Information

Explanation of the components of these products can be reviewed in Table 2 which displays the component names, specifications, and quantities. The embodiment of this product design can be seen in Figure 3.

Table 2. Specifications for the components of the air conditioner simulator (AC).

No	Component name	Specifications	Amount
1	*Main switch*	5 terminals	1
2	*Fuse*	20 Amperes	4
3	*Relays*	4 feet	4
4	V-belts	Type B	2
5	*inverters*	*ATV312HU22N4*	1
6	Step down transformers	12V 45 Amperes	1
7	evaporators	Pipe and fin type	1
8	*Dual pressure switches*	Minimum 1.5 kg/cm ^{2} - Max 15 kg/cm ^{2}	1
9	*expansion valve*	*thermostatic expansion valve*	1
10	Lookout glass	*Transparent glass*	1
11	blower switch	5 terminals	1
12	Condenser	*straight fin flat tube*	1
13	*Receiver drier*	*Dryer type*	1
14	Cooling fan	*Electric dynamo*	1
15	*Electric motors*	*Three-phase induction motor 3 HP/2.2Kw*	1
16	*Thermostats*	Mechanical models	1
17	AC compressor	*Wobble plates*	1
18	blower resistance	prisoner	1

Figure 3. Ready-to-install simulator support frame and simulator

The feasibility value of the media seen from the appearance and how to use the media. The results can be seen in Table 3.

Table 3. Results Validation Media Aspect

No.	Respondents	Score	Category
1.	Validators 1	39	Very Worthy
2.	Validators 2	37	Very Worthy
3.	Validators 3	38	Very Worthy
Average Score		38	Very Worthy

From table 2 for the scores given by experts, an average score is obtained with a value of 38. The average value is x≥30, which means it is included in the very feasible category. For more details, we can see in the form of a diagram in Figure 4.

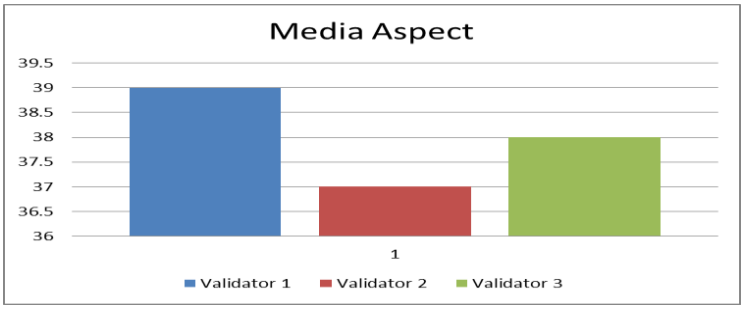

Figure 4. Value validation by media experts

For the feasibility value seen from the material side, namely the compatibility between the media and the material taught in learning Air Conditioning Technology can be seen in Table 4.

Table 4. Results Validation Aspect Material

No.	Respondents	Score	Category
1.	Validators 1	37	Very Worthy
2.	Validators 2	38	Very Worthy
3.	Validators 3	39	Very Worthy
Average Score		38	Very Worthy

In table 3 the values given by the testers obtained an average value of 38. This value is in the range x≥33, so the level of feasibility is in the very decent category. For more details can be seen in the diagram in Figure 5.

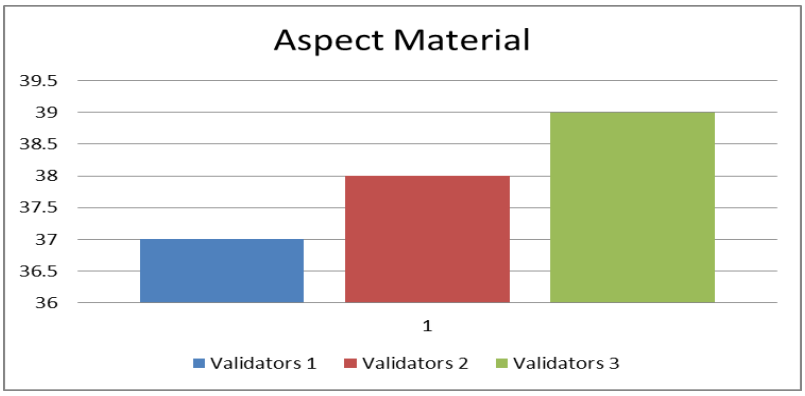

Figure 5. Value validation by material experts

For the feasibility value obtained from users which is based on the contribution of the media in helping to achieve learning objectives and understanding of material from the Air Conditioning Technology course with 23 respondents can be seen in Table 5.

Table 5. Results Validation Aspect Material

Respondents	Score	Category
1	31	Very Worthy
2	36	Very Worthy
3	32	Very Worthy
4	34	Very Worthy
5	36	Very Worthy
6	37	Very Worthy
7	35	Very Worthy
8	35	Very Worthy
9	36	Very Worthy
10	34	Very Worthy
11	38	Very Worthy
12	37	Very Worthy
13	34	Very Worthy
14	36	Very Worthy
15	32	Very Worthy
16	34	Very Worthy
17	34	Very Worthy
18	31	Very Worthy
19	34	Very Worthy
20	36	Very Worthy
21	30	Very Worthy
22	34	Very Worthy
23	32	Very Worthy
Average Score	34.26	Very Worthy

From Table 5 the values obtained from users with an average of 34.26, this value is included in the range of scores x ≥ 30 with a feasibility value from the media side and helps in learning in the very feasible category, to be more clearly displayed in the form of a diagram in the Figure 6.

From media validation data and material from both experts and users in line with the increase in student competence after learning using a media simulator, this is evidenced by learning outcomes compared between pretest and posttest. Overall, students experienced an increase in competence from 23 respondents.

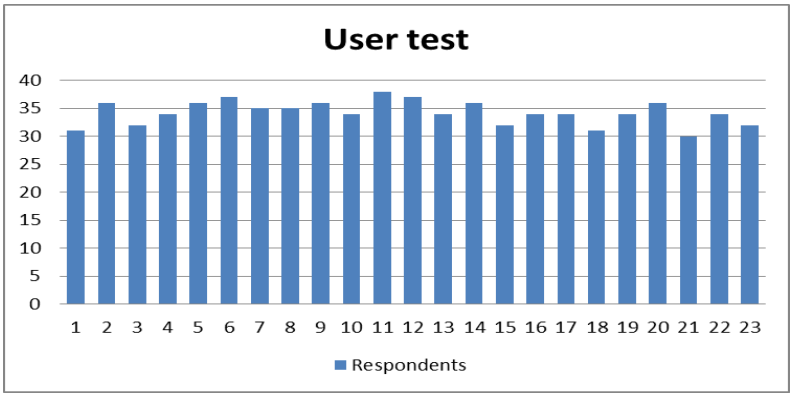

Figure 6. Validation value by media and material users

There is an increase in the value of learning in the Air Conditioning Technology course from the pretest score when compared to the posttest score. The average pretest score of 63.35 increases to 83.09 or if in percentage, which is with a value of 23.90%, this result proves that he use of media simulators can improve student competence well in the Air Conditioning Engineering course.

Discussion

The use of simulators in the implementation of learning in Air Conditioning Technology courses has been properly and carefully reviewed and assessed. Furthermore, the level of effectiveness in learning activities obtained increases rapidly and significantly. From making and using this simulator in learning, it can increase the competence of students when doing practical learning (Jiantoro, 2014).

Steps in improving so that learning objectives are achieved by using the right simulator and having compatibility with the components in the real car or vehicle. The simulator is a medium and is also a determinant of achieving learning objectives properly and maximally. Simulator is a media that has very important elements, namely physical hardware and non-physical software, namely learning modules and job sheets and the hardware is an air conditioner (AC) simulator. The air conditioner (AC) simulator is one of the learning media that is used to speed up and make it easier for students to understand and master competence.

On the other hand, simulators are designed with the aim of achieving the same learning objectives and according to standards, then active and participatory learning and better efficiency of learning duration. The level of effectiveness in using media in learning cannot be separated from how to plan the steps in its use. Some of the things that should be of concern are among them the objectives of learning the state of the student and the tools that support these activities as well as the time allotted for the activity and the ability of the teacher to provide understanding and information. In this case, using a simulator is expected to fulfill all these requirements. Then the simulator is designed and developed regularly and structured so that it can solve problems in learning. The making of the simulator in this study has a scope that refers to compulsory courses concerning the development of mandatory competencies for a student.

So the development of this simulator is in accordance with the actual conditions contained in the car, both in terms of how it works, principles, components and problem solving in the air conditioner (AC) system. a product that has exactly the same conditions as the realistic and interactive original. In education, simulators are media that are used in learning whose concepts and forms have quite large similarities in theory and practice learning. The simulator is also a unit that has a resemblance to the original object both in terms of dimensions and size as well as in its function in a system (Nasrullah and Illahi, 2020).

The making and designing of this simulator is the main attraction for students, where the existence of a simulator makes students more interested and easier to understand the concept and workings of a fairly complex air conditioner (AC) system. Furthermore, in learning the lecturer acts as a companion and only directs and students can gather information from teaching modules and job sheets that have been adapted to the learning topic. In learning, learning-oriented simulators can

be applied which can develop abilities in skills, factual skills that are in accordance with reality, then learning based on concepts. In developing learning, air conditioning technology by utilizing simulators can improve 4 competency elements, namely: (1) factual knowledge; (2) conceptual knowledge; (3) procedural knowledge; and (4) metacognitive knowledge (Kalay, 2015). Factual knowledge is basic knowledge that is utilized in knowing and understanding basic knowledge. Knowledge can be signs, symbols that have a relationship with real and concrete learning, which can provide the necessary information. Conceptual knowledge, including competencies that lead to correlations between components and other components in broader and more complex terms. Procedural knowledge, including about how to understand how to do something, can be approached with inquiry that is developing skills. Metacognitive knowledge is knowledge related to competence and cognitive knowledge in a broad sense and the ability to understand one (Andrizal et al., 2020). The learning model developed should be related to living conditions related to the world of work and the industrial world as well as the characteristic conditions of life in society which can assist in forming professional competencies as teaching staff in secondary schools according to their respective majors. Furthermore, the development of an air conditioner (AC) simulator can also avoid misconceptions from students in learning Air Conditioning Technology in the future and so on.

CONCLUSION

After carrying out the development, design and manufacture of the air conditioner (AC) simulator, several things can be concluded, namely the manufacture of the simulator has a very feasible category from media experts in terms of media design and also has a very decent value. From users giving value to material aspects, it gives a very decent rating. To increase the value of competence can be seen in the pretest and posttest scores there is a significant increase in value. For further development, several things are of concern, namely the installation of component positions and how components work because several components must be installed neatly and systematically according to how they work so that it makes it easier for students to understand learning concepts related to air conditioning (AC) systems. For further developments that can be developed is in the form of digital instruments in understanding and diagnosing damage so that learning is not only an increase in competence about air conditioners (AC) but also an understanding of the use of tools in maintenance and repair of AC systems that are better and newest.

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Jurnal Inovasi Teknologi Pendidikan
Volume 10, No. 1, March 2023 (43-54)
Online: http://journal.uny.ac.id/index.php/jitp

Effectiveness of blended learning implementation for algorithm and programming course

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ARTICLE INFO

Article History
Received:
19 December 2022;
Revised:
2 February 2023;
Accepted:
28 February 2023
Available online:
09 March 2023.

Keywords
Algorithm and programming; blended learning; classroom action research

ABSTRACT

Algorithm and programming is a prerequisite course at the beginning of the semester, which not only requires an understanding of the basic concepts but also how these concepts can be implemented using a programming language. However, 72% of students have never studied programming at all. This is a challenge for teachers to be able to achieve learning objectives. This study aims to describe the learning design using the Blended Learning model so that its effectiveness can be measured in increasing student understanding in algorithms and programming courses. This research is Classroom Action Research (CAR) with a one-group pre-test post-test design for seven cycles implementing Blended Learning. Through the Wilcoxon Signed Rank test, it was found that there is an average of 92% increase in student understanding from the pre-test to the post-test. Therefore, the application of Blended Learning needs to be done and provides mature readiness for students during face-to-face meetings and teachers can evaluate learning outcomes more quickly and determine the direction of further learning actions.

How to cite:
Yuricha, Phan, I. K. (2023). Effectiveness of blended lerning implementation for algorithm and programming course. *Jurnal Inovasi Teknologi Pendidikan*, 10(1), 43-54. doi: https://doi.org/10.21831/jitp.v10i1.54707

INTRODUCTION

Algorithm and Programming is one of the prerequisite courses in universities. This course has many names, but all have roughly the same content: introducing basic programming. Students are challenged to understand fundamental theories and concepts while simultaneously being able to apply them using a programming language (Lahtinen et al., 2005). The understanding and programming skills gained from this course become the foundation for advanced programming courses in the following semesters.

A good understanding of the Algorithm and Programming course can be a solid foundation in completing around 20-30 percent of the courses related to programming (Dicoding Internal, 2020). Conversely, a lousy understanding can cause a prolonged domino effect on students. One possible result of this domino effect is the delay in student graduation (Agwil et al., 2020). This happens because the prerequisite courses did not reach the target, so students could not take the next course and needed another year to retake the course. The timeliness of graduation is an indicator of assessment and accreditation in tertiary institutions (Widarto, 2017).

Many fundamental theories and concepts in programming are associated with problem-solving skills and an understanding of the mathematical logic (Derus & Ali, 2012). Found that students tend to understand written theories and concepts faster but slower when these theories and ideas have to be implemented into a programming language (Demaidi et al., 2019). So this is not only a challenge for students but also for the lecturers of these courses (Barroso et al., 2018). In the era of student-centered education, the way lecturers orchestrate learning is the key to student success in achieving learning goals which are also contained in learning designs (Shohib, 2018). One approach that can be applied to learning is Blended Learning (Cronje, 2020).

The application of Blended Learning allows learning through face-to-face meetings and the internet as a media (Budiningsih et al., 2019). Several advantages are obtained from this application, such as ease of accessing learning materials, improvement of the quality of learning, and saving on knowledge costs (Stein & Graham, 2014). With a combination of education using the internet as a media, students can access materials and instructions from lecturers from anywhere and anytime (Beaver et al., 2015). Lecturers can also take advantage of this application by enriching students' knowledge and experience in basic programming.

Several previous studies using the Blended Learning approach in Algorithm and Programming courses, such as those carried out by (Bibi & Jati, 2015), showed that the average increase in understanding of students taking these courses was 30.288. This study also showed an increase in student learning motivation by an average of 11.705. The research focuses on comparing conventional learning and learning by applying Blended Learning. The research needs to focus on the learning design and the Blended Learning model used in teaching. Implementing Blended Learning has an essential role in learning because it combines face-to-face and online learning and several learning techniques, learning media, technology, and modes of delivery offline and online (Tang, 2013).

The Blended Learning approach is also applied (Jusuf, 2017) in the Algorithm and Programming course by utilizing games on the www.code.org website. 46% of respondents who take the approach consider learning more varied and preferred. In addition, this model is also liked by as many as 35% of respondents, which is directly proportional to the increase in students' motivation to learn to program. This research does not describe the division between online and face-to-face learning structures and only focuses on how online activities are carried out. A good and balanced learning structure between face-to-face and online learning and how to divide portions between theoretical material and practical material (Demaidi et al., 2019) are essential for lecturers to pay attention to in programming courses.

Described how the learning design implements Blended Learning by dividing online and face-to-face learning structures in programming courses (Zhang & Cui, 2021). The research only focuses on the K-12 level, namely the elementary to high school / vocational school, not the undergraduate level. The learning design also uses scratch at www.code.org, focusing on training computational thinking skills. This will be different if it is applied to undergraduate students. Students are not only required to think computationally (Computational Thinking). Still, they can also apply it using a programming language, which can later form simple programs that solve problems (Hawa et al., 2022).

At the undergraduate level, students must also play an active role in learning independently (Fitriasari et al., 2018; Hendrik et al., 2021). Blended learning is proven to form student independence in learning as long as it is mixed in such a way that students are accustomed to independent learning (Diana et al., 2020). This discipline can also train students from the beginning of the semester as a provision for learning in the following semester's (Bati et al., 2015).

One of the Blended Learning approach models that can be applied is the Flipped Classroom (Muzyka & Luker, 2016a). Implemented Flipped Classroom in programming subjects and showed an increase in students' average scores from 58.8 to 82.75 after this implementation (Zakhia & Dermawan, 2021). Likewise, with research conducted by (Muzyka & Luker, 2016b), the application of Flipped Classroom allows students to access material before and outside class so that during face-to-face meetings, students can discuss and get a more detailed explanation of the theories and concepts involved. To be conveyed by the lecturer.

Learning design also needs to consider students' backgrounds and programming experience (Aleksić & Ivanović, 2013). Early-semester students taking Algorithm and Programming courses often experience difficulties in terms of familiarity with computers, using compilers, and writing specific program code (Demaidi et al., 2019). These three things can also factor in student failure in achieving the objectives of the Algorithm and Programming course. Appropriate learning orchestration can minimize student failure, especially in subjects that require practice (Krpan et al., 2014; Mukhidin et al., 2019).

Based on the description above, this study focuses on learning design by implementing Blended Learning to improve the understanding of undergraduate-level students in Algorithms and Programming courses and calculate its effectiveness.

METHOD

The author conducts Classroom Action Research which is quantitative, by calculating the effectiveness of the application of Blended Learning. Classroom action research is a model that forms a cycle of planning, action, observation, and reflection (Adelman, 1993). This research raises the problem of improving student understanding in Algorithm and Programming courses by applying Blended Learning to learning designs. This research is a pre-experimental rearch involving only one group, namely the experimental group using the One Group Pre-test and Post-test Design t o determine the effect of applying blended learning on learning design and measure its effectiveness. This classroom action research focuses on learning design using Blended Learning which calculates the effectiveness at the end of all class action cycles. One cycle is carried out for one week, where the action is carried out at one meeting. This study collected data for seven weeks, thus producing 7 seven cycles from 22 July 2022 to 6 October 2022, as shown in Figure 1.

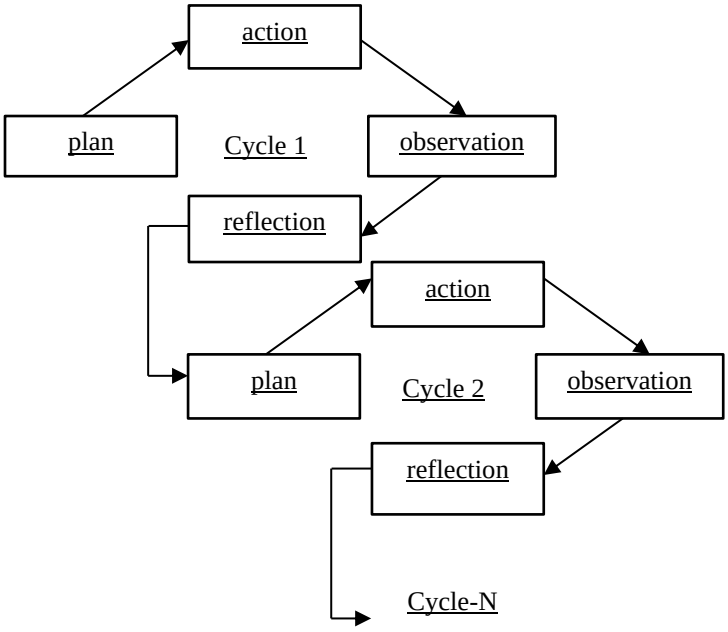

Figure 1. Classroom Action Research Model (Adelman, 1993)

Figure 1 shows that the cycle begins with the planning stage, where the author prepares a lesson plan appropriate for the material, including the application of Blended Learning. After that, proceed with the stages of action. Action stages are carried out through Google Classroom and during face-to-face learning. Then proceed with the observation stage after conducting online and face-to-face activities and end with the reflection stage. The reflection stage will determine the plan's steps in the next cycle up to the seventh cycle.

Respondent

The respondents of this study were active semester one student at the Sabda Setia Institute of Technology and Business. The number of respondents in this research was 76 students who took the Algorithm and Programming course as a prerequisite course. The courses consist of three Semester Credit Units, divided into two credits for face-to-face meetings and one credit for online sessions via Google Classroom.

Data Collection

Data collection was carried out by giving pre-tests and post-tests to respondents in each cycle. The pre-test is carried out at the beginning of the action section, while the post-test is carried out in the reflection section. The pre-test and post-test were given in the form of a survey form with a 5-point Likert scale filled in by students before (pre-test) and after face-to-face meetings (post-test). The survey form provided is a one-time filling that also collects the personal email of the respondent. All answers are analyzed per cycle, and their effectiveness is calculated.

The pre-test describes students' abilities before offline learning while the post-test describes students' abilities after offline learning with the following formula.

$$O1 \times O2 \quad (1)$$

Explanation:
O1 : pre-test value
X : blended learning application
O2 : post-test value

Learning Design

The Blended Learning approach moderates the learning session using Google Classroom (GC). Every student has a campus email account to access Google Classroom via their mobile or desktop computer. Each student has also joined the same class according to the division of classes on campus so that moderation is carried out per class. The mapping of the Algorithm and Programming material taught for seven meetings/cycles is shown in Table 1.

Table 1. Algorithm and Programming Material Mapping

Meeting	Material
1	Algorithm Basic Definitions and Concepts
2	Data Types, Variables, Constants, and Data Values
3	C# Language Scope – Part 1
4	C# Language Scope – Part 2
5	The Basic Structure of the Branching Algorithms
6	The Basic Structure of Looping Algorithms
7	The Function Paradigm

All these meetings used the C# programming language as a supporting tool in applying programming theories and concepts. Students can choose any compiler to run the C# programming language, such as Visual C#, Visual Studio Code, and online compilers on the internet.

In Table 1, the material for meetings one to three contains more theoretical material, while the rest requires practice. At meeting three, fundamental theories and concepts regarding the scope of C# were thoroughly discussed so that the direct approach could be carried out at meeting four. At meeting 4 (four), students were introduced to compilers and allowed to try directly using the C# programming language code.

The application of Blended Learning carried out in this study starts from the first to the seventh cycle. There are several Blended Learning models; one of then this study is the Flipped Classroom. Flipped Classroom is a learning model that first provides material for students to study before face-to-face learning is given (Hung et al., 2020). Flipped Classroom has three stages: before learning (pre-learning), during, and after learning (post). These three stages are connected with the

settings classroom activities. The Flipped Classroom model is carried out in D-1 meetings and requires students to access these materials. The Flipped Classroom model is connected to the class action, as shown in Table 2.

Table 2. The Relationship between Flipped Classroom and Classroom Action

Flipped Classroom Stage	Classroom Action Stage	Activity
Before learning	Action	Provision of Materials/Modules through GC
During Learning	Action	Apperception
During Learning	Action	Pretest
During Learning	Action	Review
During Learning	Observation	Code Practice
During Learning	Observation	Quiz (if it exist)
During Learning	Observation	Learning Conclusion
After Learning	Reflection	Posttest
After Learning	Reflection	Task (if it exist)

The class action stage begins with the planning stage of learning. In the first cycle, this stage begins with making a lesson plan and asking students to fill out a survey form regarding their educational background and programming experience. In the second cycle and so on, the stages of the plan are prepared based on the reflection results in the previous process.

At this stage, the action begins by providing material on the D-1 meeting through Google Classroom (Figure 2) in the form of a pdf module from the author, which contains (1) Material Title, (2) Course Learning Achievement, (3) learning indicators to be achieved, (4) elaboration of material points, (5) video/online course links as supporting materials, (6) programming code exercises, (7) conclusions, (8) references.

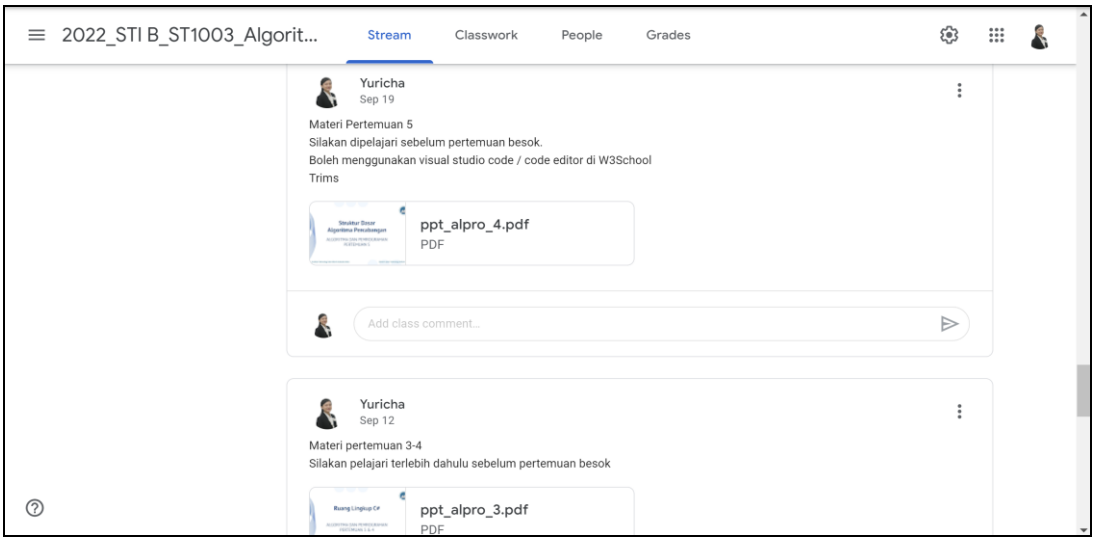

Figure 2. Google Classroom Post Thread Page View

Students must have accessed the pdf module before lectures to implement Blended Learning. The video/online course link as supporting material is adapted to the material by mapping the material. The online course link provided is a course that contains material (C# Tutorial), examples of coding/program code (C# Examples), online compilers (C# Compiler), exercises (C# Exercises), and quizzes (C# Quiz) at www.w3schools.com such as in Figure 3.

On the day of the meeting, students are given several activities in the action stages, such as (1) apperception, (2) pretest, (3) review of the given module and focus on discussion on material that students find difficult, (4) question and answer and (5) lecture. Then proceed with the observation stage by providing (1) programming code exercises by providing examples other than those in the

module as part of the observation stage, (2) giving quizzes (if any), (3) providing learning conclusions, and finally doing (1) posttest and (2) assignment (if any) as part of the reflection stage.

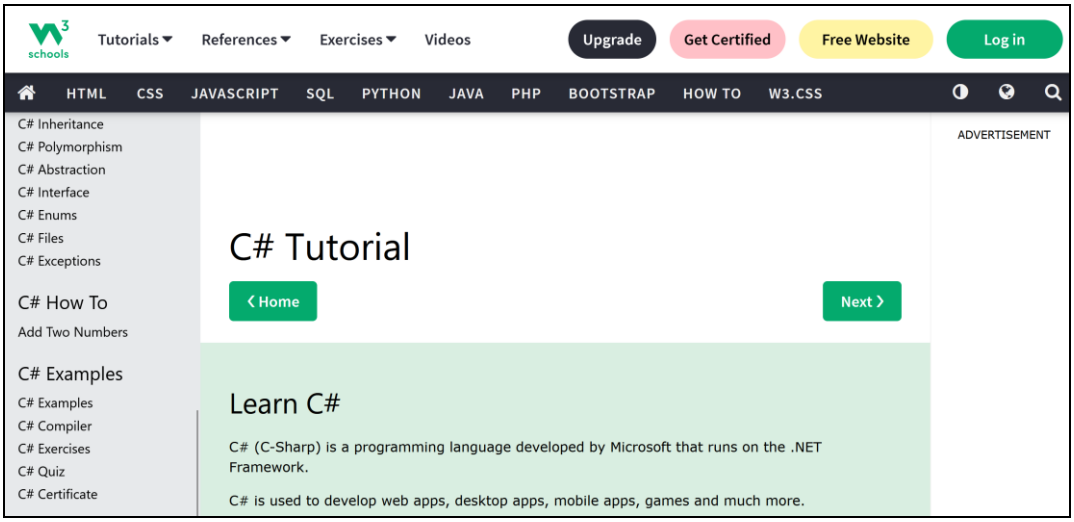

Figure 3. C# Tutorial On www.w3schools.com

Data analysis was carried out using the Wilcoxon Signed Rank test on pre-test (O1) and post-test (O2) data in each cycle, with the output interpretation which was divided into three, namely Negative Ranks (to see if there was a decrease in value from pre-test to post-test), Positive Ranks (to see the number of respondents who have increased in value along with the average increase) and Ties (to see if there are respondents who have not changed in value). Through the Wilcoxon test, if the statistical test results with Asymp.Sig. (2-tailed) have a value of more than 0.05, it can be concluded that the application of blended learning in learning design has an influence.

RESULT AND DISCUSSION

Result

In the first cycle, the authors collected some data, such as the respondents' educational background or high school origin, as shown in Figure 4. This data is needed in learning design, especially when emphasizing technical matters in learning.

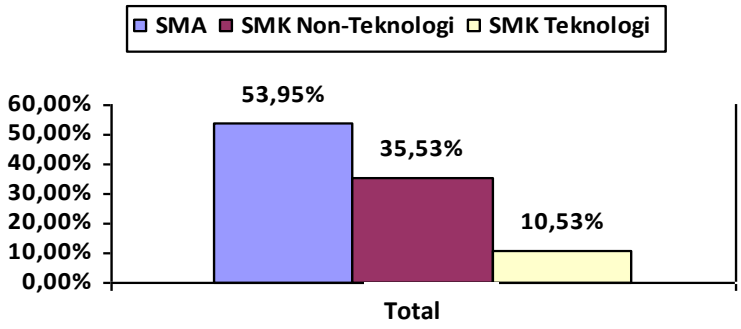

Figure 4. Educational Background

Figure 4 shows that most respondents came from Non-Technology Senior High Schools (SMA) and Vocational High Schools (such as accounting and marketing) that did not study programming in depth. Meanwhile, Technology Vocational Schools (such as Computer and Network Engineering, Software Engineering, and Multimedia) have at least one subject that discusses programming. From these data, it can be concluded that only 10.53% are familiar with programming.

The author also collects data about respondents' experience learning programming before this lecture or before the first meeting material is given in Figure 5.

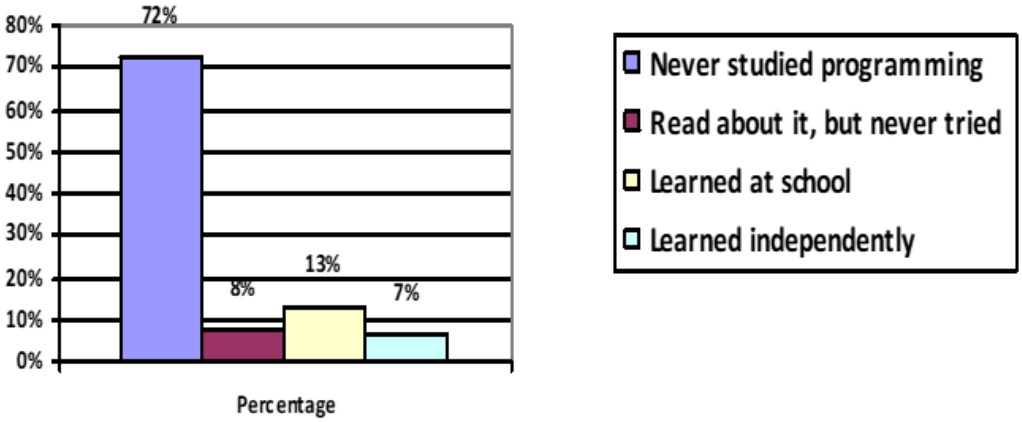

Figure 5. Experience in Learning Programming Before Lecture

Figure 5 shows the next exciting thing: out of the 76 respondents, 72% admitted that they had never studied programming, and 8% had only read about programming but never put it into practice. 80% of new respondents will practice programming for the first time. This fact is a challenge for the author, how learning design should be able to provide understanding as well as proper practice. 13% of respondents studied in schools (both through one subject and from extracurriculars), and 7% of respondents learned programming independently (self-blend).

Furthermore, data were collected from respondents who had studied programming before lectures at school and on their own, regarding the percentage of data from respondents who had studied the C# programming language, as shown in Figure 6. 60% of them had studied C# programming. In contrast, the others had never (learned another programming language besides C#).

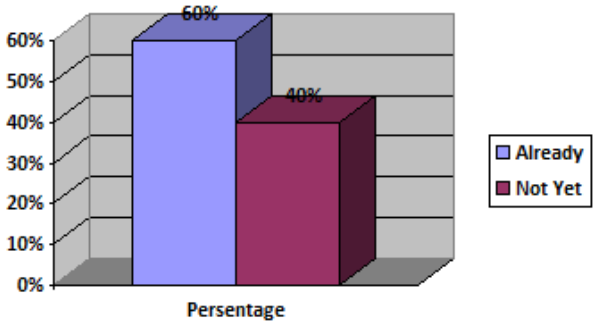

Figure 6. Percentage of Students Who Have Learned Programming in C#

Figure 6 shows that in all the data collected above, the authors realize that this is one of the challenges that need to be addressed and how the existing learning design can provide a good understanding of algorithms and programming, such as emphasizing programming logic and computational thinking. Students are given lectures and examples of cases that involve problems. In addition, the supporting material provided is accessible for students to try, namely, using an online compiler.

In the learning design using Blended Learning, moderation is needed to be able to provide instructions to students. The author also collects data regarding how respondents access video materials and learning links. These data show that the respondents are divided into two: access via a smartphone and a laptop or desktop computer, as shown in Figure 7.

The module provided is a pdf, and the video material is a YouTube link to online courses with a responsive display, allowing students to access the material using a smartphone. 73.68% of respondents admitted that accessing these materials using a laptop or desktop is better. 26.32% of them admitted that they did not have a laptop or desktop computer or saw the ease of accessing material using only a smartphone.

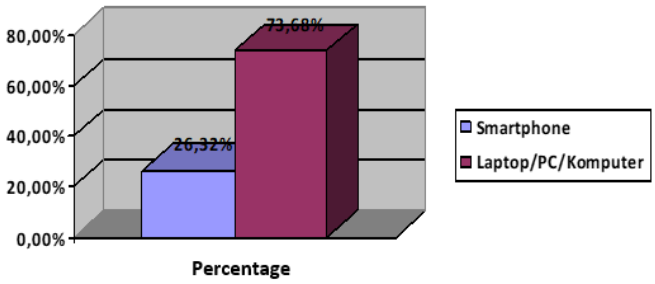

Figure 7. Graph of Devices Used to Access the Learning Material

Then the author also took data from respondents who had accessed video material and online course links and obtained data on what respondents did after getting the link through Google Classroom, which can be seen in Figure 8.

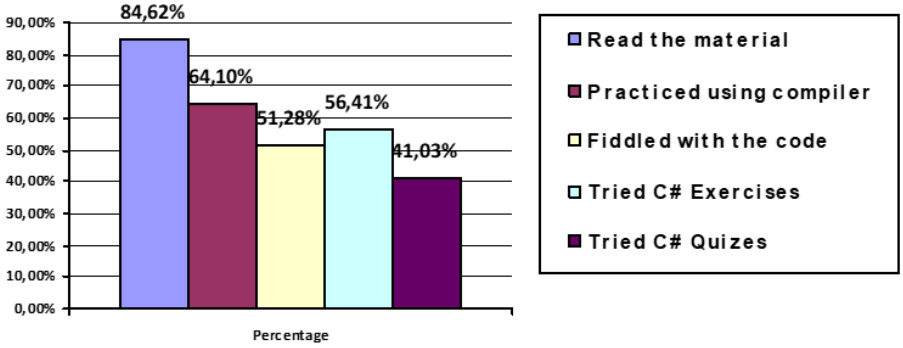

Figure 8. Student Activities in Online Courses

From the data in Figure 8, only 84.62% read the material provided, while 15.38% did not. As many as 64.10% had practiced the material using the compiler, meaning that the rest did not try to practice programming material directly using the existing compiler, so they did not also see the output produced. Furthermore, 51.28% fiddled with the coding examples to get different outcomes so that students could study other inputs for different results and see which writing structures could be changed. Practical material is contained within the compiler section, so if the students did not try it, they were considered to have not practiced the material provided before face-to-face learning. The statistical data on the pre-test and post-test results can be seen in Table 3.

Table 3. Pre-test and post-test statistical data for 76 respondents

Label	Mean	Std. Deviation	Minimum	Maximum
Pre-test 1	.475	1.0557	.0	4.3
Post-test 1	2.862	.7519	1.0	5.0
Pre-test 2	2.554	.4706	1.5	3.5
Post-test 2	4.021	.3492	3.0	4.8
Pre-test 3	2.591	.6567	1.0	4.0
Post-test 3	3.674	.5546	2.0	5.0
Pre-test 4	2.713	.7267	1.0	4.5
Post-test 4	3.838	.6046	2.0	5.0
Pre-test 5	2.905	.5041	1.3	4.3
Post-test 5	3.524	.5501	2.3	4.5
Pre-test 6	2.487	.5772	1.3	3.8
Post-test 6	3.407	.6367	2.0	5.0
Pre-test 7	3.111	.5977	2.0	4.5
Post-test 7	4.011	.5505	3.0	5.0

Discussion

On each cycle at each weekly meeting, data of pre-test and post-test tested using Wilcoxon is collected as part of the reflection stage to evaluate whether the cycle needs to be repeated or not.

The Wilcoxon Signed Rank test uses SPSS v22. The results of the comparison using Wilcoxon shows that there was an increase from the pre-test results to the post-test results for each cycle as shown in Table 4.

Table 4. Results of Pre-test and Post-test using Wilcoxon in 7 Cycles

Cycle	Negative Rank			Positive Rank			Ties
	N	Mean	Sum	N	Mean	Sum	
1	0	.00	.00	75	38.00	2850.00	1
2	0	.00	.00	76	38.50	2926.00	0
3	1	8.50	8.50	72	37.42	2694.50	3
4	1	.00	.00	72	37.40	2692.50	3
5	0	.00	.00	66	33.50	2211.00	10
6	0	.00	.00	68	34.50	2346.00	8
7	0	.00	.00	67	34.00	2278.00	9

The test results shown in Table 4 show that of the seven cycles the lowest number of positive ranks was 66 respondents (in cycles 3 and 4) meaning 10% of the total participants. All cycles show an average of 92% positive rank. The positive rank value indicates that there has been an increase from the pre-test to the post-test. The positive rank values showed a decrease in the 5th to 7th cycles compared to the positive rank values at meetings 1-4. The fifth to seventh cycles were focused on practical/coding material. This is directly proportional to what was said by (Demaidi et al., 2019) that students would be slower to understand when theories and concepts need to be implemented in the form of a programming/coding language. This becomes homework for teachers to be able to convert the 10% to be in a positive rank.

While the negative rank of all cycles shows that only twice has the value of 1, meaning that there is only one respondent that has got a decrease in value. On the 5th to 7th meeting, less than 10% had not increased or decreased in pre-test and post-test values. It can be seen from the statistical test using the Wilcoxon test in each cycle, as shown in Table 5.

Table 5. Results of Pre-test and Post-test Statistics using Wilcoxon in 7 Cycles

Cycle	Z	Asymp. Sig. (2-tailed)
1	-7.552	.000
2	-7.587	.000
3	-7.402	.000
4	-7.389	.000
5	-7.081	.000
6	-7.179	.000
7	-7.128	.000

Table 4 shows that the Asymp. Sig. (2-tailed) which is less than 0.05, indicates an influence of applying blended learning in the learning design. The Z-score averages -7, indicating that the average value is below the pre-test's mean. The author also collects data on how students assess the application of blended learning to help them understand Algorithm and Programming course material, as shown in Figure 9.

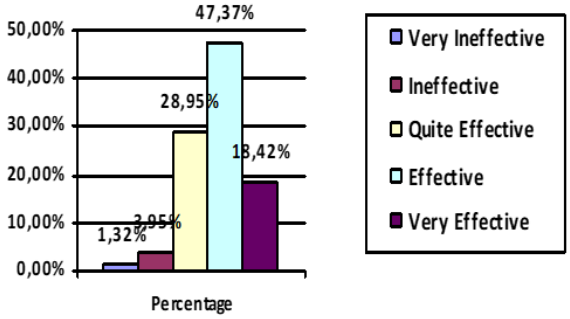

Figure 9. Student Responses to the Application of Blended Learning

Figure 9 shows that 28.95% responded that Blended Learning was quite adequate for them, 47.37% answered that it was effective, and 18.42% responded that the learning was very effective. When combined, the application of Blended Learning tends to give positive results.

CONCLUSION

From the collection and discussion results, it can be concluded that implementing Blended Learning in the Algorithm and Programming course can improve student understanding with an average positive rank of 92%. These results are considered good when viewed from the educational background and experience of learning programming owned by students and are calculated from the duration of learning, which lasts for approximately seven weeks. Further research needs to be tested more precisely, and control variables can be used to see the value of its effectiveness in greater depth. The author found that when implementing Blended Learning, which requires programming practice, students tend to avoid doing it, which impacts the effectiveness of practical/coding material. Students must be encouraged to practice the material and be open to more than just trying coding during face-to-face learning. Applying Blended Learning in Algorithms and Programming courses must be done from the results and conclusions. By combining Blended Learning and CAR, students will be more prepared to learn during face-to-face meetings and be able to explore further the material for the next meeting. Through this application, lecturers can evaluate learning outcomes more quickly and determine the direction of further learning actions.

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Jurnal Inovasi Teknologi Pendidikan
Volume 10, No. 1, March 2023 (55-63)
Online: http://journal.uny.ac.id/index.php/jitp

Research on the implementation status and improvement strategies of cloud classroom personality teaching in elementary schools

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ARTICLE INFO

Article History
Received:
19 Juli 2022;
Revised:
7 Januari 2023;
Accepted:
13 Januari 2023;
Available online:
09 Maret 2023.

Keywords
Cloud classroom;
improve learning efficiency;
personalized teaching.

ABSTRACT

Currently, the development of students' personality and the cultivation of innovative talents are regarded as an important task of education for each country, the personalized teaching has become the goal of the new curriculum reform in China. With the continuous development of cloud computing technology, network cloud platform education resources are being used more and more in the teaching process, the " personalized teaching of the cloud classroom" in primary schools has gradually become the highlight for the reform and research of the basic education in Nanjing. Since it was officially launched in 2010, Nanjing has 1380 high-quality courses in the cloud classroom, trained 775 backbone teachers, explored new teaching models, accumulated a wealth of teaching cases. At the same time, in the implementation process, it also faces many problems and challenges related to educational concept, technology and application. This study use the literature design and case study method to define the relevant conceptss in analyze the teaching. The result of this study shown that the use of cloud classroom teaching can provide teachers visual expression tools for the smooth implementation of teaching, reduce the teaching burden of teachers, and provide students with a teaching environment rich in pictures and texts, stimulate learning interest and improve learning efficiency.

How to cite:
Mao, L. X., & Leny, S. (2023). Research on the implementation status and improvement strategies of cloud classroom personality teaching in elementary schools. *Jurnal Inovasi Teknologi Pendidikan*, 10(1), 55-63. doi: https://doi.org/10.21831/jitp.v10i1.52458

INTRODUCTION

In the context of the "big data" era, cloud technologies and the Internet have spread to every aspect of human life. Working styles and thinking are changing dramatically as a result of changes in study and lifestyle. With the application of new technologies, new ideas, and new models in education and teaching, changes in the field of education are also far from reach. Educational trends that lead from school to home, library, workplace, and university are becoming more common (Bell, B. S., & Federman 2013). The educational concept of "personalized teaching" and the methods of teaching autonomy, collaboration, and research are gradually adopted by teachers and incorporated into the teaching practice in the classroom.

Outline of the National Medium- and Long-Term Education Reform and Development Plan of China (2010-2020) is presented as follows: Updating the concept of talent training to "establish a diverse talent concept, respect individual choices, encourage personal development, and cultivate talent in an electrical way concept, respect individual choices, encourage personal development, and cultivate talent in an electrical way". Since the official launch of the cloud class project in 2010, Nanjing's development and implementation of cloud class projects have shifted from a pilot school to a comprehensive stage of promotion and application, exploring the personalized teaching environment of a cloud classroom, promoting balanced education development in Nanjing, and promoting educational equality to provide a new angle of theoretical analysis. Basic school cloud classes move from knowledge learning to knowledge and comprehensive capability development from single class learning into many ways to learn, paying attention to each student's level of knowledge and learning. fully realize a more personal learning, attempting to overcome the disadvantages of traditional classroom teaching's high consumption and low efficiency, and improving teaching quality.

The goal of education is to make people become themselves. One of the most important symbols of the success of personalized teaching in the cloud classroom is to begin with the individual learning needs of students, in accordance with their interests and learning nature, and to cultivate their spirit and innovative abilities. Confucius in ancient China and Socrates in ancient Greece summed up the practice of teaching as "teaching can be considered the idea of personal teaching." In the 17th century, the famous Czech educator Kwamenius suggested that education should be based on human nature. In "Emil on Education," the 18th-century French thinker Rousseau emphasized the possibilities and conditions for children to move freely, and teachers should fully respect children and give them more freedom to learn, think, and express. Dewey, an American educator, proposed the educational principle of "child-centrism."

In 21st-century China, with the progressive advancement of quality education, a large number of domestic scholars taking advantage of the concept of private teaching abroad have carried out relevant research on personalized teaching in the classroom. Deng (2012) and Xu et al. (2020) outline the concept of "personalization" and deal with the personalized teaching mission of three levels of objectives, processes, and structures: cultivating the subject of individualization in accordance with the laws of individual physical and mental development and paying attention to the systematic nature of personalized instruction.

There is currently no system in place for teachers to analyze student learning in depth. Instructors are only able to predict instruction by making subjective, generic judgments based on experience and their hazy thoughts and feelings about students' learning. Teachers' personal factors have a big impact on this kind of instruction. Information technology is thus a crucial component of classroom instruction. Also, it is wasteful for teachers to use questions and assessments to determine if students have understood what they have learned in a traditional classroom setting. Thus, the usage of a cloud in the classroom, in the cloud classroom environment, enables teachers to have a better understanding of the learning level of the students. Today, "personalized teaching" has become the focus of the reform of Chinese subject-class teaching. However, in teaching practice, personalized teaching is difficult to realize. Can Nanjing cloud class teachers adapt to the new concept? What problems are still to be solved during the application process? How can these problems and difficulties be solved? This research and summary of the problem have both theoretical and realistic guiding values.

In according to Jing, Wang, & Zhuo (2017), the term of cloud classroom means online open classroom platform built on the integration of cloud computing, educational clouds, and integrated educational information resources. With the support of Internet technology and touch tablets, users can quickly and efficiently share audio, video, and data files with students, teachers, parents, and other users around the world with simple actions via the Internet interface. Cloud classrooms can not only effectively enhance the online classroom learning effect but also meet large-scale student needs, improve learning efficiency, and build competitive networking learning systems (Juan, 2014).

A cloud-based classroom system mainly consists of courseware production tools, real-time interactive classrooms, courseware-on-demand systems, learning management systems, and learning gates. Cloud teaching platforms absorb cloud computing features and increase network and mobile

terminal popularity; a variety of smart terminals, apps, and other additional learning software are emerging and becoming more diverse and mature (Chun, 2017). Cloud classes come from one-on-one digital learning, a global digital education innovation program. to meet personalized educational needs. Cloud classroom is a form of information teaching shaped by the integration of cloud computing and cloud systems with educational teaching, which mainly includes two parts: traditional offline classroom teaching and online cloud classroom instruction (Yun, Yang, & Xianjin, 2018). Representative projects include: schools in over a dozen states in America participating in the One-to-One Computing Project, as well as the BYOD project (Shanghai, 2010-2020). project "Improving Learning Strategies" in Quebec, Canada. Since 2007, China has launched a one-on-one digital teaching pilot in a variety of ways. In 2007, three pilot schools were established in Beijing. In 2008, the Shanghai Middle- and Long-Term Education Reform and Development Plan 2010-2020 proposed to "promote the development of complementary teaching methods such as "e-bags" and "cloud computing" (Bangqi et al., 2019).

The old offline teaching method is no longer capable of providing the necessary instruction due to technological advancements. It is crucial to encourage the growth of "Cloud Classroom" in the context of the "Internet+" era. Research on this initiative began later in China than it did for MOOC and Icloud classroom. The ongoing pilot school did not have a detailed follow-up survey, and the research focused only on relevant concepts, application advantages, and the level of research promotion, lacking depth. Personalized teaching in cloud classrooms since the late 20th century, China has given great importance to information education and continues to improve its systems. affirm the strategic position of information technology such as the internet, cloud computing, and big data, with a special emphasis on combining information with education (Jin, 2016). The rapid development of network information technology and the need for education reform in the 21st century make cloud computing more sensible to use in the classroom (Anshari et al., 2016). "Personalized teaching in the cloud classroom" refers to violating traditional school education or "union class" teaching by respecting the individuality of students and thus enforcing a targeted classroom lesson plan (Zhang et al., 2018).

Students and teachers can interact during the learning process, and teachers can provide guidance to each student at anytime, anywhere, on request, which is an effective way to improve the effectiveness of the teaching process in the classroom. According to Dong Su, director of the information department of the Nanjing Teacher Development Center, Nanjing's cloud-based curriculum covers all disciplines in elementary schools and all study segments. In addition to courses of study, they also include science and technology, physical education, the arts, moral education, mental health, and family education.

METHOD

Based on personalized teaching studies in its predecessor cloud classrooms, the research focuses on teaching methods in Nanjing's cloud classroom school programs, the development of teacher education technologies, and the status quo in the field of independent study. Class observation and case analysis, communication with teachers and students after class, and other methods are used to understand the implementation of personalized teaching in Nanjing cloud classrooms. Collecting books, magazines, and newspapers through libraries and gathering relevant theoretical research in networks forms the basis of this research. Observe the teaching process and behavior by entering the classroom. Focus on the personalized implementation of cloud-based teaching. And for primary school cloud classes, qualified teachers should conduct case analyses against example classes of teachers who are superior in cloud classes.

This research uses literary methods and case study methods to determine relevant concepts, analyze teaching cases, find out existing problems, analyze the root causes of those problems, and then advance improvement strategies. For example, reviews are useful when researchers want to evaluate the theory or evidence in a particular field or check the validity or accuracy of a particular theory or a competing theory (Snyder et al., 2016). Case-study research consists of in-depth investigations, often with empirical data gathered over a specific time period from a well-defined

case to provide analysis of the context and processes involved in such phenomena (Rashid et al., 2019).

RESULT AND DISCUSSION

Result

In cloud classrooms, the individualized teaching standards are student-centered, make clear the teacher's primary function, and respect and play up the subjectivity of the student. Assess student circumstances and assist them in using digital teaching tools to tailor their learning. The following are two examples of classroom scenarios using Nanjing clouds. The Nanjing primary school's present cloud classroom analysis is tailored to teach class facts, with specific teaching applications in the cloud classroom as well as upgrades and promotions to offer a solid foundation.

The individualized teaching standards in cloud classrooms are student-centered, make clear the primary function of the teacher, and respect and play the subjectivity of the student. Assess the circumstances of the students and assist them in using digital teaching tools to individualized their learning. These are two examples of Nanjing cloud classroom settings. In order to teach class information, the present cloud classroom analysis of the Nanjing primary school is tailored. It also includes individualized teaching applications in the cloud classroom, as well as upgrades and promotions to give a solid basis.

For these lessons, when the teacher's tasks are open, give the student the opportunity to play freely. In the third part, the teacher gives the student an open task, which can be expressed by the student using a study sentence pattern. We can see that students are enthusiastic and creative in their studies. The first group used artistic expression, and the second group played with plot roles. The subject matter is English for grade 4. The class arrangement 1 can be show in Table 1 as follows.

Table 1. The Class Arrangement 1

Teaching first link: play audio and introduce courses	
Teacher Activities	Students Activities
1. The teacher creates her voices according to the content of the teaching and imports new and interesting lessons 2. The teacher took an apple and imitated the sound of snow white Asking: Do you like apples?	1. Students watch the video 2. Students start thinking by looking at models
Teaching second link: Interaction between teacher and students	
Teacher Activities	Students Activities
1. Part 2a of the recording 2. Distributed training part 2a 3. Show the training screen 4. The teacher grouped students, open the voice-filling software, and the group completed the duplication in 3 minutes.	1. Listen to the recording of part 2a 2. Complete exercise 2a 3. Each group finishes recording
Teaching third link: Students view	
Teacher Activity	Students Activity
Guiding students to expand their learning, so students learn to use: Do you like … ?	Students make their own performances with the sentence patterns they learn.

Based on the Table 1, its show that when the teacher's tasks are open, give the student the opportunity to play freely. In the third part, the teacher gives the student an open task, which can be expressed by the student using a study sentence pattern. We can see that students are enthusiastic and creative in their studies. The first group used artistic expression, and the second group played with plot roles.

English language intelligence classes in SD Cloud environments are like the integration of information technologies such as the internet, cloud computing, and big data into English to create an informative English language education environment (Min et al., 2019). In these lessons, students learn through the cloud classroom audio, the teacher's voice replay, and the independent sound replay. The learning process is fun, but personalized embodiment is not enough. Teachers can consider pre-test improvements.

The lesson is simple, but the teacher has not followed the pre-tests, resulting in an inadequate hierarchy of the learning process. Teachers can use pre-tests to divide students into groups based on different levels of study, assign different tasks to each group, and personalize their instruction. Especially when answering questions, each group answered the same questions in turn to reduce learning efficiency. If each group was allowed to express itself freely according to different problems, the group would learn better together. The data of class arrangement 2 can be shown in Table 2.

Table 2. The Class Arrangement 2

Teaching first link: review the basic characteristics of the bars and cubes, introducing new lessons.	
Teacher Activities	Students Activities
1. Teachers use a 3D demo to review the faces of boxes and squares, prisms, and nodes and guide students to learn. 2. Teachers compare their differences with model teaching aids.	1. Students watch their own videos. 2. Students observe the model and begin to think.
Teaching second link: Explore new knowledge.	
Teacher Activities	Students Activities
1. Teacher asks: If you tell the length of the gift cube, width and height, can you know how many square centimeters of packing paper are needed? 2. If the paper remains were cubes, would the student count them? 3. Calculation of the volume	1. Students calculate the surface area and volume of a cube based on data provided by their teacher. 2. Students send their results to the group's learning system to find out their correct level and error rate.
Teaching third link: Group presentation	
Teacher Activities	Students Activities
1. Teachers listen to student group reports, and 3D shows the calculation process. 2. The teacher corrected the mistake.	1. The Pad screen shares calculations and presentation results. 2. Methods for Group Reporting
Teaching fourth link: Application expansion	
Teacher Activities	Students Activities
1. Give different data and let each student calculate independently. 2. Use the learning system to get the student to the right level. 3. Correction of different student	1. Exercise independently. 2. Recognizing their own errors. 3. Independent expansion independent. expansion Exercise independently.

Based on Table 2, it can conclude that through 3D demonstrations and providing fixed formulas, teachers enable students to master basic knowledge. During the course of group training, students can discuss and interact to master knowledge; each student will have their own thinking

process. With cloud-based class statistics, teachers can instantly understand the level of knowledge acquired by each group of students. After correcting the mistake, each student performs the exercise in class before submitting the results. Teachers can understand classroom learning and personalize their teaching to each student's situation. The teacher then directs the student to combine mathematical learning situations at this stage to make comprehensive summaries and reflections based on the characteristics of the student's cognitive development in the summary stage (Gao 2020). The learning environment at Ruijin Road Nanjing Elementary School while attending classes can be shown in Figure 1 and Figure 2.

Figure 1. Each Student Performs the Exercise in Class Before Submitting the Results

Figure 2. The Learning Environment at Ruijin Road Nanjing Elementary School while Attending Classes

Discussion

Personalized teaching interviews in Elementary School cloud classrooms

Using the interview research method, work was done at five elementary schools in Nanjing. I used sampling to select teachers; I selected 12 teachers to be interviewed from Xiaozhuang Nanjing Elementary School, Xijie Nanjing, Haiying Nanjing, Ruijin Nanjing, and Cuipingshan Nanjing. Each

interview will take about 20 minutes. The interview consists of four parts: 1. Ask the teacher about the basic situation and the personalized teaching attitude in the cloud classroom; 2. Ask the teacher about changes in teaching modes and technical choices; 3. Understand the teacher's willingness to train and learn; and 4. Ask the teacher to give advice.

Teachers 3 mention: "In the cloud classroom teaching environment, student class tasks and other learning conditions are easy to reach timely feedback on through on-site evaluation, making it convenient for teachers to understand in time and adjust the rate of teaching according to each student."

Teachers 2 say: Some teachers can use the interactive classroom cloud teaching platform to analyze each student's learning situation. However, teachers who are used to learning through experience, communication, and observation are finding it difficult to understand the learning status of all students. Personalized teaching in a cloud classroom is impossible to discuss unless you have test results to master learning and no need to understand learning.

Most teachers (11 out of 12 teachers) mentioned: "In terms of lesson preparation efficiency, most teachers think that subject preparation is very special, supported by a cloud classroom environment." Open network resources and interaction platforms for timely feedback provide a variety of options for teacher lesson preparation. In the preparation of classroom teaching materials, in addition to traditional teaching programs, teachers prefer to use networking teaching resources and interactive platform support resources. There are also some teachers who must collect, edit, and generate personalized teaching resources to meet their needs.

Teachers 7 mentions: "The teaching model has changed since the start of the required teaching in the cloud classroom, but teachers need to strengthen their learning and training."

Teacher 12 says: "In practice, the cloud classroom is not used very often, about 1-2 times a week." In addition to the conditions of use, the student's eye health should also be taken into account.

Teacher 6 says: How do you maintain a weak student base while promoting the development of the entire student body? Is teaching individualism practical? The special color of science and education and the special characteristics of information technology must be present, so how do we do it?

Case studies, classroom observations, and communication with teachers and students revealed the following: While personalized teaching in cloud classes at Nanjing Primary School has achieved some results, there are still some problems. Among those problems is that the teaching status is embarrassing and does not receive enough attention. Personalized instruction in a cloud classroom, which is a novel development in Nanjing's educational landscape, may foster students' all-round skills and help them grow as individuals.

The government hopes to realize the modernization of education driven by education informatization. It is also hoped to manage educational resources and standardize the development of educational resources, so that users can access educational resources in various ways. However, despite the implementation of schools and classrooms, the frequency of use is not high. The following problem is a less-than-sufficient standard for project development, with no evaluation of practical teaching applications; the purchase of electronic teaching materials, digital resources, and platform applications will appear impractical, unusable, and so on.

The third problem is that there are not enough communication activities for teaching applications and there is a lack of teacher training. Every year, the city of Najing holds one or two live presentation training sessions for dissertations and case evaluations. The number of teachers involved is limited, training materials are rare, and there is a lack of success story communication. This is why many teachers have to do it themselves. Teachers do not have training and guidance in systematic education and teaching theory, the application of educational technology and learning, or student personal research.

The fourth issue is that teaching evaluation is limited to a single subject; comprehensive protection is insufficient. Through interviews, it was found that the most recommended advice made by teachers was the expectation that the education management department would change the single evaluation mechanism and give teachers more policy inclination. In fact, elementary school teachers

have heavy tasks, tremendous pressure, and not much time to invest in a new teaching model. Because the personalized cloud classroom preparation time for its teaching is extended after a period of teaching application, some teachers do not want to explore it actively. In addition, the personalized teaching applications in the cloud classroom are a comprehensive system. Even if problems are discovered during the application process, they are challenging to solve independently, which is a severe setback for the pilot teacher's desire to pursue his or her passion.

Students Aspect

On student aspects, since the launch of personalized teaching in cloud classrooms, many schools have been enthusiastic at first. Still, they are concerned about the impact of personalized instruction on test values and the teaching sequence. Lack of understanding of project development and lack of sustainable investment in the education sector have resulted in a lack of effective development of world-class research projects. In addition, the focus of the education sector has not yet shifted from educational information to personalized teaching research. Due to a lack of construction, coordination, and order, the Department of Education has not yet formed a personalized teaching working group in the cloud classroom.

Teacher Aspect

For a long time, teachers in China have had heavy teaching duties and too much pressure. Due to insufficient time and energy, many teachers are reluctant to try out personalized teaching programs in cloud classrooms. And the integrated abilities of some teachers also need to be enhanced, but there is a lack of enthusiasm to investigate themselves.

CONCLUSION

The research brushed aside the personalized teaching profile of the cloud classroom at Nanjing Elementary School. The status of personalized teaching in the cloud classroom implementation was investigated. It was discovered that the benefits and drawbacks of personalized teaching in the cloud classroom are in elementary school teaching. Based on this research, the following conclusion can be drawn: the personalized pilot project of teaching in the cloud classroom is intended to promote educational reform against the backdrop of an increasingly mature new technology in order to meet the personalized teaching needs of elementary schools. In teaching, teachers focus on student-centered cooperative and interactive learning to help students learn independently and to enhance their personalities. Then personalized cloud classroom teaching is applied to the classroom with new technologies, concepts, and a new model of emphasis. Student interest in learning can be stimulated, new teaching models are gradually formed, and teachers are no longer the only authorities in the classroom. further promote equality and the development of balanced urban and rural education. China is pushing innovation in the concept of universal education through information technology. The Department of Education seeks to personalize cloud classroom teaching to address the shortage of teaching resources and teacher shortages in rural areas. Through a network of cloud classrooms, teachers develop educational equality in ways such as resource sharing, which will contribute to the development of balanced urban and rural education.

In this study, the researcher found that many teachers, having become accustomed to terminal operations and smart platforms, hope to solve the problem of a lack of teaching resources to conduct personalized teaching in cloud classrooms. Once resources are integrated, teachers can guide students to focus on learning, quote or upload a planned task, and provide strong support for students to practice on their own after independent learning. Cloud classrooms should encourage school teachers to upload and generate teaching and learning resources, build teaching resources, and build and share them to meet the personalized teaching needs of more students and teachers. Improving the teaching ability of teachers in the information age is a prerequisite for promoting information technology and the depth of teaching. Teacher training in the cloud classroom is in great need of development. In interviews, I learned that teachers are full of hope for training and have confidence in strengthening teaching with information technology. Due to time and resource limitations, several parts of the case studies and teacher interviews that were lacking may be studied in greater detail during the research

but did not take into account the actual condition of rural schools. It is therefore highly advised to conduct additional investigation.

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Jurnal Inovasi Teknologi Pendidikan
Volume 10, No. 1, March 2023 (64-75)
Online: http://journal.uny.ac.id/index.php/jitp

Development of digital teaching material in the South Sumatra traditional games course

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ARTICLE INFO

Article History
Received:
16 December 2022;
Revised:
14 February 2023;
Accepted:
28 February 2023
Available online:
09 March 2023.

Keywords
Digital teaching material; traditional games; South Sumatra.

ABSTRACT

The advances in technology and information development are increasingly rapid is a great potential that learners can utilize to improve the quality of learning. It is consistent with the characteristic of students as active users of digital technology. So, lecturers need to make updates to improve the quality of learning. One of them is by providing teaching material according to the needs of students. This study aims to develop digital teaching material for the South Sumatra Traditional Games course at the Study Program of Early Childhood Education Teacher Education, Faculty of Teacher Training and Education, Universitas Sriwijaya. This study used the ADDIE Research and Development (R&D) method with five stages: analysis, design, development, implementation, and evaluation. Data collection techniques were carried out through interviews, questionnaires, and tests. Data analysis techniques using quantitative and qualitative data analysis. The results showed that the evaluation of digital teaching material products that experts had carried out showed that the material aspect scored 87,5% in the Very Good category, the language aspect scored 85% in the Very Good category, and the media aspect scored 92,5% in the Very Good category. Based on this evaluation, it can be concluded that the digital teaching material in the developed South Sumatra Traditional Games courses are valid, feasible, and practical to be used in the learning process. Research can be continued by developing interactive digital teaching material.

How to cite:
Suningsih, T., Rukiyah, Andarini, S. (2023). Development of digital teaching material in the South Sumatra traditional games course. *Jurnal Inovasi Teknologi Pendidikan*, 10(1), 64-75. doi: https://doi.org/10.21831/jitp.v10i1.54862

INTRODUCTION

The rapid development of technology and information is a necessity that cannot be denied in education. The influence of this development has a positive impact by being more open and spreading knowledge throughout the world, breaking the boundaries of space and time, and making it easier for students to access information and learning materials according to their needs quickly. The research shows that most students use the internet according to their needs, whether browsing, resourcing, searching, e-mail, or mailing list (Yunelti et al., 2013). It shows that digital technology is believed to increase retention and persistence of learning in students, provide rich content, and is more suitable for application in 21st-century learning models (Mawarni & Muhtadi, 2017). Therefore, digital technology is absolutely necessary to support the learning process, so it is

expected to improve the quality of national education. The use of digital technology changes learning interactions between students and lecturers, as well as digitizing teaching materials that contain various information related to a series of materials.

A lecturer is a professional educator who is one of the essential parts of achieving learning success. One of the obligations of a lecturer contained in the Law of the Republic of Indonesia Number 12 of 2012 concerning Higher Education Article 12 states that "Lecturer is an individual or in groups are required to write teaching material or textbook, which tertiary institutions publish and scientific publications as a source of learning and for developing academic culture and cultivating reading and writing activities for the Academic Community" (UU Republik Indonesia, 2012). Teaching material is anything lecturers can use to support learning activities, making it easier for students to understand learning material to gain knowledge, understanding, skills, values, attitudes, and interests related to achieving specific competencies. Especially at the Higher Education (University) level, students use teaching materials to make them more effective and efficient in understanding learning material. The use of teaching material can also provide treatment to students according to individual characteristics. It can overcome problems related to the lack of self-actualization of students so that students can explore poorly understood materials through teaching material (Rukiyah et al., 2022). So that can be said that teaching materials need to be developed to meet the needs of their users in terms of material renewal, validity, practicality, convenience, attractiveness, communication, to accessibility to motivate students in the learning process.

The development of teaching material is a crucial component of improving the quality of learning. It is necessary to pay attention to several essential principles or standard references as material for improvement in the teaching material. Principles of developing teaching material, namely: (1) the eligibility of material/content is developed based on the principles of completeness, suitability, adequacy, ease, contains character values, and relevance; (2) the presentation is developed based on interesting, creative, and innovative, systematic, and active principles; (3) a language is developed based on the principles of convenience and communicativeness; and (4) the graphic is developed based on interest, creative, and innovative principles, as well as practically (Arsanti, 2018). These four principles also need to be developed by considering the suitability of the times. With the development of technology in this era, teaching material is no longer printed but in digital form (Musdzalifah & Rohayati, 2018). Digital teaching material is a teaching material that uses digital devices, which include personal computers (PCs) in the form of desktop computers, notebook computers (laptops), and tablet computers, as well as utilizing specific application software. Digital teaching material is not much different from printed (conventional) teaching material, namely in terms of the main content, whose main components include material objectives, teaching materials, summaries, exercises, and feedback, in addition to other complements such as preface, table of contents, glossary, index, to the bibliography. The file type most often used for digital teaching material is the portable document format (PDF) which is converted to digital book software, so that the appearance of PDF files becomes more attractive like a book. Therefore, one form of professional educators is being able to utilize technology to be used as a supporting medium in the learning process, namely the development of teaching material based on digital.

The development of digital teaching material can be categorized as learning media according to needs so that it can positively impact its users. One of the users of digital teaching material in higher education (University) is students. The positive impact of using digital teaching material on students is related to increasing effectiveness and efficiency in the learning process. To increase the efficacy, students can be actively involved in the learning process related to various simulations contained in digital teaching material. Meanwhile, the connection with increased efficiency is that students can learn independently to study learning material more flexibly, whenever and wherever students are. This positive impact also corresponds to student life closely related to technological developments. Today's students are born in the digital era and live by technology, so this generation is called the digital native generation. According to Prensky, digital natives were taken when the world was already in the information and communication technology era, so they will be

very fluent in using information technology (Purwaningtyas, 2022). The characteristics of this generation are always wanting to be fast, able to do two or more jobs at once (*multitasking*), interactive multimedia users, like instant access, collaboration, and always network (*networking*). According to the latest report submitted by Nielsen, around 78% of internet users in Indonesia access the internet using mobile phones (mobile phones), 29% use laptops, 31% use desktop computers, and 2% use tablets (Sumarlin & Malahina, 2019).

Furthermore, based on a survey report with a survey sample of 7,568 respondents in 2021-2022 regarding the 2022 Indonesia Internet Profile, it stated that internet usage behavior based on the age range of 19-34 years was 98.64% (Asosiasi Penyedia Jasa Internet Internet, 2022). Based on these data, it can be concluded that in this age range, students become mobile users who actively access the internet. The relation with learning is the need for the use of technology in the learning process carried out by students because the use of technology cannot be separated from students' daily lives, so the use of digital teaching material in the learning process can be classified into learning media that are following the characteristics of students in the current era.

Students, as users of digital teaching material, can become more motivated. Because students are faced with displays of digital teaching material that are more varied, interactive, and interesting, so they are not dull. Students cannot just read texts, but can also view pictures or videos, listen to sound, and access many sites connected to the internet. Thus, students' insights and knowledge become increasingly broader, deeper, and more complex in understanding material. Apart from speeding up the learning process, other advantages of digital teaching material include cheap financing, easy access, not depending on distance, flexibility, time efficiency, and the use of the latest or updated digital services. Concerning affordable financing, digital teaching materials tend to be more economical. Because it's easier to get for free through the internet, as long as these digital teaching materials are publicly published (*open source)* so that students can access, store (*save*), and collect digital teaching materials through their digital devices, students can use digital teaching material through their digital devices in various conditions and opportunities, both on and off campus. Digital teaching material can be stored without special care, just like traditional teaching materials (*print books*) that require ample space or a special place to store and use them. Because it can be reserved via cloud storage or data storage (hard disk, memory card, and others), it can be accessed from digital devices or any location and is easy to carry anywhere. If digital teaching materials are stored through cloud storage, it requires an internet or online network to be able to access them. However, if digital teaching materials are stored via data storage, then there is no need to need an internet or offline network to access them.

The South Sumatra Traditional Games course is a compulsory subject for undergraduate students (S-1) of the Early Childhood Education Teacher Education Study Program (PG-PAUD) of the Faculty of Teacher Training and Education (FKIP) at Universitas Sriwijaya. The presence of this course is closely related to the existence of Universitas Sriwijaya (abbreviated as UNSRI) as a State University located in South Sumatra Province, Indonesia. South Sumatra is a province in Indonesia located in the southern part of the island of Sumatra, with Palembang as its capital. The general description of the area of South Sumatra and the people's diversity create a plurality in the distinctive cultural features of the Sriwijaya land (as South Sumatra has been called since centuries ago). It became one of the influences in the formation of courses in the PG-PAUD Study Program FKIP at Universitas Sriwijaya, namely the South Sumatra Traditional Games course. Through learning in this course, it is hoped that students will be able to skillfully simulate and design traditional game activities based on the results of analysis of play theory, games, and game tools, as well as the effects of regional cultural studies of South Sumatra in building the character of loving local culture and introducing cultural literacy to early childhood. In addition, based on the results of the preliminary study that the researchers conducted with the lecturers and the teaching team supporting the South Sumatra Traditional Games course, it was explained that there was a lack of literature (such as books, journals, papers, and others) that could be used as a source of reference or reference in discussing traditional games. In the South Sumatra area, thus requiring students go to the field (cities or districts in South Sumatra Province) to obtain information or data related to the material in the course.

Furthermore, the results of the interviews that the researchers conducted with students taking the South Sumatra Traditional Games course stated that in carrying out information or data search activities, students had to provide a significant amount of time, energy, and materials. Students need a long time to get information related to course material. And also feel tired because students need to conduct interviews with the community or make direct observations in certain areas in South Sumatra as well as material that needs to be issued by students to support the implementation of these activities. The observation results show that students need digital teaching material to make it easier to understand the South Sumatra Traditional Games course lecture material.

Based on these facts, the researcher provides a solution by developing a teaching material that contains material in the South Sumatra Traditional Games course, which is packaged attractively according to the characteristics of its users. These students are accustomed to using technology and in accordance with current learning styles based on digital technology. Using learning resources in the form of non-printed or digital teaching materials can improve the creative thinking skills of its users (Nazifah et al., 2021). Therefore, technological advances in the presentation of content or material allow students to develop creative thinking skills by developing digital teaching material in the South Sumatra Traditional Games course. The development of digital teaching material is presented through digital devices consisting of an arrangement of integrated parts so that teaching material is suitable for use by students. These sections include instructions for using digital teaching material, explanations of competencies to be achieved, teaching materials, exercises, to evaluations to measure the level of mastery of competencies that students have mastered after participating in learning activities.

Previous research (Aminuddin et al., 2021) entitled Development of Digital Teaching Materials in Class X Economics Subjects at Public High School 12 Makassar describes that digital teaching materials developed using the ADDIE model show that the results of the validation of material experts are categorized as very valid. The validation of media experts is classified as very accurate so that digital teaching material can be used in the learning process. The results of student responses show that students can use digital teaching materials very practically. This indicates that the digital teaching material developed has practicality in terms of appearance, and language, the typeface used is clear and easy to read, the images in digital teaching materials support learning materials, and the learning concept follows the grade 10 Learning Implementation Plan (*lesson plan*) in the Economics subjects. Furthermore, in analyzing the level of effectiveness using the post-test, the value obtained is in the effective category. Based on these stages, it can be concluded that the development of digital teaching material is considered very good for use in Economics subjects in achieving learning objectives.

Following this description, the formulation of the problem in this study is to develop digital teaching material in the South Sumatra Traditional Games course, which is tested valid and feasible to be used by PG-PAUD FKIP at Universitas Sriwijaya students. The digital teaching material developed is PDF files assisted by digital devices, which contain narratives and images that are presented simultaneously so that the presentation is more varied, not dull, conveying meaning that is easier to understand directly and more precise. This research aims to develop digital teaching materials that are valid by experts and suitable for use in the learning process so that they can potentially increase student understanding and learning outcomes.

METHOD

This research was conducted in the PG-PAUD Study Program FKIP at Universitas Sriwijaya in 2022. Type this research used to research and development (R&D) which is intended to produce a product with scientific value (Faradiba & Budiningsih, 2020), which is then validated and tested to become a viable development product. This study aims to develop digital teaching material for the South Sumatra Traditional Games course used by undergraduate students of the PG-PAUD FKIP at Universitas Sriwijaya. The development model used in this study refers to the ADDIE development model, which consists of the analysis, design, development, implementation, and evaluation stages, as presented in Figure 1.

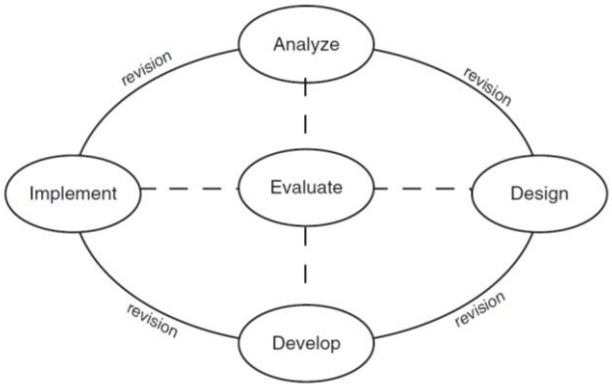

Figure 1. ADDIE Model Procedure (Branch, 2009)

In the analysis stage, the researcher identified the causes of the emergence of gaps that might occur in the learning process in the South Sumatra Traditional Games course. In the design stage, the researcher verifies the expectations to be achieved by the supporting lecturers, team teaching, and students and designs products according to the expectations to be completed. Furthermore, the researcher produces and validates the development product at the development stage. In the implementation phase, the researcher prepares the learning environment and involves students in trying out product development. At the evaluation stage, researchers assess product quality in the learning process, both before and after using product development.

The population in this study were fourth (IV) semester students who took the South Sumatra Traditional Games course in 2021/2022, then a research sample of 20 (twenty) undergraduate PG-PAUD FKIP Universitas Sriwijaya students was selected. The data collection technique used in this research is in the form of observations related to learning activities that occur in the South Sumatra Traditional Games course as initial information data regarding facts that occur in the field, interviews with lecturers and teaching teams, and students regarding the development of required teaching material, validation questionnaires for experts (*expert review*) consisting of material experts, linguists, and media experts, as well as a response questionnaire on the use of digital teaching material by students. The data analysis technique used in this study is a quantitative descriptive analysis technique. The type of data taken is in the form of qualitative data, which is quantified using descriptive judgments (Permitasari et al., 2022). The goal is to analyze data by describing the data collected as it is without any engineering.

RESULTS AND DISCUSSION

Results

In the preliminary study stage or the analysis stage (*analyze*), researchers conducted a literature study regarding the role of teaching material in supporting the learning process in tertiary institutions. The researcher also obtained and analyzed preliminary information regarding the lack of literature on the South Sumatra Traditional Games course at the PG-PAUD FKIP Study Program, Universitas Sriwijaya. The researchers discussed with the supporting lecturers and the teaching team for the South Sumatra Traditional Games course and learned that students had difficulty getting material related to the course. This was triggered due to the lack of books discussing Traditional Games of South Sumatra, so students need to observe and interview the community in certain areas to obtain information or data relating to the material in the course. These activities make it difficult for students because they have to spend a lot of energy, time, and material.

Furthermore, the researcher interviewed several students who took the South Sumatra Traditional Game course to find out the needs of students regarding the problems that occur in the learning process in that course. The results of the interviews showed that students needed books (teaching material) related to the Traditional Games of South Sumatra course. The availability of

teaching material can be one of the supports for successfully implementing the learning process (Taufiqy et al., 2016). Therefore, the provision of teaching material needs to be applied in the learning process to facilitate, streamline, and make students more efficient in understanding teaching materials in these courses.

At this design stage (*design*), the researcher verifies the expectations to be achieved by the supporting lecturers, teaching team, and students and makes product designs following the expectations to be achieved. Based on the conclusions at the analysis stage, it was explained that students needed teaching material in the Traditional Games of South Sumatra course. Furthermore, the researchers conducted discussions to find out the needs of students in-depth regarding teaching material. It was found that the development of digital teaching material in the South Sumatra Traditional Games course had not been carried out. The suggestions that students give to improve the quality of the learning process are the development of digital teaching materials to make it easier for students to study these teaching materials. This follows the character of today's students who are used to interacting with technology.

Furthermore, suggestions from supporting lecturers and teaching teams regarding developing digital teaching material are that teaching materials must be linked to early childhood concepts. This is consistent with the principle of relevance in the development of teaching material, namely having a relationship with the achievement of learning objectives (Sanjaya & Inawati, 2019). The learning achievements of the course (CPMK) are that after participating in learning in the South Sumatra Traditional Games course, students are expected to be able to skillfully simulate and design traditional game activities based on the results of an analysis of play theory, games, and game tools, as well as the effects of cultural studies of the South Sumatra region in building the character of loving local culture and introducing cultural literacy in early childhood. Based on suggestions from supporting lecturers, teaching teams, and students, the researchers designed digital teaching material for the South Sumatra Traditional Games course related to the concept of early childhood.

In the development stage (*development*), researchers produce the product as digital teaching material for the Traditional Games of South Sumatra course. The material in digital teaching material is developed based on the course syllabus that has been prepared. Researchers create digital teaching material by presenting 7 (seven) components, namely: (1) Materials descriptions that adapt to the course syllabus; (2) Learning Objectives that contain targets that are expected to be achieved by students; (3) Teaching Materials that contain material information that is discussed in depth and accompanied by theories related to early childhood concepts; (4) The summary contains the results of summarizing the teaching materials; (5) Exercise to measure students' ability to master learning material through several questions; (6) Feedback that functions to assist students in assessing their abilities after using digital teaching material; and (7) Bibliography to make it easier for students to find additional information.

The preparation of the material topics in this digital teaching material is in accordance with the course syllabus for the South Sumatra Traditional Games and is linked to the concept of early childhood, consisting of 7 (seven) materials, namely: (1) Basic Concepts of Play and Games, consisting of the following topics: a) The Definition of Play and Games, b) Play and Game Characteristics, c) Stages of Play Development, and d) Urgency of Play for Early Childhood; (2) Play Theory, consisting of the following topics: 1) Classical Play Theory, and 2) Contemporary Play Theory; (3) Educational Game Tools (APE) for Early Childhood, consisting of the following topics: a) APE Definition, b) APE Urgency, c) Types of APE, d) Characteristics of APE, and e) Principles of Selection APE; (4) Traditional and Modern Games, consisting of the following topics: a) Definition, b) Characteristics, and c) Weaknesses and Strengths of Traditional and Modern Games; (5) Regional Culture of South Sumatra, consisting of the following topics: a) Geographical Location, b) Traditional Houses, c) Regional Dances, d) Traditional Clothing, and e) Typical Food; (6) Regional Traditional Games of South Sumatra, consisting of 20 (twenty) types of traditional games of the South Sumatra region; and (7) Introduction to Literacy through Traditional Games, consisting of the following topics: a) Read and Write Literacy, b) Numerical Literacy, c) Scientific

Literacy, d) Digital Literacy, e) Financial Literacy, and f) Cultural and Citizenship Literacy, can be seen in Figures 2 to 5.

Figure 2. Front Cover

Figure 3. Back Cover

Figure 4. Preface

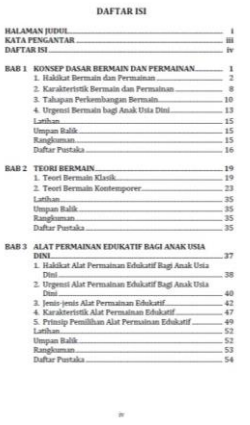

Figure 5. Contents

Furthermore, this digital teaching material was tested for validity by 2 (two) experts, a material expert and linguist and a media expert with expertise in ICT-based learning media and teaching materials (*Information and Communication Technology*). Table 1 show the validation testing by experts, including material experts, linguists, and media experts. The validation aims to assess the feasibility of the digital teaching material being developed and provide suggestions for improvements to improve digital teaching material.

Table 1. Recapitulation of validity test instruments

No.	Aspects	Indicators
1.	Material	a. Content Eligibility
		b. Presentation Eligibility
2.	Language	a. Language Component
3.	Media	a. Graphic Eligibility
		b. Display Eligibility

Source: Modification of National Professional Certification Agency (BNSP) Assessment Standards

Based on the data as presented in Table 1, it is known that there are 3 (three) aspects of the validity test, namely: (1) Material aspects which consist of content eligibility indicators (completeness of material, breadth of material, depth of material, suitability of material with scientific developments, as well as the latest), and indicators of presentation eligibility (systematic consistency of presentation of material, practice questions, feedback, summaries, and student involvement); (2) Language aspect consisting of indicators of language components (effectiveness of sentences, readability of messages, conformity with students' level of understanding, accuracy with writing conventions, and consistency in the use of terms and symbols); and (3) Media aspect which consists of graphic eligibility indicators (appropriateness of teaching material sizes with International Organization for Standardization/ISO standards and suitability of sizes with materials), and display eligibility indicators (appearance consistency, color harmony, illustration suitability, layout consistency, element completeness, typography, ease of understanding, and ease of using digital teaching material).

Table 2. Recapitulation of Validity Test Results

No.	Aspect	Score (%)	Category
1.	Material	87,5%	Very Good
2.	Language	85%	Very Good
3.	Media	92,5%	Very Good

Source: Data Processing Results

Based on the data presented in Table 2, it is shown that the material aspect obtained a final score of 87.5% in the Very Good category, the language aspect received a score of 85% in the Very Good category, and the media aspect obtained a score of 92.5% in the Very Good category. So the conclusion from this score is that the digital teaching materials developed are valid for testing and can be used in learning.

Digital teaching material products that have been validated by experts and declared valid for testing, then a revision and refinement process is carried out following suggestions for improvement from experts, both in terms of material, language, and media. The product revisions that have been carried out consist of (1) Digital teaching material is reasonable, only a little needs to be added about the latest early childhood scientific studies; (2) Consistency in the use of words, please readjust it; and (3) Try to use self-documented pictures and photos.

In the implementation phase (*implement*), researchers applied digital teaching material to undergraduate students in the PG-PAUD FKIP Universitas Sriwijaya Study Program who took the South Sumatra Traditional Games course. First, the researcher prepares a learning environment that follows the policy in the conditions that are currently happening, namely the application of the hybrid learning method (a learning method that combines online learning dan offline learning). At this stage, the researcher conducted one-to-one trials on 6 (six) students with high, medium, and low ability category criteria. Researchers provide learning using digital teaching materials that have been developed. At the end of the lesson, students were asked to fill out a response questionnaire regarding using digital teaching material.

The results of the questionnaire that students filled in at the one-to-one trial stage obtained responses from students of 94.6% in the Very Eligible category. Next, the researcher conducted a small-scale or small-group trial of 15 (fifteen) students with high, medium, and low ability category criteria. Researchers provide learning using digital teaching materials that have been developed. At the end of the lesson, students were asked to fill out a response questionnaire regarding using digital teaching material. The results of the questionnaire that students fill in at the small-scale trial stage or small group obtained responses from students of 91.3% in the Very Eligible category. The results of this trial show that in the aspects of attractiveness, convenience, and usefulness of using digital teaching material that has been developed, they are declared suitable for use by students in the learning process in the South Sumatra Traditional Games course.

In the last stage, namely the evaluation stage (*evaluate*), the researcher assessed the quality of the product in the learning process, both before and after using digital teaching material. Researchers used questionnaires and tests (pre-test and post-test) in large-scale trials or field tests on 20 (twenty) students to measure the practicality and potential effects of using digital teaching material developed to increase student learning outcomes in the South Sumatra Traditional Games course. The average pre-test score was 66.1, and the post-test average was 92.7. The results of large-scale trials or field tests show an increase in student learning outcomes of 26.6 and an N-Gain of 0.78 in the High category. Based on the results of large-scale trials or field tests shows that the use of digital teaching material that has been developed is stated to be practical and has a potential effect on the ability of student learning outcomes in the South Sumatra Traditional Games course at the PG-PAUD FKIP Universitas Sriwijaya Study Program.

Discussion

Teaching material is one of the materials that contain a description of material about knowledge and experience as well as theory and practice, which is specifically discussed and used by students and learners to make it easier to understand several materials or certain subjects that are in line with the curriculum in the learning process. It is further explained that textbooks and instructional materials are crucial in teaching and learning. These assist teachers in achieving a lesson's objectives (Frimpong, 2021). This shows that the existence of teaching material is essential to improving the quality of education. Teaching materials make it easier for students to obtain knowledge and information related to teaching material in a systematic and programmed manner. Through teaching material, students can develop competence according to the teaching material

and can motivate mastering teaching material, either with specific methods or media. Teaching material can also make it easier for lecturers to convey material programmatically according to the demands of the curriculum. The expected learning outcomes can be explained systematically in teaching material so that lecturers are assisted in determining the media, methods, and assessment tools according to plan.

The rapid advancement of information technology in education has changed conventional teaching material into digital teaching material. Digital teaching material is a teaching material that utilizes digital devices and is supported by specific application software. The development of this technology influences the behavior of students who tend to use technology in everyday life. Generally, the age range of 20-25 years is students who use computers for 35.3 hours per week to do assignments using software, do office work, and communicate through social networks (Juraida, 2016). This is an opportunity and a challenge for lecturers to carry out the learning process following the behavior of students accustomed to using technology. One is the development of digital teaching material as a form of technological advancement in world education.

The results of the preliminary study that the researchers conducted with lecturers, teaching teams, and students of the PG-PAUD FKIP Universitas Sriwijaya Study Program found that in the learning process in the South Sumatra Traditional Games course, it was stated that the lack of availability of literature as a source or reference for materials related to those courses. While participating in learning in these courses, students need to go to the field (community environment in certain areas) to gain knowledge and understanding related to learning material. These activities reduce the effectiveness and efficiency of the learning process, resulting in decreased student learning outcomes. Because these activities require a lot of energy, time, and materials, making it difficult for students, lecturers, and team teaching.

Based on the problems above, this study aims to develop digital teaching material for the South Sumatra Traditional Games course for undergraduate (S-1) students of the PG-PAUD FKIP Study Program at Universitas Sriwijaya. The development of digital teaching material is prepared based on the course syllabus and adapted to the characteristics of its users, namely students as prospective Early Childhood/Kindergarten educators. Digital teaching materials are developed by utilizing technology, and this needs to be done to meet the needs of students who are digital natives (FH et al., 2021). A digital native is a term attached to generation Z (the generation that grew up in an all-digital and sophisticated world). The presence of this digital teaching material has a potential effect on improving the learning outcomes of undergraduate (S-1) students in the PG-PAUD FKIP Universitas Sriwijaya Study Program in the South Sumatra Traditional Games course.

The development of digital teaching material in the South Sumatra Traditional Games course for undergraduate (S-1) PG-PAUD FKIP Study Program, Universitas Sriwijaya, uses the Research and Development method. One design for the development of digital teaching material that is often used is the ADDIE model (Cahyadi, 2019) through 5 (five) stages, namely: the analysis stage (*analyze*), the design stage (*design*), the development stage (*development*), the implementation stage (*implement*), and the evaluation stage (*evaluate*). The ADDIE model can guarantee the quality of digital teaching material. Because the systems approach to the ADDIE model divides the product development planning process into several steps, sequenced in a logical sequence, then using the output of each step as input for the next step.

The results showed that the development of digital teaching material in the South Sumatra Traditional Games course was based on validity tests from experts, namely from the material aspect, language aspect, and media aspect, it obtained the Very Good category from the indicators of content eligibility, presentation eligibility, a language component, graphic eligibility, and display eligibility. Based on the analysis results obtained from experts, several suggestions are used as reference material for improving the digital teaching material being developed (Sari et al., 2022). Furthermore, the digital teaching material produced was field tested through 3 (three) stages, namely the one-to-one trial stage, which was carried out on 6 (six) students, small group trials, which were carried out on 15 (fifteen) students, and field tests conducted on 20 (twenty) students. Researchers used student response questionnaires regarding digital teaching material in one-to-one and small-group trials. The conclusion from the results of the response questionnaire that students have filled in is that it is in the Very Eligible category.

Meanwhile, at the field test trial stage, the researcher used the pre-test and post-test to use the developed digital teaching material. The field test trials showed an increase in student learning outcomes of 26.6 and an N-Gain of 0.78 in the High category. Students responded positively in the practical category to learning using the developed digital teaching material. This practicality shows the convenience of students in using digital teaching materials produced following the tools, materials, and media used in learning that are readily available and easy to use (Suniasih, 2019). Based on the results of validity tests and field trials, it was shown that the use of digital teaching material in the South Sumatra Traditional Games course was stated to be valid, eligible, and practical and had a potential effect on the learning outcomes of undergraduate students in the PG-PAUD Study Program, FKIP, Universitas Sriwijaya.

Researchers realize that the development of digital teaching material is not perfect, so it has limitations, namely, this research only develops teaching material in digital form. This digital teaching material has not been developed interactively, so it is necessary to carry out further development to create interactive digital teaching material by combining two or more media to assist users in visualizing material clearly through pictures, videos, and animations designed attractively and can interact with its users (Khamidah et al., 2019). Thus, it is hoped that it will have implications for users of teaching material to be more effective (more accessible) and efficient (faster) in understanding the materials presented.

CONCLUSION

Digital teaching material for the Traditional Games of South Sumatra course was developed based on the results of preliminary studies conducted by researchers and adapted to the needs of students as their users. The development of this digital teaching material has been validated by experts (*expert review*) on the material aspect, which scored 87.5% in the Very Good category, the language aspect, which scored 85% in the Very Good category, and the media aspect which scored 92.5 % in the Very Good category. This concludes that the digital teaching material that has been developed is valid to be used in the learning process. In the one-to-one, small group, and field test trials, positive responses were obtained from undergraduate (S-1) PG-PAUD FKIP Universitas Sriwijaya Study Program students regarding the use of digital teaching material in the South Sumatra Traditional Games course. The results of the one-to-one trial were 94.6% in the Very Eligible category, while the small group trial results were 91.3% in the Very Eligible category. Furthermore, in the field test trials, digital teaching material improved student learning outcomes, as indicated by an increase in pre-test and post-test scores of 26.6 and N-Gain of 0.78 in the High category. So it can be concluded that the digital teaching material developed has been tested as valid, eligible, and practical to be used in the learning process in the South Sumatra Traditional Games course at the PG-PAUD FKIP Study Program, Universitas Sriwijaya. The recommendation for further development is needed to create interactive digital teaching material that combines two or more media (text, images, graphics, audio, and video) which are controlled by following directions from an order. For further research, this teaching material can be developed in an interactive digital manner so that users can understand more clearly and in detail.

ACKNOWLEDGEMENT

The researcher would like to thank the Rector of Universitas Sriwijaya, who has funded this research through the DIPA Budget of the Universitas Sriwijaya Public Service Board for Fiscal Year 2021. SP DIPA-023.17.2.677515/2022 Dated December 13, 2021 Number: 0019/UN9/SK.LP2M.PT/2022 June 15, 2022, following the Phase II Science, Technology and Arts Scheme Research Contract of LPPM Universitas Sriwijaya for the 2022 Fiscal Year Number: 0165.057/UN9/SB3.LP2M.PT/2022 June 27, 2022. Thanks to expert reviews, validator digital teaching material aids, undergraduate (S-1) students of the PG-PAUD Study Program FKIP Universitas Sriwijaya, and all parties involved and assisted in the completion of this research. The researcher also thanks the Jurnal Inovasi Teknologi Pendidikan team for helping and providing input in publishing this journal article.

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Jurnal Inovasi Teknologi Pendidikan
Volume 10, No. 1, March 2023 (76-86)
Online: http://journal.uny.ac.id/index.php/jitp

Development of Android-based landslide disaster mitigation learning media for disabilities elementary school

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ARTICLE INFO

Article History
Received:
19 July 2022;
Revised:
7 January 2023;
Accepted:
13 January 2023;
Available online:
09 March 2023.

Keywords
Android;
disabilities;
learning media;
disaster mitigation;
landslide.

ABSTRACT

The Klaten Regency area is included as a disaster-prone area. One of the disasters that often hit this district are landslides. This increases the risk that human safety is threatened, especially for people with disabilities. This condition will get worse if they do not have education about disaster mitigation. This study aims to develop an Android-based landslide disaster mitigation medium for elementary school disabilities. This media uses three types of software: Kodular to create Android applications, Blender to create 3D animations, construct to make games, and FlipPDF to create e-books. This study used the Research and Development (R&D), research method in conjunction with a waterfall process development model. To get the feasibility results, this medium was tested on experts and users, the first being tested on two media experts, with a percentage result of 88.8%, so that it was declared very feasible. The second was tested on two e-book material experts with a percentage of 98.5%, so it was declared very feasible. The third was tested on two video material experts with a percentage of 98.94%, so it was declared very feasible. The fourth was tested on users and got a percentage result of 78.4%, so it was stated that this medium was appropriate.

How to cite:
Rosyada, A. Q., Pramudita, D.A., Sayekti, I. C., Susilawati, S. A. (2023). Development of Android-based landslide disaster mitigation learning media for disabilities elementary school. *Jurnal Inovasi Teknologi Pendidikan*, 10(1), 76-86 doi: https://doi.org/10.21831/jitp.v10i1.52575

INTRODUCTION

Geographically, the Republic of Indonesia is a country located between the Asian and Australian continents and the Indian and Pacific oceans. While astronomically the Unitary State of the Republic of Indonesia is located right on the equator where in this case the position is based on latitude 6º LU (North latitude) - 11 º LS (South latitude). Geographical and astronomical location is what causes the impact of climate change in Indonesia. The location of Indonesia which is on the equator causes Indonesia to have a tropical climate. The negative impact of the condition of Indonesia's territory makes Indonesia vulnerable to geological disasters such as volcanic eruptions, floods, landslides, etc. (Aini & Daniah, 2020).

Based on the 2013 Indonesian Disaster Risk Index (IRBI) released by the National Disaster Management Agency (BNBP) shows that Klaten Regency has a high disaster risk index for natural disasters, one of which is landslides. According to one of the Klaten BPBD officers, areas that are vulnerable to landslides in Klaten Regency include the Bayat, Ganwarno, Cawas and Wedi sub-

districts. The geographical location of Klaten Regency is on the slopes of Mount Merapi which has quite high slopes. In terms of percentage, the slope ranges from 5% to >45%, and the slopes are classified as gentle to very steep, making it possible for landslides to occur. In addition, according to (Priyono et al., 2015) said that people in the Klaten district carry out mining activities where most of these activities are carried out manually and do not meet safety standards. This activity causes the base of the slope to be eroded and the impact is landslides.

This risk poses a threat to human safety, especially disaster-prone groups. One of the disaster-prone groups is people with disabilities/ disabilities (Siregar & Wibowo, 2019) Based on Law Number 19 of 2011 Concerning Legalization of the Rights of Persons with Disabilities, it is stated that a disability is a person who has physical, mental, intellectual or sensory limitations for a long period of time where interacting with the environment and attitudes of society can encounter obstacles that make it difficult to participate fully and effectively on the basis of equal rights.

Persons with disabilities are one of the groups that are vulnerable to natural disasters, especially when they lose their family, assistive devices and mobility devices which hinder access to information (Hayati et al., 2021). This condition will get worse if persons with disabilities do not have knowledge about disaster mitigation. The findings from a survey conducted by The United Nations Office for Disaster Risk Reduction (UNDRR) in 2013 stated that 70% of persons with disabilities who participated did not receive a personal preparation plan and only 17% knew about disaster management plans in their respective communities. This proves that information about disasters and mitigation training for persons with disabilities is still lacking.

Based on DTKS (social welfare integrated data, ed) there are 11,661 people with disabilities in Klaten. This means that in every region persons with disabilities have problems facing disasters (Santoso et al., 2015). Then according to Klaten Regent Regulation No. 6 of 2014 concerning Disaster Guidelines for Klaten Regency, it is stated that Klaten Regency has implemented disaster preparedness schools from the lowest school level, namely early childhood education programs to Senior High School, but this implementation does not include learning for children with special needs.

Based on the results of interviews and observations conducted at 13 SLB elementary schools in Klaten Regency, it was found that education about landslide disaster mitigation in schools is still lacking. Learning media for landslide natural disaster mitigation in schools is also still minimal. Several schools have provided disaster mitigation education through outreach and disaster mitigation simulations for disabilities, while others have not provided disaster mitigation materials for disabilities in schools.

The Android platform was chosen because in terms of technology this platform has developed rapidly and there are many choices of devices, so many people choose to use this platform. In addition, the Android platform has many advantages such as easy use, easy to carry anywhere, providing convenience, multi-tasking, etc. In addition, based on interviews with several SLB teachers in Klaten Regency, they said that Android devices were more practical and comfortable to use as learning tools. Users with disabilities also find it easier to operate Android by using a feature found on Android, namely "talkback".

METHOD

This research was conducted in 13 elementary schools in Klaten District using the Research and Development (R&D) method. The research development model was designed using the Waterfall Process Model Development model. According to (Pressman, 2005) this model consists of 5 steps, namely: (1) Communication; (2) Planning; (3) Modeling; (4) Construction; (5) Deployment as shown in Figure 1.

The first stage is communication, in this stage information is collected about user needs. The activities carried out are user needs analysis, software requirements analysis and literature study. Researchers collected user needs analysis data by distributing questionnaires to several parties, namely teachers and elementary school students in Klaten Regency in order to find out what kind of learning media they wanted. The results of this needs analysis can be used to proceed to the second

stage, namely Planning to plan application development, an explanation of the product to be produced and planning a schedule of activities. Next is the Modeling stage, at this stage the overall system design is carried out, starting from the data structure design, system workflow, system interface display. After the system design is made, the next stage is the Construction stage, namely the coding process. In developing this application researchers use codular software as shown in Figure 1.

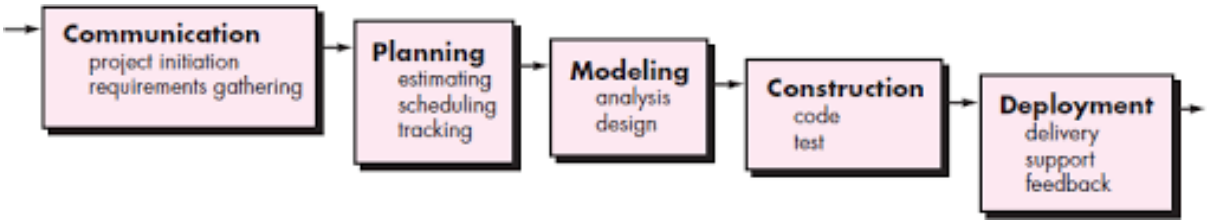

Figure 1. Waterfall Process Model by (Pressman, 2005)

The last stage is Deployment, the application that has been made will be tested to get feedback. This test is done to ensure the application is appropriate or not. In addition, another goal is to determine the feasibility of this developed application. This test is carried out using expert testing methods in Figure 2 as follows:

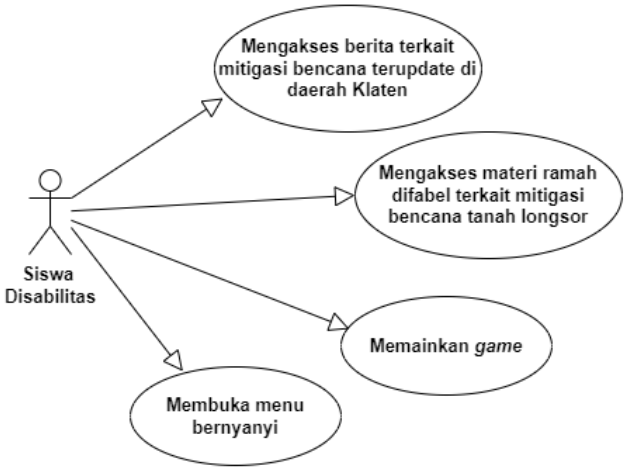

Figure 2. Use Case Application Diagram

RESULT AND DISCUSSION

Result

This research develops a product intended for persons with disabilities in order to gain knowledge about Android-based landslide disaster mitigation. This media was developed using 3 software, namely, Kodular Creator to make the main application, Blender to make 3D animated videos and Construct to make the game. This media was developed based on the analysis of user needs to match what they want. Needs analysis was obtained by distributing questionnaires to respondents, namely teachers and elementary school students in Klaten Regency.

As many as 57.5% of teachers have used learning media, meaning that more than half of the total SLB teachers in Klaten Regency have used learning media. The learning media used mostly is learning videos (53.5%). Then according to them as much as 58.3% of teachers are more comfortable using smartphones as teaching aids because they are more convenient and practical. Then as many as 59.8% of SLB teachers in Klaten Regency have used interactive learning media, according to them (61.1%) the media is effective. Furthermore, as many as 99.2% of SLB teachers in Klaten Regency agreed that an Android application would be developed as a learning medium for disaster mitigation. The results of the questionnaire can be shown in Figure 3.

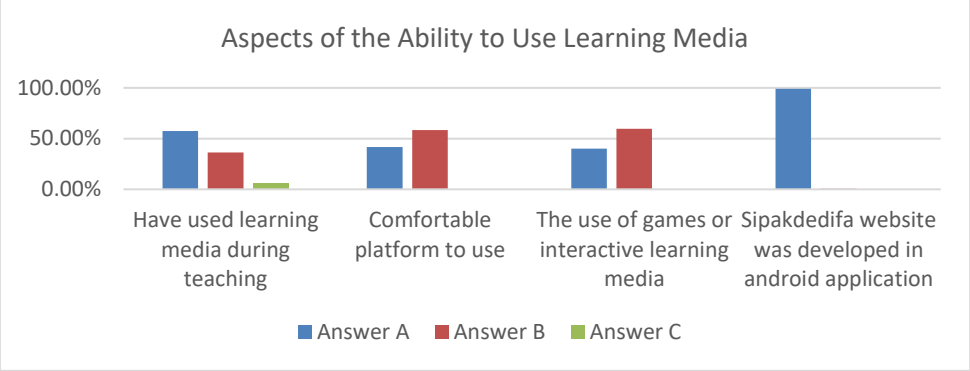

Figure 3. Aspects of the Ability to Use Learning Media

After that, as many as 62% of teachers and 50.3% of students said that e-books were not available for persons with disabilities, meaning that there was still little availability of e-books for persons with disabilities. Furthermore, as many as 51.2% of teachers and 54% of students said that the landslide e-book was inadequate. Then as many as 99.2% of teachers and 100% of students said the landslide mitigation e-book needed to be developed. The result can be seen in Figure 4.

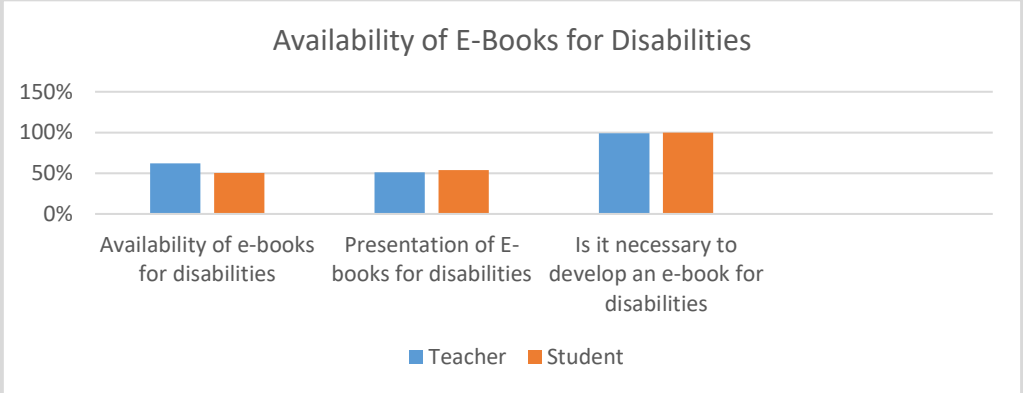

Figure 4. Aspects of the Need for E-Books

In addition, as many as 63% of teachers and 48.6% of students said that disaster mitigation videos for disabilities were not available. Then as many as 98.3% of teachers and 99.3% of students said that disaster mitigation videos needed to be developed. The developed media contains material in the form of e-books and animated videos. Based on the results of the analysis of the needs of the e-books and videos along with the specifications of the videos and e-books developed, the result can be seen in Figure 5.

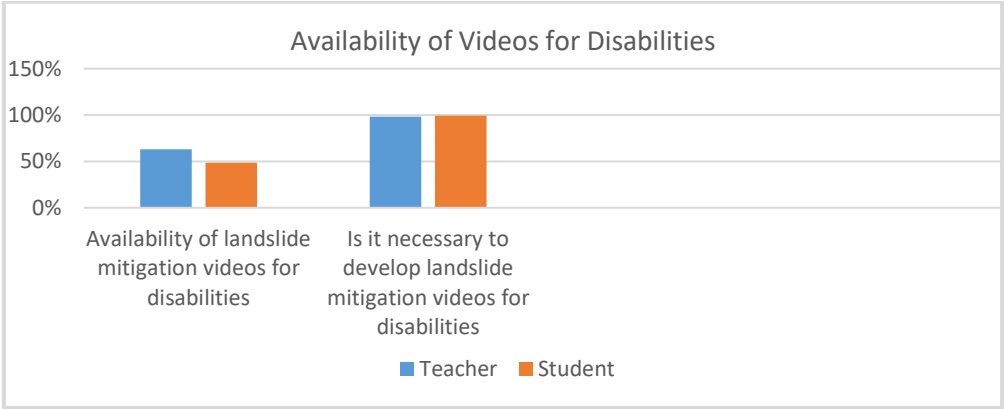

Figure 5. Aspect of Video Requirements

Furthermore, the result of the analysis aspect of video requirements as shown in Figure 5., it is found that there is a need for the development of disaster mitigation videos, which include media in the form of e-books and animated videos. The contents contained in the e-book and animated video can be seen in Table 1.

Table 1. Specifications for E-Books and Animated Videos

E-Book	Video
a. Presentation of material that has to do with the area around	a. The mitigation video contains learning objectives
b. Learning objectives are written clearly after the original	b. Detailed and clear video presentation
c. There are instructions for using the module	c. There is an introduction/opening video
d. The module display criteria are lots of interesting info about landslide disaster mitigation and lots of pictures	d. The video contains material in animated form accompanied by examples
e. There are quizzes, interesting info and facts	e. There is sign language
f. At the end of the e-book there are evaluation questions	f. The language style used is communicative
g. Image presentation is full color with HD quality	g. Use of language that is easy to understand
h. The presentation of the material is brief accompanied by examples	h. Presentation of material in the form of visual audio with text
i. The style of language used is using language that is easy to understand	i. The video display is balanced between material and simulation
j. The criteria for using language are a mixed style, polite and easy to understand	j. Free music theme
k. The appearance of the e-book cover is full color and the images represent the contents of the book	k. Free video display color
l. Author customized e-book design	l. Video duration is 5-10 minutes
m. A4 book size	
n. n. The font is adjusted by the author	

Learning media can be accessed via Android so that it is more practical. This media has 4 main menus, namely news update menu, learning menu, playing menu and singing menu. Products that have been developed by researchers have been tested to determine the feasibility of the products that have been made. This test was carried out by distributing questionnaires to respondents.

Media Eligibility Test

The media test was carried out on 2 lecturers of Informatics Engineering Education (FKIP) Muhammadiyah University of Surakarta using a Likert scale. According to (Sugiyono, 2019) the Likert scale is used to measure attitudes, opinions, and perceptions of a person or group of people about social phenomena with the following scale options in Table 2 as follow:

Table 2. Likert Scale

Scale	Interpretation
1	Very Not Good
2	Not Good
3	Pretty God
4	Good
5	Very Good

The results of this test get a score of 222 out of a maximum score of 250. The score obtained is the sum of the scores given by the experts, while the maximum score is obtained from the total maximum rating score. The following are the results of the tests carried out as shown in Table 3.

Table 3. Media Test Result

Question Code	Expert 1	Expert 2	Question Code	Expert 1	Expert 2
1	4	5	14	5	5
2	4	5	15	4	5
3	5	5	16	5	5
4	5	4	17	4	4
5	4	4	18	5	5
6	4	4	19	4	5
7	5	5	20	5	5
8	4	4	21	3	4
9	5	4	22	4	4
10	5	4	23	4	4
11	5	4	24	5	4
12	4	4	25	4	5
13	5	4			
Total Score			222		
Maximum Score			250		

$$\textit{Eligibility presentation}\ (\%) = \frac{Total\ score}{Maximum\ score} \text{ x } 100\% \qquad (1)$$

$$\textit{Eligibility presentation}\ (\%) = \frac{222}{250} \text{ x } 100\% = 88{,}8\%$$

The results of the media feasibility calculation get a percentage is 88.8% as shown in Formula 1. Based on the feasibility percentage in Formula 1 it shows that the developed media is very feasible as shown in Table 4.

Table 4. Likert Scale of Media Eligibility Percentage

Eligibility Presentation	Interpretation
81%-100%	Very feasible
61%-80%	Feasible
41%-60%	Enough
21%-40%	Not worth it
1%-20%	Not Feasible

Feasibility Test of E-Book Material

The material test was carried out on experts, namely one member of the BPBD of Klaten Regency and one of the SLB SD teachers in Klaten Regency. Feasibility testing by material experts was carried out by calculating the Likert scale and obtaining a score of 197 out of a maximum score of 200. The following are the results of the tests that have been carried out and can be shown in Table 5.

Table 5. E-Book Material Test Result

Question Code	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Total
Expert 1	5	5	5	5	5	5	5	5	5	5	4	4	5	5	5	5	5	5	5	93
Expert 2	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	95
Total Score																				188
Maximum Score																				190

Feasibility Test for Video Animation Material

The results of the media feasibility calculation get a percentage of 98.5%. Based on the feasibility percentage table using the Likert scale, it shows that the media developed is very feasible.

The material test was carried out on experts, namely one member of the ULD-PB of Klaten Regency and one of the SLB SD teachers in Klaten Regency. Feasibility testing by material experts gets a score of 188 from a maximum score of 190. The result can be shown in Table 6.

Table 6. Video Animation Material Test Result

Question Code	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Total
Expert 1	5	5	5	5	5	5	5	5	5	5	4	4	5	5	5	5	5	5	5	93
Expert 2	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	95
Total Score																				188
Maximum Score																				190

The results of the media feasibility calculation get a percentage of 98.94%. Based on the feasibility percentage table using the Likert scale, it shows that the media developed is very feasible.

User Test

The user test was carried out by representatives of 50 elementary school students in Klaten Regency. This test is calculated using the Guttman scale. The results of the questionnaires that have been filled in by students are then included in the percentage scale range with the following calculations in Formula 2 and Formula 3.

Answer "Yes" : 1 x average / 100%
: 1 x 0,784 x 100%
: 78,4% (2)

Answer "no" : 0 x 100% / 0%
: 0 x average / 100%
: 1 x 0,216 x 100%
: 0% (3)

So, it can be described on a Formula 4 as follows:

0%----------50%----------78,4%----------100% (4)

From the Guttman Scale analysis in Formula 4, the suitability point is above 50%, namely 78.4%, so it can be said that the media is close to being suitable. The conclusion is that the media approaches the percentage of 78.4%.

Discussion

After finishing developing the animated video, the following views are obtained. The first display in this video animation is the Splash page and main menu display in Figure 6.

Figure 6. Splash Page and Main Menu Display

In this view several main menus are presented namely the news update menu, the learning menu, the play menu and the singing menu. The news update menu is a menu that contains the latest

news regarding the activities or potential of persons with disabilities in Klaten. The learning menu is a menu that presents material on landslide disaster mitigation. The game menu is a menu that presents games. Then sing menu is a menu that presents audio sing.

This media animation provides an e-book which contains material on disaster mitigation for persons with disabilities in Klaten Regency. This page presents landslide mitigation material in the form of an electronic book. This e-book is equipped with a sign language trainer to help the deaf and mute with disabilities. In addition, this e-book is also equipped with audio to help blind people with disabilities. There is also a game menu that makes it interesting, which contains some buttons, namely the button simulation before the disaster, during the disaster, and after the disaster. These menus can be seen in Figure 7.

Figure 7. Display of E-Book, Video Content, and Game Pages

In the initial appearance of the game page, it is presented in the form of cases or simulations of landslides. This display encourages people with disabilities to do the right thing when an avalanche occurs. After finishing reading the instructions or questions, then we will be directed to the landslide disaster simulation view. Presented conditions where there are a lot of goods before the landslide occurred. In this game, the user is asked to put the items needed in the event of a landslide into a disaster prepared bag. If the item is entered correctly, the user will get a score of 10 and if it is wrong, the score will be reduced by 5. The display can be seen in Figure 8.

Figure 8. Game Simulation before Disaster

The other display in this learning media, there is of the “during disaster” play page. This page is one of the games provided in this application. In this game the user is asked to follow the evacuation route to find a gathering point and is given 1 minute to challenge this game. If the time runs out it will be game over. This game has the intention of simulating when a landslide occurs, all you have to do is go out following the evacuation route to the assembly point. The page is illustrated in Figure 9.

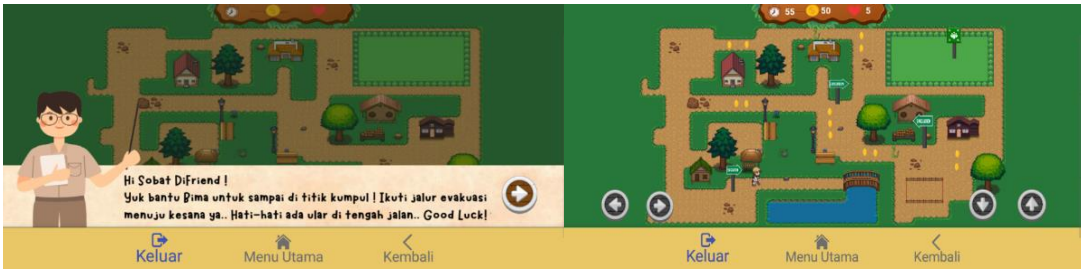

Figure 9. Game Simulation during Disaster

In the last one, there is “after disaster” game, which means the user is asked to choose the correct action after a landslide disaster occurs by pressing the numbers on the game screen that is presented. The user is given 1 minute to choose the answer provided. If the answer chosen is correct, a tick notification will appear indicating that the answer chosen is correct and 25 points will be awarded, whereas if the answer chosen is incorrect, a cross notification will appear indicating that the answer is wrong and points will be reduced by 15. The display can be shown in Figure 10.

Figure 10. Game Simulation after the Disaster

Furthermore, in this learning media, there is the last menu which name sing menu. This is the menu which contain of simulation when the disaster is coming. This page contains song lyrics as well as play and pause buttons. The play button functions to start singing, here the application will make a singing sound, while the pause button functions to pause singing, here the application will stop the singing sound. In addition, this page provides back and exit navigation buttons. The back button functions to return to the previous page or home page, while the exit button functions to exit the application. The lyric is illustrated in Figure 11.

Figure 11. Sing Page Display

CONCLUSION

Based on the test results and discussion in this study, it can be concluded that the product developed in this study is an Android application which includes material on landslide disaster mitigation for persons with disabilities. This media presents 2 forms of material, namely 3D animated videos and also e-books. In addition, this media provides a simple game to find out how much users understand after using the application and also provides information on the latest disaster news in Klaten Regency. This media is equipped with audio and sign language demonstrations to make it easier for persons with disabilities. The media that has been developed by this writer is classified as very feasible. This is evidenced by the results of the media expert, material expert and user questionnaire calculations.

ACKNOWLEDGEMENT

Thank you to the students and teachers at SLB Klaten Regency who have helped fill out the questionnaire for research data needs. Thank you to BPBD Klaten Regency for their willingness to provide the data the researchers needed, and to all parties involved in completing the feasibility test of the Android application as a landslide mitigation medium.

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Jurnal Inovasi Teknologi Pendidikan
Volume 10, No. 1, March 2023 (87-105)
Online: http://journal.uny.ac.id/index.php/jitp

Trends of education and training teacher competency in information and communication technology

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ARTICLE INFO

Article History
Received:
05 December 2022;
Revised:
14 February 2023;
Accepted:
06 March 2023.
Available online:
09 March 2023.

Keywords
Competency-based training; information and communication technology; teacher competence.

ABSTRACT

The industrial era 4.0 is a time when all fields of work involve technology. Massive technological changes occurred in the industrial era 4.0, including the world of education. The world of education must be able to produce Human Resources (HR) that can compete in the industrial era 4.0. The development of human resources, especially educators, is one of the things that must be considered in the industrial era 4.0 and education 4.0. This research is a type of Systematic Literature Review research that seeks to describe the importance of competency-based education and training to improve Information and Communication Technology (ICT) competencies in the industrial era 4.0. In this study, the authors used a variety of written sources such as articles, books, and documents relevant to the study. This study focuses on the role of competency-based education and training curricula in enhancing teachers' ICT competencies. The results of the study show that competency-based education and training are quite effective in increasing ICT competence in teachers in facing the industrial era 4.0. Therefore, recommendations for further research could be in the form of developing a competency-based education and training curriculum in improving teacher ICT competence.

How to cite:
Ekantiningsih, P. D., & Sukirman, D. (2023). Trends of education and training teacher competency in information and communication technology. *Jurnal Inovasi Teknologi Pendidikan*, 10(1), 87-105. doi: https://doi.org/10.a/jitp.v10i1.52630

INTRODUCTION

The industrial revolution was a massive change in various fields and had a major influence on technological civilization. We never know how much the development of technology will affect human life because technological developments are still growing today. One that becomes a reference in the industrial revolution is that all work carried out by humans will later be replaced by machines.

The history of the industrial revolution began at the end of the 18th century, which was marked by the discovery of steam engines and work mechanization. This period is referred to as the era of the Industrial Revolution 1.0. At the end of the 19th century, there was a significant change seen in the industrial world marked by the presence of factories based on electrical energy. This period is referred to as the era of the Industrial Revolution 2.0. During the Industrial Revolution 3.0, which occurred in the 20th century, a very rapid development of technology was marked by the use of

electronic equipment and information technology (IT) used in the production process in factories. In this era, there is a lot of reduction in labor or laborers because the use of human labor has been drastically reduced. In the Industrial Revolution 4.0, there was a very significant change and development. At this time there was a comprehensive change in various industrial fields through the merging of digital and internet technology with conventional industries (Gabriela Pereira Carvalho and Walmir Cazarini, 2020). These changes are innovations in the Industrial Revolution 4.0, including the Internet of Things (IoT), Big Data, Printing 3D, Artificial Intelligence (AI), vehicles without drivers, genetic engineering, robots, and smart machines.

The Era of Industrial Revolution 4.0 changed the concepts and structures of work and competencies needed by the world of work. Digitalization systems in work facilitate companies in the production process. Work becomes effective and efficient and produces more production. This condition benefits the company because there is no need to add workers (employees) and can even reduce it.

The industrial era 4.0 is dominated by digital technology. Whatever the job, almost all digital. For the millennial generation, the development of technology will be easily accepted, but for generations X and previously, it will be difficult to accept and follow the times. Therefore, the ability to operate technology in the 4.0 era is needed.

Increasing the competence of workers in the industrial era 4.0 requires the world of education to improve. The world of education does not only focus on the transfer of knowledge but also the transfer of skills. The curriculum used must also be oriented to the competencies needed to face the industrial era 4.0.

Industrial Revolution 4.0 is related to the development of Information and Communication Technology (ICT). The development of ICT plays an essential role in the development of the world of education. As time develops, learning technology has experienced development. Before digital technology entered the realm of education, all learning and school administration still used manual techniques, such as printed books, manual blackboards, written administrative journals, and other manual techniques. Nowadays, a combination of technology is often found, which helps to learn easier, more interesting, more effectively, and more efficiently, such as the combination of audio-data, video, audio-video, and the internet. The internet is beneficial in meeting learning information resources and administrative implementation, such as sending letters, tasks, etc.

Information and Communication Technology (ICT) is a technology that includes all technical equipment for processing and conveying information. ICT includes two aspects, namely Information Technology and Communication Technology. The term information technology includes all matters relating to the process, use as a tool, manipulation, and information management. While communication technology is everything related to the use of tools to process and transfer data from one device to another (Sutopo, 2012). Although ICT is often equated with information technology (IT), ICT coverage is more comprehensive. ICT often describes a broader choice of type, data format, and communication. The development of ICTs continues to increase along with human needs that also continue to increase. The use of electronic-based facilities continues to emerge, such as e-wallets, e-learning, e-government, and others.

Welcoming the Industrial Era 4.0, teachers are also required to have the following five competencies: (1) Educational Competence; (2) Competence for Technological Commercialization; (3) Competence in Globalization, the world without a bulkhead, not stuttering to various cultures, hybrid competencies, and advantages of solving problems (problem solver competence); (4) Competence in Future Strategies, the world easily changes and runs fast so that it has the competence to predict precisely what will happen in the future along with its strategy; (5) Counselor Competence. To realize this, the competence and creativity of teachers are needed to face these challenges. Teachers who master the knowledge and ability to adapt to new technology and global challenges can influence students' skills and knowledge (Zulkifli, 2020).

The challenge of teacher competence during the rapid development of technology is to have strong competence and soft skills and equip students with 21st Century Skills (Fitriyah, 2019). The reality on the ground is that many teachers still have not been able to keep up with technological developments. As happened at SMP N 1 Muaro Jambi. Where some teachers have not been able to carry out the ICT -based learning process, especially compiling and making teaching materials, so

the learning process is only traditional, namely by lectures, and a little question and answer (Yantoro and Idrus, 2021). The same thing happened in SMP N 8 Bekasi, the use of technology to help the teaching and learning process is still very minimal. Especially computers as learning media. This is because the skills in computer operation are still very minimal (Wibowo et al., 2020). There are still many teachers who use products in the 80s in the sense that teachers are still teaching in conventional ways while students used modern equipment, whereas the way to teach teachers in pre-modern periods is not suitable for the character of students today (Latif, 2020). Therefore, training is needed for teachers to improve their abilities or competencies in utilizing ICT. The training program is designed in such a way as to be adjusted to developments in the era of the Industrial Revolution 4.0 so that teachers become competent and professional (Fitriyah, 2019).

In organizing training to improve competencies participants can use competency-based training models. Competency Based Training (PBK) is a training approach that emphasizes the development of skills, knowledge, and attitudes (knowledge, skills, and attitudes) to meet a competency standard (Putra et al., 2020). Previous research, has implemented a CBT training model for training and teaching imaging and sonography, and achieved good results (Fong et al., 2021; Goniewicz et al., 2021). The same thing was experienced with employee training in the company, and the implementation of competency-based training was able to improve employee competencies and performance. Even competency-based training has significant positive management of performance improvement. That means that if the implementation of competency-based training is getting better, the performance of the employee will also increase. Then, competency-based learning can be a valuable asset for learning organizations that focus on improving the performance of their employees (Chen et al., 2022; Emerson & Berge, 2018; Hani, 2020; Octhanantha et al., 2017).

In this literature study, researchers contribute to exploring the study about (1) The conditions of Teacher ICT Competencies in Indonesia today, (2) The importance of ICT competencies for teachers, and (3) the role of competency-based education and training in improving teacher competencies. This article will further highlight the application of competency-based training that can improve teacher ICT competencies.

METHOD

This research is a qualitative study using the Preferred Reporting Item for Systematic Reviews and Meta-Analytic (PRISMA) Methods. All articles that pass the selection are then reviewed and summarized based on the title, purpose, author's name, year of publication, number of respondents, research methods used, and research results. This article highlights the concepts of competency-based education and training and improves teacher competencies in the field of ICT through competency-based training.

The literature search in this study is limited to articles published in 2017-2022 and published in Indonesian and English (IC1). Search articles are done online using the search word "Education and Training, Teacher Competencies, ICT for Education, Competency Based-Training" in Title and Keywords. Other criteria included include research on the condition of teacher competencies in Indonesia today, increasing competencies with competency-based training, and research on the Industrial Revolution 4.0 (IC2). Furthermore, the excluded criteria are research in the form of a final project (thesis, dissertation, thesis, etc.). The research database used is from Google Scholar, Eric, and Taylor & Francis. The search process begins with reviewing the title and abstract of all search results and comparing them with established criteria.

A literature search can be seen in Figure 1. Search for research databases based on predetermined criteria obtained 100 research articles consisting of Google Scholar 54 articles, Eric as many as 20 articles, and Taylor & Francis as many as 20 articles. After scanning the title, abstract, and keywords 60 articles can be processed, two articles cannot be processed because they are final project research and 32 articles that cannot be processed. After all, they are not by IC2. In addition, the process that can be processed is filtered again by looking at the entire text. Twenty-six (26) articles are not processed because they are not by IC2 after being seen as all text and 34 articles can be processed as literature review material.

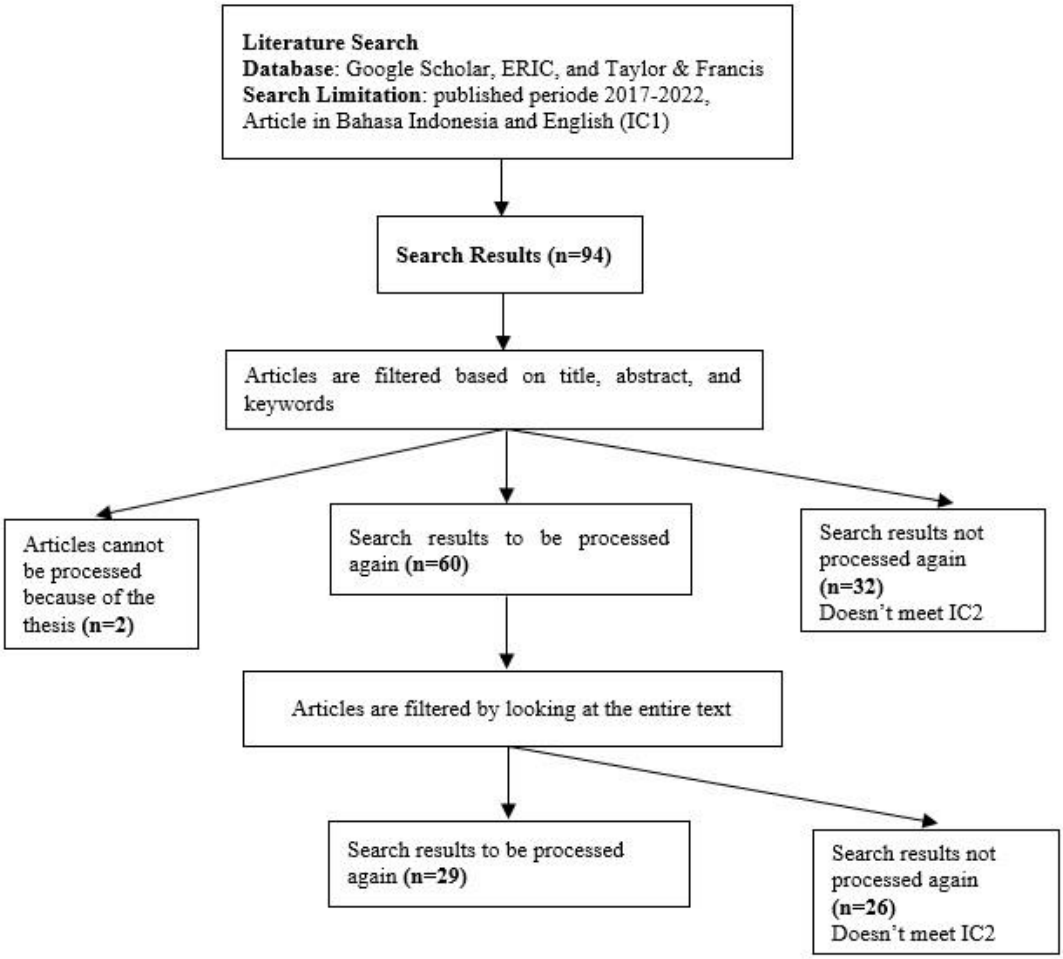

Figure 1. The Literature Search

RESULTS AND DISCUSSION

Results

Research conducted by Thabit Saleh Ahmed and T. A. Qasem (2020) with the title "Computer-Assisted Language Instruction in South Yemeni Context: A Study of Teachers' Attitudes, ICT Uses, and Challenges" gives the results that South Yemeni teachers' lack of implementing ICTs in their EFL classes. This can be attributed to many factors such as the lack of ICT tools in their departments, unavailability of the internet, and lack of computer competence and training. The study concluded with some recommendations that may help in implementing ICTs better in EFL education at the concerned universities particularly and at Yemeni universities generally. This study used a qualitative method with a sample of 81 EFL teachers.

Research conducted by Ahmed and Sayed (2020) with the title "Development of competency-based training system in Assiut ITEC: A case study" gives the results that the implementation of competency-based training not only gives students evidence to recognize their skills and knowledge but also provides information that school institution needs to improve teaching and learning. This study used a case study method. The sample used in this research is the Vocational School of ITEC, Egypt.

Research conducted by Ahmed and Sayed (2021) with the title "An extensive model for implementing competency-based training in technical and vocational education and training teacher training system for Assiut- Integrated Technical Education Cluster, Egypt" gives the results that the main feature of each competency-based training is to measure the learning that occurs in the training

program, not the time. This study used a case study method. The sample used in this research is the teacher of ITEC Assiut.

Research conducted by Amilia and Maiziani (2020) with the title "The competency of learning media based on information and communication technology by teachers in high school" gives the results that the average score of competency or mastery of ICT-based learning media in SMA Koto Tangah Padang City is included in the medium category of 45.06 %. Based on the data obtained, it is known that most of the teachers in the Koto Tangah District High School in Padang City are in the medium category (58.5%). From the survey, it was also found that the teacher still has not mastered the use of Microsoft Word and Microsoft PowerPoint applications. This will impact the optimization of ICT -based learning media in the learning process by the teacher. This study used a mixed method with a sample from the teacher at SMA Koto Tangah, Kota Padang.

Research conducted by Ardıç, Ö., and Çiftçi, H. (2019) with the title "ICT Competence and Needs of Turkish EFL Instructors: The Role of Gender, Institution, and Experience" gives the results that indicated that EFL instructors perceived their current ICT competence as low in the seven major areas. However, gender and previous PD (Performance Development) experience in ICT played a role in their perceived ICT competence. The study also revealed that regardless of gender, type of institution, previous PD experience in ICT, and teaching experience, EFL instructors reported a medium and higher amount of ICT training needs. The most preferred modes of PD in ICT were immersion or internship activities while the least preferred modes of PD were workshops/conferences/seminars. The implications of the study are also presented. This study used a quantitative method with a sample of 193 teachers of EFL.

Research conducted by Bahrissalim and Fauzan (2018) with the title "Evaluation of the training curriculum in improving the pedagogical competencies of PAI teachers at the Jakarta Religious Education and Training Center" gives the results that (1) The formulation of the training objectives and competencies of training participants in the curriculum design needs to be improved; (2) Training teaching staff guarantees the qualifications that have been determined by The Ministry of Religion Training; (3) Evaluation of the process and evaluation of post-training needs to be increased and added to monitoring and evaluation, and mentoring programs; (4) The education and training process can improve PAI teacher competencies. This study used a survey method. The sample used in this study is the Elementary School PAI Teacher Training at Jakarta Religious Training Center.

Research conducted by Batubara (2018) with the title "Competency of Information and Communication Technology for Elementary/MI Teacher (Portrait, Factors, and Efforts to Leave it)" gives the results that overview of the Competency of ICT Elementary/MI Teachers in Indonesia is in a good category and needs improvement, especially teachers in the outer regions. Some aspects of the teacher's ICT competency that are of concern are mastery of ICT devices, understanding of the design of teaching material development using ICT, and the method of using ICT devices in the classroom. ICT competency improvement strategies Teachers must involve the government, schools, teachers, professional organizations, and the community. This study uses the literature review method with the object of research being Elementary Schools Teachers in Indonesia.

Research conducted by Briones (2018) with the title "Teachers' Competency in the Use of ICT in Teaching Physics in the Junior High School" gives the results that (1) The ICT competency level of the Grade-8 Physics Teachers is proficient. The teachers are at the basic level both in Pedagogy and Organization and Administration domains; (2) The ICT-based innovative practices performed by the teachers in teaching Physics which were categorized into three themes such as (a) lesson preparation, (b) lesson implementation, and (c) collaboration; (3) There is a moderate positive correlation that exists the between the teachers' level of competency in the use of ICT and the student's performance in Physics. The relationship is found to be significant; (4) The teachers perceived that the use of ICT; helped improve students' understanding of science ideas, increases students' motivation in learning science ideas, stimulates students' interest to scientific ideas, facilitates the teaching of and learning process, and provides the teacher the opportunity to be innovative in delivering the lesson. The teachers also enumerated the top five most pressing challenges encountered that include the following; poor/no internet connection, lack of seminars and

training in ICT, lack of technical support, lack of time to plan and prepare lessons using ICT, and unavailability of ICT tools and software: and (5) An Enhancement Program entitled "ICT Competency Enhancement Program for Physics Teachers." was proposed to address the advancement of the competency level of the teachers in the use of ICT for a more innovative teaching and learning process. This study uses the descriptive-correlational design with a sample of 10 SPVs, 23 teachers, and 920 students.

Research conducted by Fajar et al. (2017) with the title "Improve the competence of high school teachers and equivalent through ICT -based learning training" gives the results achieved from the training activities that participants have increased knowledge about Microsoft Excel and learning that uses Prezi's software. This study used Descriptive Quantitative. The sample in this study is 38 students in Senior High School.

Research conducted by Calderón-Garrido et al. (2021) with the title "Music Education Teachers' Knowledge and Use of ICT at Spanish Universities" gives results that indicate that teachers are aware of the benefits of ICT in their teaching and the professional future of students. They kept the educational needs of the students very much in mind when choosing each resource. Despite knowing the benefits, the teachers did not train their students to learn how to use ICT. The biggest concern was the technological and gender gap identified. This study used Descriptive Quantitative. The sample in this study is 112 teachers.

Research conducted by Hasibuan (2021) with the title "Madrasah Ibtidaiyah Madrasah Teacher Competency Analysis in the Utilization of Information and Communication Technology in Learning (Case Study on MIN 4 Langkat)" gives the results that teacher competence in ICT is very low in the ability to use and use applications which is 52%. Furthermore, a very low indicator is found in the aspect of experience following the training, 57%. This shows that training activities are the most dominant factors that are the causes of teacher competencies in the use of ICTs in learning and therefore become the most effective solution to overcome. This study used Descriptive Quantitative. The sample in this study is teachers in MIN 4 Langkat.

Research conducted by Herliani and Wahyudin (2018) with the title "Mapping of Teacher Information and Communication Technology Competencies (ICT) in the pedagogical dimension" gives the results that ICT competencies have been mapped that can be achieved by teachers through the development of sustainable professionalism in stages in three levels of competency that are equipped with competency descriptions at each level. This research is a preliminary study of development research using the RnD method. This research develops an ICT competency framework for teachers.

Research conducted by Hidalgo et al. (2020) with the title "Digital and Media Competences: Key Competences for EFL Teachers" gives the results that training centers must provide ESL/EFL teachers with ample instruction to develop their digital and media competencies so that they can promote the active use of languages among students, motivate them towards learning, and help them become fully-prepared citizens of the 21st century. This research is a literature review research. The literature review used 68 articles relating to EFL teacher training for the development of their digital competencies.

Research conducted by Japar et al. (2020) with the title "Training in making ICT -based learning media to improve the competence of PPKn Junior High School teachers" gives the results that there are still many PPKn teachers who only rely on the lecture method so that learning becomes less interactive and seems to be centered on the teacher. In addition, the ability of PPKn teachers is still limited in utilizing and making ICT -based learning media. This study used Descriptive Quantitative. The sample used in this study was a junior high school PPKn teacher.

Research conducted by Kuşcu and Zaimoğlu (2022) with the title "The Perceptions of Turkish EFL Lecturers on Teaching through Information and Communication Technology" gives the results that the training positively affected the participants' perceptions of teaching through ICT and helped them utilize ICT implementations such as digital tools, in-class activities, lesson plans, and evaluation types. This study used Descriptive Quantitative. The sample used in this study was 15 EFL teachers.

Research conducted by Malik et al. (2018) with the title "The Competency-Based Training Model For Vocational High School Teachers From Electrical Expertise Programs" gives the results

that (1) the training model fulfilled the criteria of validity so that the model might be implemented for the training activities of electricity program vocational high school teachers; (2) the training model had fulfilled the criteria of practicality that were measured from the level of model stage (syntax) implementation; (3) the training model had fulfilled the criteria of effectiveness that had the following indicators: (a) the level of knowledge and understanding exposed by the training participants, (b) the level of teaching skills exposed by the training participants, (c) the quality of training participants' portfolio and (d) the response of the training participants and the trainers. This study uses the RnD method. The sample used in this study was 22 teachers of the electrical study program at the Vocational High School.

Research conducted by Nurbaiti (2021) with the title "Improvement of teacher competencies in making learning videos through in-house training (IHT) in SMP Negeri 26 Depok" gives the results that IHT can increase teacher competence in mastering ICTs for learning. The ability of IT teachers in SMP Negeri 26 Depok, in general has been above the average in some ways, only for making learning media that can bridge between teachers and students still a few are able. This research is a school action research, so it uses a qualitative method with data collection, namely observation and self-reflection. The research sample used was 40 teachers.

Research conducted by Nuryani and Handayani (2020) with the title "Teacher Competency in the 4.0 era in improving the quality of education" gives the results that (1) The problem of education in Indonesia today is the low quality of education compared to other countries, (2) Education 4.0 is the answer from the era of the industrial revolution 4.0 in the world of education. (3) The role of teachers is irreplaceable in the industrial revolutions 4.0 era. This research is a literature review research. The articles analyzed are those related to increasing teacher competency in the 4.0 era.

Research conducted by Özgür (2020) with the title "Improving Teachers' Qualifications for Preparing ICT-Based Educational Materials" gives the results that teachers' scores on the TPACK-deep scale increased significantly compared to the pre-study. It was also shown that the in-service training activity that was carried out increased the knowledge and skills of teachers about current technologies that can be used in the learning-teaching process, as well as increasing their self-confidence and self-efficacy for developing ICT-based educational material. As they adopted the use of ICT-based educational materials prepared within the scope of in-service training during school courses, teachers have also been shown to report that students' interest, desire to participate, curiosity and excitement, and motivation towards the lesson had increased. On the other hand, teachers who teach lessons with ICT-based educational materials stated that they felt their selves more useful in lessons, their performance increased, and that such materials facilitated the teaching in crowded classrooms. This research is an action research study with 40 samples used.

Research conducted by Puspita et al. (2019) with the title "Implementation of Information and Communication Technology (ICT) State High School Teachers in North Banjarmasin District" gives the results that the teacher has implemented ICT in learning, including a high category of 84.4%. ICT implementation in communication includes the teacher communicating with students, parents of students, fellow teachers, school committees, and residents around the school environment, including low categories, namely 62.5%, because teachers rarely socialize with school committees, school environment, students, and parents. This research uses a quantitative descriptive method. The sample in this study is 123 teachers of SMA Negeri in Banjarmasin Utara.

Research conducted by Putrawangsa and Hasanah (2018) with the title "Integration of Digital Technology in Learning in the Industrial Era 4.0 (Study from the Perspective of Mathematics Learning)" gives the results that the basic principle in the integration of digital technology in learning mathematics, namely the use of technology does not result in poor understanding of conceptual or replacing the role of students' intuition in mathematics. Conversely, the technology aims to improve students 'conceptual understanding and develop students' intuition abilities in mathematics. Three Dedactic Functions of Digital Technology in Mathematics Learning; (a) Technology for Doing Mathematics; (b) Technology for Practicing Skills; (c) Technology for Developing Conceptual Understanding. This research is a literature review study. The articles analyzed are articles related to the implementation of ICT in learning, especially mathematics to face the industrial revolution 4.0.

Research conducted by Susilo and Rohman (2018) with the title "Increasing the teacher's ICT competency as a learning innovation in the digital age" gives the results that there is an increase in teacher competence in developing and creating an IT-based learning media. This shows that the teacher's ICT competence is a provision to innovate in developing children's learning in digital times that have developed so far. This research is an action research study with Early Childhood teachers as samples used.

Research conducted by Syahrial et al. (2022) with the title "Professional teachers: Study of ICT capabilities and research competencies in urban and rural" gives the results that there is a relationship between teacher professionalism, ICT competence, and research competence. This finding is that there is a relationship between ICT competence and research competence simultaneously on teacher professionalism. It was stated that the ICT competence of teachers and the insight into teachers' research abilities affected teacher professionalism. It shows that teacher competence is the spearhead of students' understanding and implementation of teaching in schools. This research uses mixed methods. The sample used was 120 teachers.

Research conducted by Ulandari and Santaria (2020) with the title "Teacher Professionalism Development Strategies Through Education and Training" gives the results that in carrying out education and training there are several stages carried out, namely analysis of needs, determination of targets, determination of program content and program evaluation. Education and training is a development strategy that aims to improve teacher competence both from knowledge, skills, and attitudes. This research is a literature study in which the articles analyzed are related to the development of teacher competence through training.

Research conducted by Vilppola et al. (2022) with the title "Teacher Trainees' Experiences of the Components of ICT Competencies and Key Factors in ICT Competence Development in Work-Based Vocational Teacher Training in Finland" gives the results that work-based VET teacher training has the potential to develop teacher trainees' ICT competencies because it allows immediate implementation and experimentation concerning new ICT ideas and tools. By aligning this research with prior research, it is possible to construct a comprehensive ICT competence framework to support VET teacher training and workplace development. Six main ICT competence components were identified during the work-based training: (1) The use and creation of digital learning materials, (2) the planning and use of digital learning environments, (3) synchronous digitally enhanced teaching, (4) general ICT competencies, (5) digital interaction, and (6) digital assessment. This research uses a descriptive qualitative method with 44 teachers as a sample.

Research conducted by Wenely (2018) with the title "Efforts to improve the ability of teachers in the use of Information and Communication Technology (ICT) in TK Aisyiyah Dumai City" gives the results that the implementation of ICT workshops in improving teacher competencies in terms of use of ICTs as a teaching medium in the second cycle has been running as expected. This research is an action research study with 5 Early Childhood teachers as samples used.

Research conducted by Wibowo et al. (2020) with the title "Utilization of ICT learning in optimizing the teaching and learning process of junior high school teachers" gives the results that the use of technology to help the teaching and learning process is still very minimal. Especially computers as learning media. This is because the skills in computer operation are still very minimal. The results show that this activity can familiarize the teacher to use several additional programs in learning such as macro media, movie makers, power points, and Microsoft word, the average results of both theory and practice are good enough. It can be concluded that community service activities can help teachers and learning processes in class. This research is an action research study with 69 Junior High School teachers as samples used.

Research conducted by Yantoro and Idrus (2020) with the title "Training on improving teacher competencies in improving the quality of ICT -based learning at SMP Negeri 1 Muaro Jambi" gives the results that some teachers at SMP N 1 Muaro Jambi have not been able to carry out the ICT -based learning process, especially compiling and making teaching materials, so that the learning process is only traditional, namely by lectures, a little question, and answer. This research is an action research study with 37 teachers at SMP N 1 Muaro Jambi as samples used.

Research conducted by Yoon (2018) with the title "The effectiveness analysis for the education and training of research equipment in South Korea" gives the results that the education and

training characteristics, particularly the education and training environment and the educator and trainer, were found to influence learner satisfaction. Job creation, treatment improvement, the certificate system, and an education and training program were also found to be needed to boost the effectiveness of education and training on research equipment handling. Education and training on research equipment handling can contribute to the more effective and efficient operation of research equipment, and the national research equipment management system. This study uses a qualitative method. The sample used in this study was 50 people.

Discussion

The Current Condition of The Teachers' ICT Competency

Education 4.0 is education that is much influenced by the Industrial Revolution 4.0, where the learning process implements the existence of digital technology (cyber system). Implementing learning with digital technology is possible not limited by space and time. Students can learn anytime and wherever they want. Utilization of digital technology for learning is still homework for the world of education in Indonesia. The challenge of education in the era of the industrial revolution 4.0 is how to change the way students learn, think, and act while developing creative innovations in various fields. There is no choice in facing the challenges of the industrial revolution, where all lines of society must move forward and develop, not just stand still. That is the condition of the Indonesian education system that should follow the times or will be lagging. Because the world has chosen to advance digital technology in all fields, including education.

The role of the teacher as a facilitator in the implementation of education must be able to provide convenience for students to learn the learning delivered. The convenience obtained by students, namely the teacher provides learning media. Learning media functions to help teachers in delivering material and attracts the attention of students to learn. The problem that occurs lies in the ability of teachers who are less optimal in developing media, especially ICT which is a more interesting learning media. This is a teacher's need to always innovate with technology so that it can create real and interesting learning media that can stimulate optimal child development (Susilo and Rohman, 2018).

ICT competencies that need to be possessed by teachers can refer to the framework of ICT competencies for teachers that have been developed by United Nations Educational Scientific and Cultural Organization (2018), as in Figure 2.

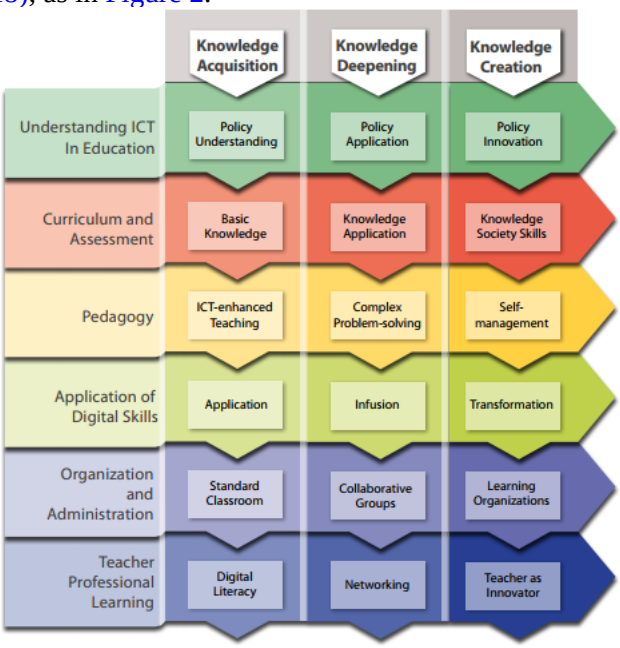

Figure 2. Framework ICT for Teacher

The study also explained the ICT competency that the teacher must have in Table 1 (Herliani and Wahyudin, 2019).

Table 1. ICT Competency Framework

Component	ICT Competency		
	Technology Literacy	**Knowledge Deepening**	**Knowledge Creation**
Teacher Competence	The teacher must know where with whom, when (and when not), and how to use ICTs for learning and presentation activities.	Teaching in this approach is centered on students. The teacher's role is to provide structured tasks, guide students to understand, and support students in collaborative projects. The teacher must have the skills to help students create, apply, monitor, and provide solutions in their project plans.	The teacher's role in this approach is that explicitly model the learning process and create a situation in which students apply cognitive skills and guide them in achieving skills. The teacher also collaborates with colleagues in applying an educational setting that is activated with ICT.

Other research from Vilppola et al., (2022) explained that six components of ICT competencies must be mastered by the teacher in training, namely (1) the use and manufacture of digital learning materials; (2) Planning and use of the digital learning environment; (3) teaching synchronous that is digitally increased; (4) General Competence of ICT; (5) Digital interaction; (6) Digital assessment. The competency of ICT utilization is also found in pedagogical competencies and professional competencies, namely the indicator "Utilizing Information and Communication Technology for the sake of implementing an educational development activity" contained in pedagogical competencies and indicators "Utilizing Information and Communication Technology for Communicating and Developing Self" on professional competence. Both of them can be concluded that teachers must be able to use ICTs in the learning process, communication, and self-development

But based on the results of the researcher's analysis, there are still teachers who do not have ICT competencies and have not used optimal ICT in their learning activities. Research from (Hasibuan, 2021) also shows that teacher competencies in ICT are very low, reaching a percentage of 52%. The very low ability in the study lies in the ability to use and use applications. Furthermore, a very low indicator is found in the aspect of experience following the training, 57 %. This shows that training activities are the most dominant factors that are the causes of teacher competencies in the use of ICTs in learning and therefore become the most effective solution to overcome these problems. The results of other studies (Batubara, 2018) say that the description of the competency of ICT Elementary/MI teachers in Indonesia is in a sufficient category and needs to be improved, especially for teachers who are in the outer regions. Junior high school teacher competence also has the same condition, which is necessary to increase ICT competencies. In the learning process in junior high school based on the results of the article analysis shows that the lack of optimal use of ICTs, especially in the use of learning media (Japar et al., 2020; Nurbaiti, 2021; Wibowo et al., 2020; Yantoro and Idrus, 2021). Likewise, high school-level teachers are also less optimal in the use of ICT -based learning media (Amilia and Maiziani, 2020; Fajar et al., 2017). Utilization of ICT not only in the learning process, but in the communication process in schools can also use ICTs, but what happens in public high schools in North Banjarmasin District also has not utilized ICT optimally in the communication process (Puspita et al., 2019).

The Importance of ICT Competence for Teachers

At present students are used to the rapid flow of information and industrial technology 4.0. This shows that students who graduate must be able to answer the challenges of industry 4.0. The results of educational products must be able to print and produce quality generations to be able to

compete with the flow of technology and information development. Therefore, educators are required to be able to increase their competence to meet the teaching criteria in the education era 4.0.

The development of technology in the era of the Industrial Revolution 4.0 is very fast, and it brings significant changes to the education system in Indonesia. This significant change in the education system affects the role of the teacher as an educator. Teachers are required to have technological competencies and information that are qualified to be able to produce graduates of students who can adjust to the development of technology today.

Some studies have shown that ICT competencies are important for teachers, in addition to optimizing learning and also for teacher self-development. The teacher realizes that there are many benefits of ICT in the learning process and also aware of good practices in the use of ICT because it can help the future of their students (Calderón-Garrido et al., 2021). The use of ICTs in learning is very important, as stated by Palacios Hidaldo in his research that there are many learning resources available as teaching teacher material, and their benefits in learning language are very good because of the communicative nature of the learning resources. However, students will not get maximum results if the teacher cannot integrate it in the right way. Therefore, training is needed for teachers to develop their ICT competencies (Hidalgo et al., 2020). Furthermore, one of the benefits of ICT is an interesting material for various types of learning. If students experience obstacles in material, other materials can help them in overcoming these obstacles (Kuşcu and Zaimoğlu, 2022). ICT can also be a trigger for student interaction in learning both written and verbal when learning English. Not only in English lessons, and in mathematics learning, but ICT can also increase students 'conceptual understanding and develop students' intuition abilities in mathematics. They also said there were three didactic functions of digital technology in learning mathematics, namely (1) Technology for doing mathematics; (2) Technology for Practicing Skills; (3) Technology for Developing Conceptual Understanding (Putrawangsa and Hasanah, 2018).

Teachers in the era of the Industrial Revolution 4.0 must have five competencies, namely: (1) Educational competence, namely the ability of teachers in internet-based teaching as basic skills, (2) competence for technological commercialization, namely the ability of teachers to educate students to have an entrepreneurial attitude based on technology innovation, (3) Competence in Globalization, i.e., teachers must have the competence to apply learning by taking more global topics and the latest issues related to globalization so that students do not stutter on various cultures, have hybrid competencies and excellence in solving problems (Problem Solver Competition). (4) Competence in Future Strategies, namely the ability of teachers to teach that refers to the future, the teacher can implement a learning strategy that helps students to prepare themselves to deal with a world that quickly changes. (5) Counselor Competence, which is a competency where the teacher can become a counselor, not only the problem of students in learning but also related to psychological problems because in the future the process that is faced by children not only learning difficulties but also psychological problems (Nuryani and Handayani, 2020).

Teachers are pillars of education, therefore the success of education in a country is greatly influenced by the strategic role of teachers. Therefore, it is necessary to increase teacher competence to face an age that continues to develop. Supported by the pattern of education in the 21st century where education is required to guarantee students have learning skills and innovation, skills to use technology and information media, and can work and survive by using life skills (life skills). The teacher is required to create creative and innovative learning by integrating ICT into learning activities to equip students to develop themselves as lifelong learners by having information literacy skills, media literacy, and ICT literacy (Herliani and Wahyudin, 2019).

Improved ICT competencies can help teachers communicate with colleagues online, can make teaching materials by utilizing internet sources, and also help in completing administration. In addition, using ICTs in learning can increase students' understanding of teaching materials, increase motivation, stimulate interest, and provide learning process facilities (Briones, 2018). These benefits must, of course be accompanied by adequate resources so that the implementation of learning is more optimal. The use of ICT is very meaningful when implemented into the learning process, as evidenced by learning in public high schools in Edirne Province, Turkey. The results showed that when the teachers adopted the use of ICT-based material that was prepared during in-service training,

the teachers reported that interest, desire to participate, curiosity, excitement, and motivation of students towards the lesson had increased. On the other hand, teachers who teach ICT -based lessons state that they feel more useful in lessons, their performance increases, and the material facilitate learning in classrooms full of students (Özgür, 2020). The development of teacher ICT competencies also affects the professionalism of teachers. If the teacher's professionalism is optimal, the learning carried out will also be optimal and can achieve optimal educational goals as well. This shows that teacher competence is the spearhead of students' understanding and the implementation of learning in schools (Syahrial et al., 2022).

Improved teacher competencies related to the use of Information and Communication Technology (ICT) are an urgent need to become a professional teacher in the 21st century (Herliani and Wahyudin, 2019). However, not all teachers can use ICT. Therefore, the development of learning with the existence of technology must be followed by the development of resources for educators. To support the development, facilities or facilities related to technology, information, and communication are also needed so that synchronization will occur, when teachers are required to develop to face technological developments, the infrastructure needed must be available.

The Role of Competency-Based Education and Training on Improving Teacher Competencies

Development of Educators' Resources can be done by conducting education and training in competency-based teaching staff. Competency-based education and training (education) or in English known as competency-based training (CBT) is a structured training and assessment approach that allows individuals to obtain skills and knowledge to carry out simple or complex tasks for certain standards. CBT focuses on (a) Implementation of tasks and obligations by individuals; (b) conditions in which they must carry out these tasks and obligations; and (c) their standard for performing (International Labour Organization, 2020).

Education and Training must be competency-based because training is an activity to improve one's competence so that there is no employee competency gap in an organization or institution. His activities are competency-based because it focuses on mastering work competencies to improve work performance. State Training Board Victoria Australia (Brown, 1994) views competency-based training as a system consisting of: outcomes, namely the specific skills standards that will be produced; Curriculum, which is a package of material that will be obtained during the training; Delivery, which is the training method, which was chosen by adjusting the abilities that the participants had because in general participants who took part in the training had previous abilities but were not optimal so it needed to be improved by following the training; Assessment, which is an assessment to find out what competencies have been mastered by participants as a result of training; Record, which is a note about the competencies that have been obtained from training.

According to the Confederation of Australian Industry (CAI) (Brown, 1994), competency-based training is training that exercises what is needed in work (outcomes). Thus competency-based training does not care about how the training is carried out (input). In other words, competency-based training is more concerned with the special standards demanded by the world of work than a person's relative achievements than members of his group. Meanwhile, according to Veetac (Brown, 1994), competency-based training is regarding the acquisition of the ability to demonstrate special skills and special knowledge and their applications according to the minimum industrial capability standards (the world of work) as stated by the Australian National Training Council (NTB).

Based on the curriculum model (Brown, 1994) there are three main components of competency-based training (CBT) that we should pay attention to. First, the existence of competency standards firmly formulated by professional organizations or by users of training graduates compiled based on real needs in the work to be undertaken. Second, there is a quality training program design (curriculum). Third, the implementation of quality training uses methods or approaches that provide the greatest opportunity to achieve training goals.

Foyster (Brown, 1994) revealed that in essence when talking about CBT, it should fundamentally re-seen the role of the participants in the training process. He more clearly stated that: In PBK the study needs of the training not first see the needs of the individual training participants solely, but try to bring up descriptive about what the community needs or the needs of the world of

work (school). Veetac (Brown, 1994) revealed that in Australia competency-based training could be viewed from two points of view, namely as a vocational education system and training, as well as a learning approach.

As a CBT system consists of a series of interrelated processes, which include: (1) Development of National Competency Standards, (2) Competency-Based Curriculum Development to meet the above competency standards, (3) training accreditation, (4) training (4 Delivery), (5) ability test system, (6) certification.

As a learning approach, CBT has the following uniqueness: gives a strong emphasis on what can be carried out by the training participants (what the learner can do), more focusing on achieving learning outcomes (outcomes) than the learning process or time achieved to achieve the learning outcomes (Mastery Learning); It is very concerned about the acquisition of the ability of learning outcomes and the ability to demonstrate it through the application of knowledge and skills by the level of competency that has been set and recognized nationally. CBT is closely related to concern for the achievement and use of national competency standards flexibly at the company level, while not ignoring aspects of competency transfer at the national level.

Table 2 shows some differences between competency-based training and traditional training (Blank, 1982).

Table 2. The Difference Between Competency-Based Training With Traditional Training

No	Characteristics	CBT	Traditional
1	WHAT (Material learned)	1. Competencies that will be owned by participants after the training program is firmly formulated by the tangible needs of the work that will be undertaken by the participants. 2. The training program is designed with competency units that must be mastered by participants.	1. The results of the training are more theoretical, textbook oriented and do not refer to the needs of real participants in their work. 2. Training programs are designed with units, blocks, or other units.
2	HOW (How to learn participants)	1. Training is designed well. 2. Participant oriented. 3. Learning media are designed so that participants master each competency. 4. Feedback from participants is used as a reference for improving the training process.	1. The course of the training depends on the instructor. 2. The training method is more directed to lectures, discussions, and other activities that are lecture centered. 3. Opportunities to request feedback for small participants during the training process.
3	WHEN (Participants switch from one skill to another skill)	Each participant is provided with adequate time by his ability to master certain competencies completely before switching to the next competency.	Usually, the group is used as a basis for determining the time or mastery of the training unit to switch from one unit to the next.
4	IF (The results obtained if the participants practiced consequently)	1. It takes a high ability of each participant to master a competency according to their work needs. 2. The results of the training are referred to the competency standards that have been designed at the beginning of the training program.	The training results are determined by the results of the test that is usually compared to other participants in groups (NRT) although maybe someone has not fully mastered the training material or failed in a training unit.

Blank (1982) also stated that if it were developed and carried out carefully, competency-based training would be better than traditional training, especially related to outcomes for training participants. Of course, there were many other advantages. More detailed Blank also stated that some things that seemed to be increasing or better than the traditional approach, including that participants learn better, also get higher test scores, participants gain a high level of ability, the experience achieving success in the participants is experienced faster So that their learning motivation becomes high, feeling comfortable with training and their concepts to increase, at the same time can be obtained better learning outcomes, low learning outcomes can be increased, drop out can be reduced, the participants are more responsible for themselves, Instructors can further serve participants according to their needs, even though the instructor is disturbed, the program continues to run well, the participants are busier with their duties than doing less useful things. More than all that has been stated above, the implementation of the training program becomes more professional, more providing to improve morality in instructors, participants, and also the administrative staff. However, an increase in many things stated above is very dependent on the effectiveness of the programs carried out and how hard the efforts made by all the elements involved in the training program to carry out their respective duties.

Implementation of Competence-Based Training Teachers not only provide teacher participants describe information related to the skills and knowledge they have, but also provide the information education unit they need to improve teaching and learning (Ahmed and Sayed, 2020). Because the main principle of every competency-based training is to measure the learning that occurs in the training program instead of the length of time attending training (Ahmed and Sayed, 2020). The competency-based training model applied in the Teacher Training of Makassar City Electricity Vocational School and Gowa Regency showed that the ability of teachers to increase. The level of knowledge and understanding of the training participants of training materials included in the high category based on pre-test and post-test results. The level of teaching skills of teacher participants is included in a good category based on peer-teaching activities. The quality of the portfolio results of the development of learning devices is included in the good category. These results can be concluded that the training model used is effective to improve the competence of the SMK Teacher Electricity Program (Malik et al., 2018).

Competency-based training is training that implements a competency-based curriculum based on the need for the competency of the training participants. To meet the demands for the development of the era and conditions in the community, the development of the training curriculum needs to be carried out. Its development remains in the delay of curriculum development foundations, namely the foundation of philosophy, psychology, sociology, and science and technology. Research from some of the experts above about the effectiveness of competency-based training in improving the competencies of participants can be concluded that applying competency-based training in learning can improve participant competencies

Regarding the organization of training, the implementation of ICT workshops for teachers in Aisyah City Dumai City can improve teacher competencies in terms of the use of ICTs as teaching media. The results showed that there was an increase in teacher competency in the use of ICT after one week of taking part in the ICT and teaching workshop using ICT (Wernely, 2018). EFL instructors in Turkey also agreed that the self-development model they interested in attending a workshop/conference/seminar, which was a form of training (Ardıç and Çiftçi, 2019).

The use of ICT in teaching EFL at South Yemen University during observations shows that there is still a lack of implementation of ICT by teachers in learning because of infrastructure that does not support and lack of competence of ICT teachers. Then, one of the recommended ways to improve the teacher's competence is to provide training on computer skills and how to use ICT for teaching and learning language (Thabit Saleh Ahmed and T. A. Qasem, 2020).

The Jakarta Religious Education and Training Center which has a goal, one of which is to analyze the results of increasing pedagogical competencies after participants attended the training, showed that the education and training process could improve the competency of PAI teachers (Bahrissalim and Fauzan, 2018). The same thing was also shown in the results of research related to the implementation of training for handling research equipment to increase professionalism that there is an influence between the training environment and instructors with participant satisfaction. Even

so, training infrastructure also affects the satisfaction of participants and needs to be improved so that the competencies of participants also increase (Yoon, 2018).

The same research on the training of corpse maintenance workers from the National Function Directors Association (NFDA) and Cremation Association of North America (CANA) in the mitigation and management of diseases is very contagious and important to do. This is to improve workers' competencies to minimize transmission, it is even expected that transmission from the very infectious disease (Le et al., 2017). Therefore, education and training are the development strategies that aim to improve competence in terms of knowledge, skills, and attitudes. Training will be able to improve the professionalism of teachers so that things that can be done a teacher must have the competence and improve which will later help them to carry out their duties (Ulandari and Santaria, 2020).

Research from several experts on the Effect of Education and Training on the Improvement of Participants' Competencies can be concluded that education and training influence increasing the competencies of participants. However, the positive influence and effectiveness of the implementation of education and training must be accompanied by an analysis of comprehensive training needs. Often organizations fail to organize training that makes a real contribution to the organization's goals because it is not to the actual needs of the field (Fisher and Frank, 1992). The role of needs analysis in the development of training is very crucial. Analysis of needs plays a role in determining the allocation of training effectively (Schuler and Huber, 1993). In addition, needs analysis is also a way to predict the possibility of various employee performance problems and alternative solutions (Cline and Seibert, 1993). Needs analysis is one of the things that need to be considered in developing the training curriculum, in addition to other contextual factors such as the company's financial factors (Arogundade et al., 2019). As with research on CSL teacher training, this activity is carried out before organizing training and is an integral part of designing training to obtain a comprehensive picture of the skills, knowledge, and behavioral attitudes needed to improve their performance. From this analysis, it will be known what training is relevant to an organization at this time and also in the future. The organization cannot just determine the training without first analyzing the needs and objectives of what to achieve. The needs assessment is a road map to achieve organizational goals and also a basis for policymakers in their efforts to improve the quality of human resources (Cai, 2017).

CONCLUSION

Teachers are pillars of education, therefore the success of education in a country is greatly influenced by the strategic role of teachers. Therefore, it is necessary to increase teacher competence to face an age that continues to develop. The utilization of ICTs that are less optimal by teachers in learning becomes a challenge that must be completed to improve the quality of education. Increasing teacher competencies related to the use of Information and Communication Technology (ICT) is an urgent need to become a professional teacher in the 21st century. Development of Educators' Resources can be done by conducting education and training in competency-based teaching staff. Competency-based education and training (education) or in English known as competency-based training (CBT) is a systematic learning approach. Research Some experts on the effectiveness of competency-based training can be concluded that the application of competency-based training in training can improve the competencies of training participants. Likewise with research on the effect of education and training that can be concluded that education and training influence increasing the competencies of participants. However, the positive influence and effectiveness of the implementation of education and training must be accompanied by an analysis of comprehensive training needs. Analysis of Training Needs or Training Needs Assessment (TNA) is a step taken before carrying out training and is an integrated part of designing training to obtain a comprehensive picture of the material, time allocation of each material, and learning strategies that should be applied in organizing training so that training is useful for trainees. Therefore, further research recommendations can be in the form of the development of a competency-based training curriculum in improving teacher ICT competencies

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Jurnal Inovasi Teknologi Pendidikan
Volume 10, No. 1, March 2023 (106-113)
Online: http://journal.uny.ac.id/index.php/jitp

Development of the Rumah Karya application in the educational technology study program as a media database for the works of lecturers and students

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ARTICLE INFO

Article History
Received:
28 February 2023;
Revised:
06 March 2023;
Accepted:
08 March 2023;
Available online:
09 March 2023.

Keywords
Database; Rumah Karya; visualization.

ABSTRACT

This research aims to produce Rumah Karya applications that provide a media product database for lecturers and students in the Educational Technology Study Program at Makassar State University. The research method used in this research is R&D (Research and Development), with the ADDIE development model divided into five stages: analysis, design, development, implementation, and evaluation. The Rumah Karya application has been validated by the head of a study program as a material expert and an information technology (IT) expert. Validation from material experts obtained an average of 98% very feasible category, and validation from IT experts obtained an average of 92% very feasible category. This application has been tested by lecturers and students in the Educational Technology study program, which produces an average of 83.8% which includes a very feasible category. The Rumah Karya application has been registered as intellectual property rights at Makassar State University. The Rumah Karya application has been implemented and integrated with the Educational Technology study program website. This research has the potential to carry out further research related to additional development features in Rumah Karya that can enhance the user experience in using the application. This research can also be extended to other study programs or other educational institutions to measure the generalization of Rumah Karya's application in improving the quality of media products in educational institutions.

How to cite:
Mawarni, S., Hartoto. (2023). Development of the Rumah Karya application in the educational technology study program as a media database for the works of lecturers and students. *Jurnal Inovasi Teknologi Pendidikan*, 10(1), 106-113. doi: https://doi.org/10.21831/jitp.v10i1.58902

INTRODUCTION

The Educational Technology Study Program is one of the study programs under the Faculty of Education, Makassar State University, which has a graduate profile that can understand general concepts and operational knowledge of learning media and learning resources. To realize the graduate profile, the UNM Educational Technology Study Program elaborates it into several production courses, including learning multimedia, simple media development, graphic media development, cinematography, teaching material development, photo media development, online learning, audio media development, and development of video media. Each production course's final

target is media products by lecture material standards. The resulting media products can be individual or group assignments with a project-based learning model.

Educational technology students of Universitas Negeri Makassar students are encouraged to produce a Research & Development (R&D) thesis, one of the educational technology areas. The number of students taking an R&D thesis and graduating from 2021 is around 78.5%, while the rest are taking experimental and descriptive research types. The resulting Research & Development (R&D) thesis media products include teaching materials, learning videos, digital applications, and mobile learning. Media products resulting from the thesis or lecture output can be used as portfolios for Educational Technology study programs which can be used for accreditation activities, exhibitions, and comparative studies. Student media is still difficult to access quickly due to the absence of a container to accommodate this data.

Based on interviews with the head of the Educational Technology study program at Makassar State University, it can be explained several reasons that make it challenging to access media products resulting from production courses and student Research & Development (R&D) theses which are grouped into four factors, namely skills, suppliers, surroundings, and system. Based on the skill aspect, this is caused by the lack of lecturer skills in utilizing online database features, the lack of time for lecturers to manage student media products, the absence of a particular admin documenting the results of the R&D thesis, and the lack of understanding of lecturers regarding database processing applications. While on the supplier aspect, due to the absence of a particular place/location to store Research & Development (R&D) thesis results and the absence of a portal for collecting data on student media products. In the surrounding aspect, because students are not used to managing R&D thesis media or course products, and the lack of attention to R&D thesis media is caused by lecturers only focusing on the thesis. Finally, on the system aspect, there are no rules about how to collect and manage media from coursework or student R&D thesis.

Currently, the pattern of data storage leads to *cloud computing*, which means that data can be stored and accessed via the internet. If data is stored online, it does not need to take up physical space to store, and the advantages can be accessed anytime, anywhere, and by anyone. There have been many studies on online database development, one of which is research by Goh et al. (2021) which discusses the development of online *databases* in the form of e-references. This research discusses the development of a web-based database by collecting probiotic literature from various sources so that the developed e-references can become an information database for health professionals. Research on database development that aims to provide information has also been written by Sarker et al. (2022). Sarker et al.'s research discuss developing a geospatial database to identify and document the status of Tailings Storage Facilities (TSF) for the Australian government. Both of these studies have the same general goal, which is to develop *a database* as a source of reference information. The information displayed in a *database* should be able to provide consideration for certain parties concerned. The advantages of developing an online database are that it is more efficient and can be accessed anytime and anywhere, not limited to places or locations.

One of the tools that provide online database services is Google Data Studio. Google Data Studio is a site for creating data visualizations that make it easier to create reports, and the data displayed is easy to understand (Kemp &White, 2021). Google Data Studio allows users to filter the desired data based on specific categories or time ranges and can present relevant visualizations (Snipes, 2018). Other advantages of Google Data Studio include being free, being able to connect with Google products (Google forms, spreadsheets, etc.), complete widget options, being able to access comprehensive data sources, being easy to share, being able to make reports more interactive and easy to read, and having a selection of free templates. Google Data Studio is an application that focuses on presenting data or data visualization to make it simpler and more accessible for decision-makers to understand. Research on database development based on Google Data Studio is still rare. A study by Andrasto (2015), Apriani et al. (2022), Dukić (2013), and Purnadi (2021) only discusses data visualization using Google Data Studio, which describes the steps for using Google Data Studio to visualize data, combine data sources, and exchange data. Purnadi (2021) combines Google Data Studio as a data visualization tool and Google Sheets as raw data input. Rumah Karya application

development research combines several Google platforms to be able to produce a database that presents a variety of information, has attractive visualizations, and is easy for users to operate.

The development of Rumah Karya can be used as an alternative solution to the problem of difficulty accessing media products from production and R&D thesis courses for students and lecturers of the UNM Educational Technology Study Program. This study aims to produce the Rumah Karya application as an online database that stores research results, media products, and courses owned by lecturers and students of Educational Technology, Makassar State University. Rumah Karya was developed using the Google platform, which consists of Google Forms, Google Spreadsheets, Google Data Studio, and Google Sites. The Rumah Karya application produced in this study has been validated for its feasibility by material experts and Information Technology (IT) experts. This research has three major impacts, namely 1) making it easier for the public to take advantage of the work of product development students and lecturers of the Educational Technology Study Program, 2) assisting in the accreditation of study programs, 3) demonstrating the existence of the educational technology study program in local and national activities such as exhibitions, study appeal, and others. These three impacts still require separate studies to assess the effectiveness of the Rumah Karya application.

METHOD

The research method used is R&D (Research & Development) research, while the development model chosen is the ADDIE model. The ADDIE model consists of five stages: analysis, design, development, implementation, and evaluation (Bates, 2019). This research was conducted at the Educational Technology Study Program, Makassar State University, with the target research subjects being lecturers and students in the study program. Data collection techniques used in this study are questionnaires, documentation, and interviews. The questionnaire instrument consists of questionnaires for IT experts, material experts, and users (lecturers and students). Questionnaires were given to material and IT experts to determine the feasibility level of the Rumah Karya application. Questionnaires were also given to lecturers and students (users) to determine the user's responses to the Rumah Karya application. The data analysis technique used is descriptive statistical analysis. The questionnaire rating scale ranges from 1 – 5 (Very Inadequate – Very Eligible). The explanation of the eligibility score criteria, according to Arikunto (2009), is that it is said to be very Ineligible (<20%), Inadequate (21 – 40%), Adequate (41 – 60%), Eligible (61 – 80%), and Very Eligible (81 – 100%).

RESULTS AND DISCUSSION

Results

The Rumah Karya application has six main menus: Home, About, Forms, Collections, Statistics, and Contacts. The Rumah Karya application is integrated with *the website of* the Makassar State University Educational Technology study program (http://tp.fip.unm.ac.id/). The development of the Rumah Karya application is carried out using the ADDIE model flow.

Analyze

At this stage, an analysis is carried out regarding the needs for the development of Rumah Karya. The development of Rumah Karya is based on document analysis and the results of interviews with the head of the UNM Educational Technology study program. Based on the results of the problem analysis, alternative solutions were formulated to develop an online and easily accessible database. The Google platform is the first choice in developing Rumah Karya because it is free, easy to operate, has a varied appearance, and can be connected to various other types of Google *platforms* such as Google Spreadsheets, Google Forms, Google Data Studio, and Google Sites. At this analysis stage, a search for examples of database development based on Google Platform was also carried out, *and* an FGD *(Forum Group Discussion) was carried out* with the laboratory management team and the admin of the UNM Educational Technology study program. Discussions were held to discuss

what learning media data had been collected and what media data had yet to be collected, and whether it was possible to collect it.

Design

The design stage includes making *flowcharts*, designing the appearance of Rumah Karya, and compiling question items as instruments for collecting media data for lecturers and students. This question item will then be developed through a Google Form, which is integrated into the Rumah Karya application. The question items on the Google Form are used as the basis for designing the Rumah Karya application so that it can display media product data based on the categories of questions submitted. The question items submitted in the Rumah Karya Google Form in Table 1.

Table 1. Questions from Google Form Rumah Karya TP

No.	Question	Alternative Answers
1.	E-mail	Short Answer
2.	Status	Lecturer/ Student
3.	Full name	Short Answer
4.	ID number	Short Answer
5.	Types of products	Research & Development (R&D) Thesis Results/ Course Results/ Research Results (Lecturers)
6.	Media Type	Audio Media/ Video Media/ Application (Learning Multimedia)/ Games/ Simple Media/ Educational Movies/ Print/Digital Books/ Graphic Media (Posters, Infographics)
7.	Media Title	Short Answer
8.	Media Manufacture Year	Short Answer
9.	Media Handbook	Upload Files (Maximum 100Mb)
10.	Media Reviews	Upload Files (Maximum 100Mb)
11.	Media Product Uploads	Upload Files (Maximum 100Mb)

Development

The development phase consists of developing Rumah Karya applications using Google Platforms (Google Sheets, Google Forms, Google Data Studio, and Google Sites). The Rumah Karya application is developed based on Google Sites as the main framework, which combines the appearance of Google Data Studio and Google Form. The data collected by the Rumah Karya application is processed through a collaboration between Google Forms and Google Spreadsheet, then visualized using Google Data Studio. During the development stage, books and video guides for the operation of Rumah Karya were also made. The Rumah Karya application then enters the validation stage, which consists of validating IT experts and material experts. Figure 1 shows IT experts validation. The aspects assessed at the validation stage by IT experts and material experts consist of: aspects of usability quality, information quality, service quality), and visual quality (visual quality). These four aspects were adapted from the Webqual 4.0 method. Webqual is a method used to measure website quality based on the perception of the website's end users (Barnes & Vidgen, 2002).

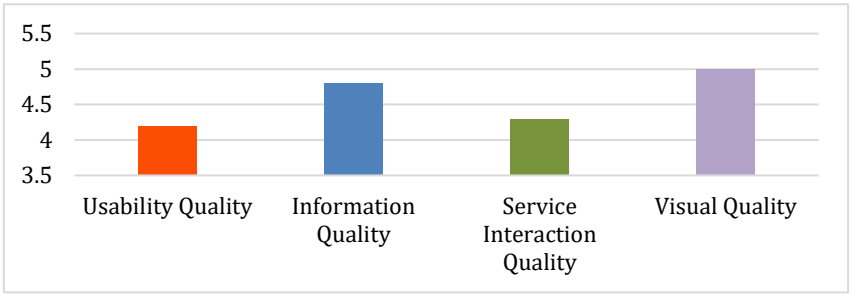

Figure 1. Validation of Rumah Karya by IT Experts

The average rating score by IT experts on the usability quality aspect is 4.2 or 84% in the Good category, in the information quality aspect, 4.8 or 96% in the Very Good category, on the service aspect interaction quality, namely 4.3 or 86%, is included in the Good category, and in the visual quality aspect, namely 5, which is included in the Very Good category. It can be concluded that the validation results by IT experts have an average overall score (4 aspects), namely 4.6 or 92%, which is in the Very Good category. Figure 2 shows validation of material expert.

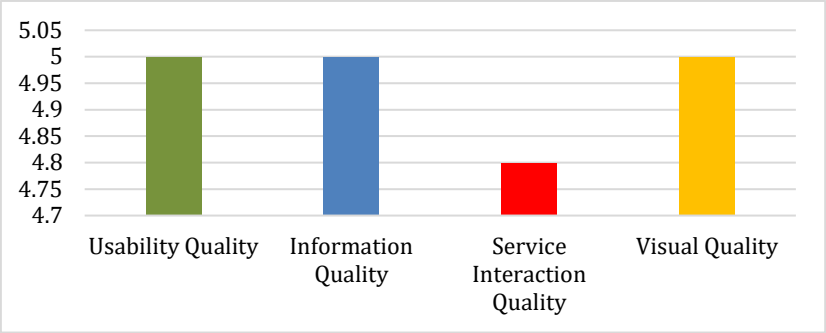

Figure 2. Validation of the Work House by the Head of Educational Technology Study Program

The average score of the assessment by material experts on the usability quality aspect, namely 5 or 100%, is included in the Very Good category, on the information quality aspect, namely 5 or 100% is included in the Very Good category, on the service interaction aspect quality, namely 4.8 or 96%, is included in the Very Good category. The visual quality aspect, namely 5 or 100%, is included in the Very Good category. It can be concluded that the validation results by IT experts have an average overall score (4 aspects), namely 4.9 or 98%, which is in the Very Good category.

Implementation

At the implementation stage, the Rumah Karya application is ready to be used by users, namely lecturers and students of the UNM Educational Technology study program. The dissemination and launching of the Rumah Karya application were carried out to make it more widely used. At this stage, the Rumah Karya application is ready to receive media data entered by users (lecturers & students) via the "Form" menu. Visitors can access media data recapitulation to the Rumah Karya application through the "Collection" and "Statistics" menus. Figure 3 to 4 show tahet The Rumah Karya application provides five main menus, namely Home, About, Forms, Collections, and Statistics.

Figure 3. Display of the Rumah Karya Application Homepage

Figure 4. Rumah Karya Application Guidebook

Evaluation

The evaluation of the Rumah Karya application is measured using a user questionnaire which contains questions regarding the feasibility and quality of the application. Question items were developed using the Google Form with a scale of 1-5 (Very Poor-Very Good), which were distributed to lecturers and students of the Educational Technology Study Program at Universitas Negeri Makassar. Several question items and the average score recapitulation can be seen in Table 2.

Table 2. Evaluation Questions for Rumah Karya Applications

No.	Question	Average Score	Percentage	Category
1.	Easy to operate	4.25	85%	Very Worth it
2.	Ease of navigation	4.25	85%	Very Worth it
3.	Attractive appearance	4.05	81%	Very Worth it
4.	Provides up-to-date information	4.35	87%	Very Worth it
5.	Provide information that is easy to read and understand	4.2	84%	Very Worth it
6.	Provide information in an appropriate format	4	80%	Worthy
7.	Provides sufficiently detailed information	4.15	83%	Very Worth it
8.	Ease of attracting interest and attention	4	80%	Worthy
9.	Ease of providing feedback	4.3	86%	Very Worth it
10.	Use of fonts/letters	4.25	85%	Very Worth it
11.	Use of color and style	4.3	86%	Very Worth it

Figure 5. Rumah Karya Application Socialization Activities

After going through the ADDIE development stages, in Figure 5, the Rumah Karya application can be implemented as a media database created by lecturers and students at the Educational Technology Study Program at Makassar State University. The Rumah Karya application that has been implemented is then socialized as a form of dissemination to the public. Socialization of the Rumah Karya application is carried out through Zoom Meetings and YouTube (https://www.youtube.com/@TPFIPUNM).

Discussion

This research discusses the development of the Rumah Karya application, which is integrated with the website of the Makassar State University Educational Technology study program (http://tp.fip.unm.ac.id/). This application has six main menus: Home, About, Forms, Collections, Statistics, and Contacts. The development of this application is carried out using the ADDIE model flow, namely, Analyze, Design, Development, Implementation, and Evaluation. The Rumah Karya application was developed based on the results of document analysis and interviews with the head of the Educational Technology study program at Makassar State University. The Google platform is the first choice in developing Rumah Karya because it is free, easy to operate, has a varied appearance, and can be connected to various other types of Google platforms such as Google Spreadsheets, Google Forms, Google Data Studio, and Google Sites. The database is visualized using the Google Data Studio application. Google Data Studio has several advantages, including being visually appealing; combining data from various sources; getting real-time updates; enabling rapid development and deployment; and being free (Muharni et al., 2022).

The Rumah Karya application is developed based on Google Sites as the main home, which combines the appearance of Google Data Studio and Google Form. The data collected by the Rumah Karya application is processed through a collaboration between Google Forms and Google Spreadsheet, then visualized using Google Data Studio. During the development stage, books and video guides for the operation of Rumah Karya were also made. The Rumah Karya application has been validated by IT experts and content experts. It includes assessments on aspects of usability quality, information quality, service quality, and visual quality using the Webqual 4.0 method. P. Longstreet (Rerung et al., 2020) defines Webqual 4.0 as a technique for assessing the quality of a website based on user perceptions. The results of validation by IT experts and material experts show that the Rumah Karya application has a very good overall score (92% and 98% fall into the Very Good category). This very good category shows that the Rumah Karya application has fulfilled the three dimensions of good website quality based on Webqual 4.0 criteria, namely: usability quality, information quality, and service interaction quality.

CONCLUSION

The development of the Rumah Karya application follows the ADDIE development steps (analysis, design, development, implementation, and evaluation). Rumah Karya, as a media database for lecturers and students in the Educational Technology Study Program, is included in the Very Eligible category from the validation results of IT experts (92%) and materials (98%). The results of the feasibility assessment by users (lecturers and students) show an average score of 83.8% in the Very Eligible category. Overall, the Rumah Karya application can be very feasible to serve as a media database for the work of lecturers and students in the Educational Technology Study Program at Makassar State University. The existence of the Rumah Karya application can help study programs manage media works from lecturers and students, both research results, theses, and production courses. In this study, the application of Rumah Karya is still limited to utilization at the level of the Educational Technology study program at Makassar State University. Suggestions for further development are that the Rumah Karya application can be adapted as well as a best practice for using cloud-based databases. This research has the potential to carry out further research related to developing additional features in Rumah Karya which can enhance the user experience in using the application. This research can also be extended to other study programs or educational institutions to measure the generalization of Rumah Karya's application in improving the quality of media products in educational institutions.

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