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Development of Interactive E-Modules in Science Learning Courses for Early Childhood: Training Students' 21st Century Skills

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ABSTRACT

Today's learning certainly needs to keep up with the times where the demands of the times are not only knowledge, but also 21st century life skills, which include the ability to think critically, creativity, cooperation and communication. The aim of this research is to produce an interactive e -module in the Science Learning for Early Childhood course as an interactive learning medium and resource to help train and improve students' 21st century skills. This research is ADDIE development research which consists of five steps, namely analysis, design, development, implementation and evaluation. The sample in this study was 150 students taking Science Learning courses for early childhood. This e-module was validated by four experts then analyzed using the Aiken formula, and showed a validity value of 0.844 in the high validity category. Next, an independent sample t-test was conducted to see the difference in treatment of 21st century skills from the sample The results show that there is a difference significant difference between students who use interactive e-modules and those who do not use them, with a sig value (0.000) < a (0.05). This indicate that the development of this interactive e -module is effective for training students' 21st century skills, which consist of critical thinking, creativity, cooperation and communication skill. This interactive e-module for early childhood science learning can help student develop their 21st century skills.

Keywords: *interactive e-modul, 21st century skills (4C), science learning, early childhood, students*

INTRODUCTION

Life in the 21st century is truly challenging, because science and technology are at an extraordinary rate (Handayani et al., 2023; Yulianisa et al., 2018), thus having an impact on many areas of life. Advances in technology, ease of transportation and communication, even the emergence of various artificial intelligences that make human life easier, but these things must be used in the right way. In this century humans have a high dependence on cyber-physical systems that will change the way humans live, work, and communicate (Popkova et al., 2018). This change also has an impact on education. Current learning should not only provide knowledge, but also skills and empowerment of students' potential in order to create superior humans who are able to compete according to the demands of the times.

Everyone hopes for education, through education, we can improve our lives, prepare the next generation to be better, and plan a brighter future. The learning process at school is not only about imparting knowledge, but also skills and developing the potential of students. The balance between knowledge and skills is the capital for building quality resources in this century (Mardhiyah et al., 2021).

All the skills needed by a person to successfully face challenges, a life that is increasingly complex and full of uncertainty, and to be successful in life and a career in the world of work are 21st century skills (Redhana, 2019). 21st century skills are also called global skills because they can respond to global challenges (Bourn, 2018). The Partnership for 21st Century Skills (P21) a national association has developed a framework for 21st century skills that includes the 4Cs, namely Critical thinking, Creativity, Communication, and Collaboration (Yulianda Putri Rahmawati & Mohammad Salehudin, 2021). The 4Cs (critical thinking, creativity, communication skills, and collaboration) competencies are critical for students, teachers, and educational staff to compete in the current industrial revolution 4.0 era (Zubaidah, 2019).

21st century students are digital learners and independent thinkers. They are accustomed to digital convenience and easy access to information. Therefore, the goal of learning is not only to prepare basic literacy for them but education should aim to hone high-level thinking skills, shape character, and life skills that are summarized into 21st century skills (Anagün, 2018). Educational goals like this will be successful if prospective teacher students are also trained and prepared to have 21st century skills.

During lectures, the 21st century skills of prospective teacher students can be developed through learning models that use scientific approaches, such as project-based, problem-based, and design-based learning (Redhana, 2019). It is important for teachers and lecturers to find appropriate models, strategies, approaches, and methods for developing 21st century knowledge and skills (Mashudi, 2021). Developing 21st century (4C) skills does not only require appropriate learning models and methods. But it also requires appropriate learning media and resources that can facilitate students to learn and hone 21st century skills, whenever and wherever they are.

So far, learning resources have only been in the form of textbooks and students have independently sought information from various digital media to support their understanding. Therefore, this study develops an interactive e-module to train the skills of prospective teachers, especially prospective early childhood education teachers in the field of science learning for early childhood. E-modules or electronic modules are self-study digital media containing learning materials that help students understand and solve problems related to lecture activities (Fausih & Danang, 2015). E-modules are designed to be systematic, engaging, and technology-oriented (Ramadayanty et al., 2021). The use of interactive web modules has been proven to help students improve one of the 21st century skills, namely critical thinking skills (Febliza et al., 2023).

The purpose of this study is to develop an interactive e-module in a science learning course for early childhood. The development of this interactive e-module is expected to be valid and effective in helping prospective early childhood education teacher students understand the concept of science for early childhood while developing their 21st century skills.

METHODOLOGY

This research uses the ADDIE development research approach which consists of five steps in developing interactive e-modules based on 21st century skills in the Science Learning for Early Childhood course. The stage are analysis, design, development, implementation and evaluation.

The first stage in this research is to conduct an empirical analysis of the need for product development and literature review. Previous researchers have conducted research in analyzing 21st century skills (critical thinking skills, creativity, cooperation, communication -4C-) of early childhood education students. The development of 21st century skills (4C) not only requires the right learning models and methods. But also requires the right media and learning resources that can facilitate students to learn and hone 21st century skills, whenever and wherever they are. At this analysis stage, (1) indicators of science learning objectives for early childhood, (2) indicators of 21st century skills, (3) Science learning materials for early childhood were produced. Based on the

needs analysis, researchers continued the development of this interactive e-module by carrying out the design stage.

The next stage is design. The design activity carried out by the researcher begins with drafting a science learning course module for early childhood, which contains concepts and challenges for critical thinking and creativity and interaction that will be included in this interactive e-module. At this stage, the researcher maps the learning outcomes of graduates, learning outcomes of the course, and study materials that will be developed in the e-module. This is done to ensure that the science concepts in this e-module are correct and in accordance with the learning outcomes of science courses for early childhood. Then the e-module design is arranged in such a way that it is attractive and easy to use. At this stage, the product design is still conceptual.

The development stage is an activity that contains the realization of the interactive e-module design plan. Researchers use the Canva and Heyzine applications in developing this interactive e-module. The interactive e-module based on 21st century skills is designed with links to several videos about cases as a stimulus for students' critical thinking skills and creativity. In addition, the module is also accompanied by a link that is directly connected to the learning management system so that students can provide comments in the discussion forum aimed at training students' communication skills. The module is developed with group assignments to train students' cooperation skills. The content of the interactive e-module consists of materials, videos, and tests/assignments that are designed in such a way as to train 21st century skills. At this stage, researchers also measure the validity of the interactive e-module based on expert assessment. This e-module was validated by four experts then analyzed using the Aiken formula. The four experts consist of experts in the field of early childhood education, experts in the field of science, experts in the field of graphics, and experts in the field of languages.

In the fifth stage, namely the implementation stage, this interactive E-module based on 21st century skills is implemented. Researchers compared the 21st century skills (4C) scores of two sample groups, namely those using e-modules and those not using interactive e-modules. The results of the 21st century skills measurement at this stage become evaluation material in the final stage, namely the evaluation stage. The evaluation results become feedback for further development improvements. The sample in the research was 150 students taking Science Learning for Early Childhood courses. The sample divided into 2 groups, namely, groups that use interactive e-modules and those that do not. This interactive e-module was used, and an independent sample t-test was carried out to see the differences in treatment.

Data collection techniques in this study used literature study techniques, questionnaires, observations and interviews. Literature study techniques were used to analyze needs based on previous research studies. Questionnaire techniques were used to measure the feasibility by experts and measure the achievement of students' 21st century skills. Observation techniques with field notes were used to observe and record the use of interactive e-modules by samples at the implementation stage. Interview techniques were used to provide feedback and suggestions for improving the e-module.

Qualitative analysis of interactive e-modules based on 21st century skills was conducted by collecting observation and interview results related to the use of the developed interactive e-modules. The results of this analysis became the basis for revision during the evaluation stage. The steps of this qualitative analysis were carried out based on the analysis steps of Milles and Huberman, namely data collection, data reduction, data display, and conclusion drawing/verification. Quantitative analysis was conducted to measure validity using the Aiken formula. If the Aiken index is less than 0.4 then the validity is said to be low, the Aiken index between 0.4-0.8 is said to have moderate validity and if more than 0.8 is said to be high. In addition, quantitative analysis was also used to determine the effect of the use of interactive e-modules on students' 21st century skills using the independent sample t-test to see the difference

in treatment. The results of the t-test calculation were compared with the t table using an error rate of 0.05.

RESULTS AND DISCUSSION

The development of interactive e-modules was carried out based on the results of a needs analysis which showed that students need media and learning resources that help them train and develop critical thinking, creativity, cooperation and communication skills known as 21st century skills (4C). Apart from needs analysis, curriculum analysis is also carried out. Researchers mapped graduate learning outcomes (*Capaian Pembelajaran Lulusan*/CPL), course learning outcomes (*Capaian Pembelajaran Mata Kuliah*/*CPMK*), and study materials that will be developed in e-modules. This is done to ensure that the science concepts in this e-module are correct and in accordance with the achievements of science learning lectures for early childhood. The following is the CPL, CPMK matrix and study materials that will be developed in this interactive e-module.

Table 1. Matrix of CPL, CPMK, and E-Module Study Materials

CPL	CPMK	Study Materials	Development Interactive E-Module
CPL 1: Work together and have social sensitivity and concern for society and the environment	CPMK1: Demonstrate a cooperative attitude between group members in finding cases and solving them to design science activities for early Childhood	Cooperative attitude	Provides a challenging space to discuss with friends in each Learning Activity in the E-Module (cooperation and communication aspects -4C-)
CPL 3: Mastering the religious, philosophical, juridical, anthropological, psychological, sociological and pedagogical foundations of Early Childhood Education	CPMK 3: Able to analyze basic science concepts and the importance of science learning for early childood	Basic science concepts for early childhood	E-Module 1: Basic Concepts of Science for Early Childhood. In this E-Module there will be 4 Learning Activities, that is "What is Science?"; the principles of science learning in kindergarten; concerning Science Learning Capabilities in Kindergarten; concerning early childhood Characteristics. In each activites, there will be challenges (for critical thinking), videos and discussion space (4C skills)
CPL 4: Mastering early childhood education and learning theories as well as approaches that can optimize the	CPMK 4: Able to analyze learning and science learning in early childhood education according to models and	Development of Science Learning for Early Childhood	E-Module 2: Development of Science Learning for early childhood. In this E-Module there will be 3 learning activities namely science learning objectives for early childhood; Scope of Science Learning; The relationship between science and critical thinking. In each activity there will be challenges (for critical thinking),

CPL	CPMK	Study Materials	Development Interactive E-Module
potential for early childhood development.	approaches along with steps in science learning according to theory		videos and discussion space (4C skills)
	CPMK 5: analyze, design and implement science activities based on early childhood scientific literacy	Scientific Literacy	E-Module 3: Scientific Literacy. In this E-Module there will be 2 learning activities, namely the Nature of Scientific Literacy; and Scientific Literacy in early childhood education In each activity there will be challenges (for critical thinking), videos and discussion space (4C skills)
CPL 5: Mastering the concept of professionalism development CPL 6: Able to apply logical, critical, innovative, quality and measurable thinking in carrying out specific work in the field of early	CPMK 6: create plans for early childhood science learning activities CPMK 7: Able to demonstrate the results of logical, critical, innovative and quality thinking in designing science activities	Science Activities in PAUD	E-Module 5: Science Activities for early childhood In this e-Module there will be 2 learning activities, namely Science Activities based on Science Study Materials; and Science Activities based on Themes in early childhood education In each activity there will be challenges (for critical thinking),

The development stage is an activity that contains the realization of the interactive e-module design. Researchers used the Canva and Heyzine applications in developing this interactive e-module. The e-module cover is designed with striking colors, to inspire joy and enthusiasm for reading in readers/users. This cover contains the title, author and agency of the authors. Each initial display of the e-module, there are buttons like those in the initial display of the main E-module, namely buttons to open the page to the right and to the left, speed up page opening, enlarge (zoom in-zoom out), search, make the screen full, and sound settings.

This interactive e-module was developed with complements, namely introduction, learning outcomes, learning activities consisting of material accompanied by related videos, assignments (in the form of challenges to hone 4C skills; critical thinking skills, creativity, cooperation and communication), as well as a summary of the material. All E-modules begin with an introduction which provides an introduction to the material to be discussed. In this introduction, there are also links that connect to previous related material, so that it can make it easier for students to understand the material that will be studied. Learning Outcomes are listed at the beginning of the e-

module, so that students know what the purpose of studying the material is, so that students can assess themselves after they have finished reading the e-module, whether they have achieved their learning outcomes or not. The following displays an interactive e-module developed to train students' 21st century skills.

Figure 1. Interactive E-Module cover with Heyzine Flipbooks

This interactive e-module includes several learning activities which are structured and developed in such a way that they can help students achieve learning outcomes while honing their 21st century skills. In one learning activity there are materials, supporting videos, assignments to train students' critical thinking, creativity, cooperation and communication skills. Students as users of this e-module can connect to the learning management system (SIPDA) forum when clicking the button that has been linked to SIPDA, so that they can connect to carry out discussions in the forum, while lecturers can monitor discussions carried out by students in accordance with challenge given. The development of an interactive e-module based on 21st century skills was validated by four validators, each of whom is an expert in their field. The four experts consist of experts in the field of early childhood education, experts in the field of science, experts in the field of graphics, and experts in the field of languages. The results of the interactive e-module validity test by the validator are displayed in table 2 below.

Table 2. Interactive E-Module Validity Test Results

Validity Criteria	Score V	Category
Eligibility of content	0.87	High
Language	0.82	High
Presentation		High
	0.84	
Graphics	0.85	High
Average CVI	0.84	High

More revision notes were obtained for linguistic criteria. In almost all interactive e-modules developed, writing errors (typos) can be found, so that this linguistic criterion has the lowest value compared to other criteria. Overall, this interactive e-module based on 21st century skills in science learning courses for early childhood can be said to be valid by experts.

21st century skills consisting of critical thinking, creativity, collaboration and communication skills are developed through the use of this interactive e-module that has been developed. Students gave a positive response to this e-module. Researchers compared 21st century (4C) skill scores in two sample groups, namely those who used e-modules and those who did not use interactive e-modules. The following graph shows the difference in the average 21st century skills of students who use and do not use this interactive e-module.

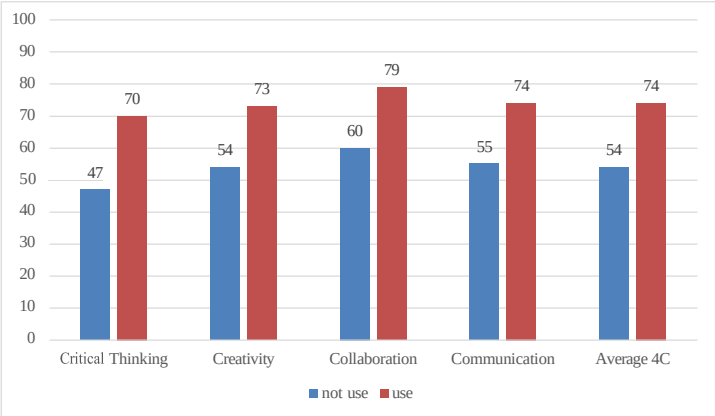

Figure 2. Comparison of Achievement of 4C Skills in Using Interactive E-Modules

Based on the graph above, it can be seen that there is a difference in the average 21st century (4C) skills of students between those who use and do not use this interactive e-module. Apart from that, every aspect of 21st century (4C) skills is also experiencing differences. The biggest difference occurred in the aspect of students' critical thinking abilities, namely an increase of 24 between the scores of students who did not use and who used this e-module. The researcher also conducted an independent sample t-test to see the differences in treatment, so it can be seen that the sig value of 0.000 is smaller than the α value of 0.5, which means that there is a significant difference in the value of students' 21st century (4c) skills between those before the use of interactive e-modules. This is after using this interactive e-module.

The use of this interactive e-module received a good response from students. They think that this e-module is easy to use and helps them understand science learning material for early childhood. In addition, learning activities accompanied by cases and introductory videos help them understand cases and challenge them to think critically in solving related problems. Problem-based learning can provide meaningful learning and help students practice critical thinking (Hutabarat & Phongsavath, 2023). Challenge learning activities connected to the learning management system to help them discuss anywhere and anytime with their group friends. Learning using modules aims to increase the effectiveness and efficiency of the teaching and learning process in schools, both in terms of time, facilities, funds and energy so that the goals can be achieved optimally, (Ardelia et al., 2022). It was explained by (Maisarmah, 2022) that the existence of modules can enable students to learn independently wherever and whenever.

Practicing and developing 21st century skills, such as critical thinking, creativity, cooperation and communication can be done in various ways, such as case method and team based project learning methods (Handayani et al., 2023), problem-based learning by preparing open ended cases (Zhang et al., 2020; Redhana, 2019; Sabur et al., 2023), preparing problem-based student worksheets (Khoiri, 2023), providing appropriate media and teaching materials (Cahyanto & Lesmono, 2022). One of the characteristics of 21st century learning is student center learning where students play an active role in learning and the teacher becomes the facilitator. Interactive e-modules can help activate students in learning (Agustini et al., 2021). Interactive e-modules are a learning medium that can help students' creativity and activeness and help make learning more effective (Ardelia et al., 2022). Creativity is an essential ability that can be developed through the learning process (Usman et al., 2023). The development of this interactive e-module has become a contemporary learning medium and resource that is effective in training and developing students' 21st century skills.

Similar research has been conducted by (Karnain et al., 2018) and shows that the development of modules containing theories and practical instructions can help teachers apply 21st century skills. In addition, research (Febliza et al., 2023) shows that the use of interactive web

modules helps students develop one of the 21st century skills, namely critical thinking, more than just using interactive videos. Research (Osman & Lay, 2020) found that digital-based interactive modules are able to help students understand the content of the material and develop their 21st century skills. This is in line with this research, that the development of interactive e-modules that have been tested for validity can help students develop their 21st century skills.

In this study, the novelty is the interactive e-module developed containing science material content for early childhood, which has not been developed by many. In fact, in accordance with the current curriculum in Indonesia, namely the Kurikulum Merdeka, it is clear that one of the elements of children's achievement in early childhood education is related to science and science literacy. Therefore, it is necessary to prepare prospective teachers who understand science according to the characteristics of early childhood, as well as prospective teachers who have 21st century skills.

The results of this study can be used as a reference by lecturers who want to develop interactive learning modules that can help prospective teacher students understand the content of the material and also develop 21st century skills. Interactive e-modules that provide materials accompanied by video links to problems related to the material, challenges (tasks) in the module that must be completed by students in groups, and links that are directly connected to discussion forums and assessment sections on the campus learning management system can help students develop critical thinking, creativity, collaboration, and communication skills. However, this study has limitations in terms of slow internet connections, so that several times it was constrained when opening videos or entering the learning management system via links in the module. Furthermore, this e-module can be developed further not only to develop 21st century skills that include 4C, but more broadly, namely 21st century skills that include 6C, namely critical, creative, cooperation, collaboration, character and citizenship.

CONCLUSION

The development of this interactive e-module was carried out by paying attention to the development of 21st century skills in PG PAUD students. At the design stage, the research team designs the content and form of the interactive e-module that will be developed. The development stage was carried out using the Canva and Heyzine applications. This interactive e-module was developed with complements, namely an introduction, learning outcomes, learning activities that contain supporting material and videos in it, challenges/exercises that provide opportunities for students to think critically, creativity, collaboration and communication, as well as a summary at the end each module. The results of validation tests by experts in the field show that this interactive e-module is valid with a score of 0.84. Meanwhile, the results of the effectiveness trial show that students who use this interactive e-module are better at critical thinking, creativity, cooperation and communication skills. Thus, the development of this e- module helps train students' 21st century skills.

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