A STEM-based Digital Module for Students University

Atika Ulya Akmal[1], Dwirani Puspa Artha[2], Jefriyanto[3], Ary Kiswanto Kenedi[4] and Hari Setia Putra[5]

[1] Primary School Teacher Education Department, Universitas Negeri Padang
[2] Development Economics Department, Universitas Negeri Padang
[3] Accountancy Department, Universitas Negeri Padang
[4] Primary School Teacher Education Department, Universitas Samudra
[5] Economic Department, Universitas Negeri Padang
arykenedi@unsam.ac.id

Abstract. This study was inspired by creating a STEM-based digital module forprimary school teacher education students that can be utilized to improve learners' independence. Students in the 4.0 era require high learning independence because the learning process does not always occur in the classroom. The investigation aimed to determine how digital STEM-based modules affected students' ability to learn independently. This study was an experiment that was carried out. The study included 60 persons in total as samples. This study analyzed a learning-independent questionnaire using the normalcy test, the homogeneity test, the T-test, the analysis of the impact between factors, and the calculation of N-Gain. The study's findings indicated that STEM-based digital modules improved student learning independence, with T-count > T-table being 4.18 > 1.69. The results of this investigation can be applied to assist pupils in becoming more independent learners.

Keywords: STEM, Digital Module, Technology, Student, University

1 Introduction

In Indonesia, the COVID-19 epidemic is continuously spreading [1]. Even though the COVID-19 epidemic has been ongoing for two years, progress has been made. This situation is supported by statistics from the COVID-19 task force, which shows that COVID-19 cases are still prevalent in some places. This condition is a joint obligation of all elements to prevent the coronavirus from spreading. People's attitudes and behaviors have shifted because of the COVID-19 epidemic, affecting religious, cultural, social, economic, and educational dimensions. In terms of education, educational institutions must organize a learning process that lessens the time students spend in face-to-face classes [2]. As a result, the Minister of Education and Culture of the Republic of Indonesia has issued circular letter number 4 of 2020 regarding the process of implementing education during the COVID-19 pandemic, which explains that the process of implementing learning during the COVID-19 pandemic is carried out online for areas where the virus is still spreading rapidly.

This circular serves as the foundation for educational institutions to integrate online learning. "Online learning" refers to a learning process that takes place entirely online.

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Learning resources controlled online by the teacher are required [3]. Students and teachers can also interact, consult, and offer assignments online using the online learning platform [4]. Because teachers cannot directly assist students in learning, the online learning method necessitates student learning independence at home. Students in online learning are expected to learn and comprehend their material. Students must be able to finish tasks by actively seeking out reference materials that can allow them to solve challenges [5]. This statement is referred to as the student's learning independence process.

Students' ability to control cognitive aspects, evaluate, formulate, and motivate themselves to study independently is learning independence. Students' responsibility in designing, implementing, and evaluating the learning they perform independently is referred to as learning independence [6]. This learning free-dom significantly impacts the online learning process, especially university-level online learning.

Many colleges, including the primary school teacher education (PSTE) study program, implemented online learning techniques during the COVID-19 epidemic. This condition is to prevent coronavirus from spreading. The use of online learning in PSTE also demands students' learning independence for online learning to be carried out effectively. Because PSTE students are preparing to become primary school teacher candidates, they must be able to meet the learning objectives that have been defined, even if they are performed online [7]. As a result, PSTE students must have a high level of learning independence to complete each online learning activity correctly.

Independent learning is critical to achieving online learning objectives [8]. To understand the material offered in the learning process, students must be able to optimize their learning independence. However, the researchers discovered that the students' learning independence needed to be improved based on their first investigation. This is supported by early research findings, which show that the average score of student learning independence in the low category is 52.78. This confirms that during the COVID-19 pandemic, student learning independence is still inadequate. As a result, an effort is required to boost the student's learning independence.

The usage of digital modules is one effort that may be made to promote student learning independence [9]. Digital modules are educational tools that are appropriate for use during the COVID-19 epidemic and are in line with the fourth industrial revolution. This is because digital modules may be accessible anywhere and anytime via computers or cell phones, allowing students to access information relevant to their studies conveniently [10]. As a result, a STEM-based digital module was produced in an earlier study to promote student learning independence. Experts have evaluated the digital module and determined it is secure. However, more research is needed to evaluate whether the digital module is beneficial in promoting independent student learning.

Research related to increasing learning independence has begun to be carried out. Research conducted by Kusumadewi stated that developing mathematics e-comic teaching materials could increase elementary school students' learning independence [11]. Research conducted by Hasibuan also states that developing realistic education-based mathematics teaching materials can increase the learning independence of junior high school students [12]. Research conducted by Bukit also

states that developing teaching materials in civics education lessons can increase the learning independence of elementary school students [13]. Research conducted by Widiartini and Sudirtha also states that the know-want-learn learning model can increase the learning independence of high school students [14]. From this previous research, efforts to increase students' learning independence have begun to be carried out. However, this research is different from this research because this research is focused on students who are in tertiary institutions. In addition, this study examines the effect of self-developed STEM-based electronic modules on student learning independence in tertiary institutions, which has yet to be conducted by anyone. Therefore, this study aimed to determine the effect of STEM-based digital modules in increasing student learning independence.

Research on the influence of STEM-based digital modules in increasing student learning independence during a pandemic is fundamental. The COVID-19 pandemic has changed the educational paradigm with distance learning and restrictions on physical interaction. The use of STEM-based digital modules can be a solution to overcome this challenge and allow students to continue studying independently. This research will provide insight into the effectiveness of digital modules in increasing student learning independence, strengthening mastery skills in managing time, searching for relevant sources of information online, and developing critical thinking skills. The results of this study will guide tertiary institutions and lecturers in designing effective and adaptive learning strategies during the pandemic to improve the quality of education and student learning experiences.

2 Method

This research is a quasi experimental study that uses quantitative approaches. A pretest-posttest design was used in this investigation. The population of this study was 210 PSTE students who were in the first generation. This study used a purposive sample strategy, with 30 students from class AT 01 being assigned to a digital mod-ule treatment and 30 students from class AT 02 being assigned to traditional learning. This research was conducted for six months.

The STEM-based digital module is the independent variable in this study, whereas student learning independence is the dependent variable. The digital module has previously been declared valid by three content, media, and language experts, so it is suitable for use. A questionnaire with a Likert scale was employed as the research tool. The questionnaire has also been declared valid by three instrument experts, so it is suitable for use. The normality test, the similarity test of two variants, and hypothesis testing, which included a different test of two averages, a test of the impact of variables, and a normalized gain test, were all utilized in the data analysis technique.

3 Result and Discussion

The experimental class was given a STEM-based digital module, whereas the control group received traditional instruction. The following table shows the results of the

recapitulation of the outcomes of the pre-test and post-test control and experimental classes:

Table 1. Recapitulation of pre-test and post-test scores

Class	Pre-test	Post-test
Experimental Class	52,78	82,65
Control Class	52,72	65,45

The average post-test value of the experimental class is more significant than the average post-test value of the control class, as shown in Table 1. A normality test is used to carry out the first test. Its goal is to determine whether the data is regularly distributed. The results of the normality test are shown in the table below:

Table 2. Results of normality test

Data	Class	X^2count	X^2table	Criteria
Pre-test	Experimental Class	0,20	0,218	Normal
	Control Class	0,17	0,218	Normal
Post-test	Experimental Class	0,20	0,218	Normal
	Control Class	0,18	0,218	Normal

The fact derived from Table 2 is that the X^2 count on each data is smaller than the X^2table, so the post-test and pre-test data are normally distributed. Furthermore, a homogeneity test was performed. This result will assess whether the experimental and control classes' post-tests are homogeneous. The following table shows the results of the homogeneity test:

Table 3. Results of homogeneity test

Variance		F-count	F-table	Criteria
Experimental class	Control class			
109,69	132,87	1,24	3,316	Homogeneous

Table 3 shows that with a significance level of 5%, F-count F-table shows that both data come from the same variance. The hypothesis test is performed using the T-test after the data has been declared normal and homogenous. The T-test results are presented in the table below:

Table 4. Test results of the difference between the two averages

Class	Averages	Variance	T-count	T-table	Criteria
Experimental	82,65	109,69	4,18	1,69	The average learning independence of experimental class students

	is greater than the control class

Table 4 shows that the t-count is more significant than the t-table, implying that the average learning independence of the experimental class students is greater than the control class average. A test of the influence between variables was conducted to determine the effect of deploying STEM-based digital modules on learningindependence. The results of the influence calculation can be found in the table below:

Table 5. Test results of the influence between variables

Class	Averages	rb	Conclusion	Criteria
Experimental	82,65	0,83	Positive	High
Control	65,45		Influence	

Table 5 shows that rb has a value of 0.83, indicating that studying with STEM-based digital modules impacts student learning independence. The normalized gain test can assess the magnitude of the improvement in student learning independence. The
following table shows the results of the n-gain test computation:

Table 6. Results of N-Gain calculation

Class	Pre-test	Post-test	N-Gain	Criteria
Experimental class	52,78	82,65	0,63	Moderate
Control class	52,72	65,45	0,26	Low

According to Table 6, the experimental class students gain more learning independence than the control class students, with a moderate increase in the experimental class and a low increase in the control class. This reveals that STEM-based digital modules strengthen student learning independence.

The findings of this study are backed up by prior research, such as Febrianti et al.'s 2017 study, which found that a digital physics module based on discovery learning was valid and practical and that it might optimize student learning outcomes [15]. A digital module for practicum computer graphics 1 in electronic publication (e-pub) format has been developed to improve the understanding of graphic engineering for visual communication design students with the topic of digital imaging, according to research conducted by Rastaman and Iqbal in 2019 [16]. A discrete mathematics module has been built in digital form with an asynchronous distribution pattern utilizing open-source technology, according to research undertaken by Sugiharni in 2018 [17]. Dinatha and Kua reported in 2019 that the nature of science (NOS)-based digital practicum module had been developed to enable students to enhance their higher-order thinking skills (HOT) [18]. According to research conducted by Rahamwaty and Arief in 2020, a valid and practical digital module on chemistry learning had been constructed, which might raise the HOTS of PSTE students. According to past studies, digital modules can benefit student learning outcomes and

HOTS. According to a different finding in this study, STEM-based digital modules can assist learners more independently.

Students learning independence refers to their attitude toward mastering competencies, not relying on others, and taking responsibility for themselves [19]. The encouragement students have in carrying out the learning process with complete confidence and self-assurance in their skills to achieve learning goals without the assistance of others is known as learning independence [20], [21].

This study shows that the produced digital module might help students become more independent in their learning. The STEM learning process, which entails a project work approach, is responsible for enhancing learning independence. Working on this assignment necessitates students' ability to study independently [22], [23].

Students are expected to be able to complete all project learning requirements to identify relevant information. Furthermore, the STEM learning process requires students to be able to find information not only from the teacher but also independently and skillfully [24], [25]. Notably, the STEM-based digital module contains all the material and is backed up by sources of information about learning resources that students can access from anywhere at any time. This STEM-based digital module presents the learning schedule and activities to be completed. Students are expected to take responsibility for the learning process [26]. There is a self-evaluation menu relating to the learning process in the STEM-based digital module. Students can select this option to report on learning accomplishments that have been implemented [27]. This is because learners who can evaluate themselves have greater learning independence. A planning menu is provided via a STEM-based digital module. Students are expected to describe the goals that must be met and possible solutions that will be employed in this planning. This is in keeping with the statement that students who can organize their learning have a high level of learning independence [28].

4 Conclusion

The study's findings were given a T-count value of 4.18 and a T-table score of 1.69. This demonstrates that t-count > t-table, indicating that the experimental class's average student learning independence is greater than the control class. This increase in student learning independence in higher education is caused by digital modules facilitating students to study anywhere and anytime with easy-to-use module access. According to the study's findings, STEM-based digital modules substantially boost PSTE students' learning independence.

5 Authors' Contributions

Atika Ulya Akmal and Dwirani Puspa Artha as the scriptwriter, Jefriyanto as a translator, Hari Setia Putra as an editor, and Ary Kiswanto Kenedi as a data processor.

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