Research and Development of Asynchronous Online Learning Module for Computer Programming

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Abstract: Asynchronous online lesson is a learning solution during the Covid19 outbreak in maintaining social distancing and supporting student learning needs and the quality of learning. However, in overcoming and minimizing the weaknesses of asynchronous online learning, the best strategy is to carry out the Research and Development (R&D) of the online learning module. Therefore, this study aims to develop a learning product and evaluate the weaknesses and shortcomings of computer learning modules before being used in authentic learning. The R&D product in this study combines qualitative and non-parametric and parametric inferential quantitative research methods. The study concludes that learning asynchronous online computer programming definitely achieves better results when online teaching materials are equipped with text, audio, pointers, discussion forums, and animated images. Each flowchart in asynchronous online computer programming learning is desired by students to be equipped with its coding into the programming language. Most students, up to 50%, strongly agree that asynchronous online learning is combined with face-to-face classroom learning methods. Most students argued that asynchronous online education of computer programming is as effective as conventional classroom teaching. Besides that, the finding concluded that the prototype of asynchronous learning R&D product for computer programming subjects proved to have a good impact on student learning outcomes.

Keywords: R&D, asynchronous online, online learning, computer programming, covid-19

1. Introduction

The Indonesian Ministry of Education and Culture has instructed universities in Indonesia to replace conventional classroom learning with online learning since the Covid-19 pandemic outbreak (March 2020). Online learning presents broad challenges for educators and students (M & Manoharan, 2021). To adapt to the conditions and demands of the new normal in teaching due to the Covid-19 pandemic by universities is not an action that immediately goes with good readiness (Kamal, Shaipullah, Truna, Sabri, & Junaini, 2020). That is why most universities in Indonesia face new teaching habits in various ways of online teaching. Some universities teach via social media such as Facebook and WhatsApp. Other universities teach through synchronous online learning, such as Zoom and Google meet. The rest of the universities teach through asynchronous online with teaching modules stored in a computer server that students can access at any time. Besides that, the change from traditional classroom learning to online learning has created a new habit that is not easy to adjust for students (M & Manoharan, 2021). So the question is: does online learning meet the learning needs of students? How do students respond to the online learning module? How well do students achieve online learning outcomes? There needs to be a scientific answer to these questions: this article provides an answer solution by conducting an R&D study. Therefore the aim of this study is to develop online learning products and evaluate the weaknesses and deficiencies of the product developed to meet students' learning qualifications and needs. Researched and developed R&D in this artikel is for asynchronous online learning product.

Online learning is web-based learning to deliver instructional material (Adedoyin & Soykan, 2020). The online learning model consists of synchronous and asynchronous online learning (Adedoyin & Soykan, 2020). Synchronous online learning is like face-to-face learning; the lecturer teaches students face-to-face directly to students (Anggrawan, Ibrahim, Muslim, & Satria, 2019). The distribution of learning materials is managed (delivered) face-to-face by lecturers to students, where students engage in spontaneous verbal communication in the learning environment. It means that, in synchronous online learning, learning takes place virtual face-to-face between teachers and students using educational web technology (teacher-centered). In other words, the learning

environment offered by synchronous online learning is the same as the face-to-face learning environment in the form of real and meaningful interactions between students and lecturers. Thus, the shift of face-to-face teaching to synchronous online learning does not have many problems for students and educators except in terms of stability and speed of internet access. In synchronous online learning, lecturers teach face-to-face remotely via the internet at a particular time.

By referring to previous research findings, it is known, the effect of online learning methods on learning outcomes is only 25% (Anggrawan, 2019). It means there are other factors outside the learning method that affect student learning outcomes in online learning. In the means time, the latest prior study has confirmed that the multimedia component needs to be integrated as a definite model into the learning system in online learning to meet student learning needs (Alsadhan, Alhomod, & Shafi, 2014). That is why the research in this article also examines the needs of student learning media in developed online asynchronous learning. However, the question is; how to make it happen? This article solves it as part of the development of this R&D study.

Asynchronous online learning is quite different from face-to-class learning or synchronous online learning. In face-to-face learning or synchronous online, the lecturer explains the learning material directly to students, and students can interact directly with the lecturers in learning processes. In contrast to asynchronous online learning, students learn independently or in groups without lecturer guidance as face-to-face learning. In asynchronous online learning, students learn teaching modules on a server computer via the internet anywhere. In asynchronous online, students no longer learn face-to-face with teaching lecturers as is found in online asynchronous learning (Anggrawan & Satria, 2020) and face-to-face classroom teaching. However, in asynchronous online learning, students learn independently or collaboratively from online learning modules. In synchronous online learning, learning occurs with physical separation at different places between teachers and students (student-centered). Students in asynchronous online learning can choose the desired learning module and repeat learning over and over the desired lesson (Anggrawan et al., 2019). Another advantage of online learning is that it can facilitate multi-level multimedia forms in learning (Anggrawan et al., 2019). An essential advantage of asynchronous online education is that students can freely choose their study time, learning speed (Anggrawan & Satria, 2020), learning atmosphere, and place of study according to their wishes. However, taking into account that asynchronous online learning has learning media and learning methods different from face-to-face.

In asynchronous online learning, students no longer encounter face-to-face learning with lecturers as is usual in face-to-face education and synchronous online learning. Thus, the shift in face-to-face teaching to asynchronous online learning impacts a new learning model for students that is entirely dependent on students learning without direction from the teaching lecturer except for teaching directions from the online learning module provided by the lecturer.

Learning in higher institutions, including asynchronous online learning, cannot be separated from developing lesson sub-modules into teaching modules. The teaching module contains teaching objectives, teaching materials, teaching method, learning achievement, and reference books as outlined in the semester learning plan. According to student learning needs, teaching materials directly impacts the quality of teaching and students' innovative abilities (Guo, 2020). The quality of education and the achievement of online learning are very dependent on the ability to meet student learning needs. Consequently, the needs of students in education must be considered and developed innovatively in the learning module for learning effectiveness. (Anggrawan & Jihadil, 2018). The learning module developed by the lecturer has not fully guaranteed the feasibility of quality as a learning module for use in real learning; it is necessary to minimize the deficiencies in the learning module that will be used in authentic learning. However, evaluation leads to the revision of learning developed, thus helping guarantee student learning in real learning (Smaldino, Lowther, & Russell, 2008). That is reason each teaching module must go through a formative evaluation first to find out the weaknesses and deficiencies that exist to be fixed. In short, a teaching module that has passed formative evaluation is not a trial and error teaching module to be applied to actual learning by lecturers in conventional classroom or asynchronously online, but is a teaching module that has been tested to produce measurable learning achievement.

Formative evaluation constitutes an essential aspect of designing or developing learning module products (Simonson, Smaldino, Albright, & Zvacek, 2012). Formative evaluation is a process used to collect data needed to

revise learning modules that are developed into learning modules that are more effective and more efficient (Dick, Carey, & Carey, 2015). It is recommended that formative evaluation be evaluated by experts in the field of science of the subjects for which the teaching module is developed and other experts, such as educational material experts, multimedia experts, or other related experts (Anggrawan & Satria, 2020). The main stages that a learning module developer needs to take are one-to-one evaluation, small group evaluation, and field trial evaluation. (Dick et al., 2015). The three evaluation phases were carried out to evaluate the asynchronous online learning module in this study.

Online learning is classified into synchronous online learning and asynchronous online learning. Synchronous online learning is learning where lecturers deliver subject matter via internet pages in real-time to students involved in education. In contrast, asynchronous online learning is learning whose subject matter can be accessed by students ubiquitously through the internet page (Anggrawan et al., 2019) (Mee, Sui, & Salam, 2018). In online asynchronous learning, students can learn according to the desired learning pace and the desired learning situation and can repeat learning lessons that have not been mastered. Due to the advantages of asynchronous online learning that synchronous online learning does not have, this research focuses on asynchronous online learning. Active learning interactions in asynchronous online learning occur when students access the learning material module on a Web page and when students learn collaboratively with other students through learning forums on the online Learning Management System (LMS) (Anggrawan et al., 2019). The LMS, also referred to as a distributed learning system, learning platform, or portal, is ideal for online learning approaches based on multimedia and internet computers. The LMS combines various scientific disciplines or knowledge management and pedagogical tools to design, build, and provide an online learning environment (Sleator, 2010). However, Moodle is a free open source platform for online learning and is one of the best-accepted platforms in its segment. Moodle is also known as a Virtual Learning Environment to create efficient online learning sites (Pekić, 2017).

Although, the previous finding confirmed that there is no significant difference in the effect of learning between asynchronous online and face-to-face learning (Anggrawan & Jihadil, 2018). Lately, the demands for online-based education have increased rapidly (Z. Y. Liu, Lomovtseva, & Korobeynikova, 2020)(Manner, 2005) to be able to reach a variety of learning styles and learning environments (Manner, 2005). Actually the demands for online learning align with students' positive attitude and flexibility to adapt to online learning (Tang & Chaw, 2013). Online teaching is valuable not only in overcoming deficiencies in conventional face-to-face class learning but also as a means of fulfilling student learning styles who do not like face-to-face learning. The fact shows the increasing number of universities throughout the world uses asynchronous online learning (A. Liu, Hodgson, & Lord, 2010)(Ramírez-Correa1, Arenas-Gaitán, & Rondán-Cataluña, 2015). Consequently, asynchronous online education has become an integral part of the learning process (Ramírez-Correa1 et al., 2015)(Blau, Weiser, & Eshet-Alkalai, 2016). Online learning is similar to face-to-face lectures, consisting of structured learning information. Still, online learning is equipped with multimedia and hyperlinks online and elements to enhance interaction (Cook & Mcdonald, 2008).

Furthermore, the facts also show that face-to-face learning students prefer a learning environment that accommodates their different needs and preferences (Manner, 2005). With that in mind, everyone has other cognitive conditions as well as different learning styles (Cook & Mcdonald, 2008), and also with that in mind, the strength of asynchronous online learning is its ability to utilize various forms of multimedia: text, audio, silent and moving visuals, and other shapes for learning purposes (Clark & Barbour, 2015), hence the development of online instructional becomes very important and helpful in accommodating various student learning styles. So it is not surprising if the contents of a journal confirm that more research is needed to analyze student needs and learning related to asynchronous online education and online instructional development (A. Liu et al., 2010).

Learning styles are essential cognitive characteristics that influence learning and in providing learning outcomes. It is necessary, instructors and developers support student learning styles to obtain better learning outcomes effectiveness. Learning styles are defined as ways in which a person begins to concentrate, process, internalize, and remember new academic information (Ma & Ma, 2014). Learning styles also reflect the natural habits inherent in a person and how a person prefers to understand, analyze and master new knowledge and information (Rhouma, 2016) and is an integral part of the learning environment (Eudoxie, 2011). However, students' various learning styles and efforts to adapt teaching and learning styles can help create an effective

learning environment (Kharb, Samanta, Jindal, & Singh, 2013). Student individually has different media preferences (Settings & Fenrich, 2006), where student media preferences are closely related to the learning styles of each student. In other words, a learning approach and learning media can deliver certain students to succeed better or fail, but that does not mean the same applies to other students. Suppose students have a dominant learning style, and the learning style is facilitated in the learning method that is followed; it means that the student has the right environment. If the learning media follows the student's learning style, it can be ensured that students will quickly learn the learning material and improve student learning performance. Conversely, if the learning method and learning media do not match the student's learning style, then the student has difficulty in capturing the material or mastering learning. Thus, in education and the study of learning models, learning styles become a crucial factor to be facilitated and researched to strengthen learning outcomes and research results significantly. Learning style is seen as how someone prefers the material to be presented (Jennifer Sudan Sitton, 2009). According to Eudoxie (Eudoxie, 2011), Psycharis et al. (Psycharis, Botsari, & Chatzarakis, 2014), and Rhouma (Rhouma, 2016), there are three types of student learning styles: Visual, Auditory, and Kinesthetic. A person with a visual learning style tends to show a more extraordinary ability to analyze and integrate visual information (Markovic & Jovanovi´c, 2012), such as pictures, diagrams, tables, and graphs (Rhouma, 2016)(Psycharis et al., 2014)(Pekić, 2017). The visual learning style person prefers tangible demonstration or practice learning rather than lectures or speeches. It is not easy to understand verbal instructions. A student with an auditory style will like to process information in conversation or voice (Markovic & Jovanovi´c, 2012). Nonverbal auditory students, students absorb the information presented orally or by listening to other people speak. For verbal auditory students, this student remembers well the information when saying and thinking (Rhouma, 2016). Students of kinesthetic learning styles prefer to process information through tactile means such as interactive media (Markovic & Jovanovi´c, 2012). Students with a kinesthetic learning style are happier, if the learning process takes place with an activity or is directly involved in the learning process. Students of kinesthetic learning styles, it is very difficult to learn in a teacher-centered class, but prefer learning to activities or practices (Rhouma, 2016).

Previous related works:

- Olasile Babatunde Adedoyin and Emrah Soykan (2020) discussed the method of migration to online learning, the challenges caused by the Covid-19 pandemic, and the benefits of online learning to combat the pandemic (Adedoyin & Soykan, 2020). This prior research confirms the need for action research to develop online learning in all disciplines further. This previous research concluded that the university's online learning delivery only focused on instructional media without paying attention to the effectiveness of online instruction (Adedoyin & Soykan, 2020). This previous research did not develop online learning products to meet the desired needs of students and did not first test the online learning modules used, unlike the research in this article.

- Anthony Anggrawan and Christofer Satria (2020) conducted development research and evaluated asynchronous online learning modules (Anggrawan & Satria, 2020). The difference is that this previous study focused on English grammar courses, in contrast to research articles that focused on Computer Programming teaching. Previous research did not conduct learning trials on students on the developed online learning prototype module in posttest (for parametric inferential statistical analysis). The previous research undertook just an opinion survey of students on the online learning prototype module developed after students had the opportunity a couple of days to execute the online prototype module on a computer server. In contrast, the research in this article tested the online learning prototype module developed in students in the trial of online learning students' classes under the lecturer's supervision.

- M. D. Abdulrahaman et al. (2020) reviewed the use of multimedia technology for learning. This previous study concludes that multimedia plays a role in improving the quality and performance of student learning (Abdulrahaman et al., 2020). The previous research method used is a study of the relevant scientific literature. In contrast to the research conducted in this article, the research method used combines qualitative, quantitative analysis, and testing of the learning module prototype. Besides that, the research in this article does not review previous studies but considers learning products and examines the needs needed by students for the developed asynchronous online learning product.

- Claudiu Coman et al. (2020) examined the success rate of implementing online teaching during the Covid-19 pandemic using a survey method. The results of this previous study found that universities were not ready to exclusively conduct online learning so that it tended to be detrimental to students in education (Coman, Țîru, Meseșan-Schmitz, Stanciu, & Bularca, 2020). Unfortunately, online learning organized by universities does not pay attention to the teaching style of online learning environments (Coman et al., 2020). In contrast to the research conducted in this article, the analysis was carried out before the actual online learning of the asynchronous online module developed and paid attention to student needs in learning, including student learning styles. Likewise, the research in this article uses the survey data triangulation method and trials that are different from the previous study, which only carried out one research method.

- Erez Cohen and Nitza Davidovitch (2020) reviewed the effectiveness of online learning in higher education, which immediately moved to online teaching methods. The previous study found that online learning occurs due to condition urgency, constraints faced, and market opportunities rather than government policies Erez (Cohen & Nitza Davidovitch, 2020). So it is not surprising that this previous research also confirms that the result of a sudden shift to online learning has implications for lack of the quality of teaching and a lack of student satisfaction. The methods of this previous research are literature review (quantitative approach) and survey of students' attitudes towards online learning (quantitative method). In contrast to the study conducted in this article, the online learning module R&D is carried out so that the learning module follows students' learning needs. Thus, the online learning module has implications for achieving quality and satisfying learning outcomes when used in authentic learning. Another difference lies in the research method used. In this article, qualitative methods are carried out on computer programming experts, visual communication design (multimedia) experts, and educational technology experts; rather than on a literature study.

- Bisse (2021) analyzed the challenges faced by faculty and students in learning English online. The method of this previous study is a qualitative method with research data from the results of observations, documentation and interviews (Bisse, 2021). This previous related work was different from the research in this article. In previous related work, it focused on achieving real online learning in English courses, as well as analyzing student learning outcomes using qualitative methods. While the research in this article makes learning products for computer programming courses with combination of qualitative and quantitative methods.

So, it is clear, by referring to related research conducted by previous researchers, shows the strength and novelty of this research article, in terms of:

(a) Research in this article examines and develops (R&D) online learning teaching materials before being used by universities so that the teaching materials taught to meet the needs of students to achieve effective learning success, as suggested by the latest related research to be developed in various disciplines.

(b) The research in this article examines the effectiveness of online teaching on trial implementation in real online learning or is a research and development (R&D) online learning product that is tested during development and after online learning product development. In short, the research in this article provides novelty that has never been done by related research before.

The subsequent writing structure of this manuscript is as follows. The second sub-section discusses the Asynchronous Online Learning Module, Instructional Development, and Data Collection and Research Method. The third sub-section discusses the research results, and the fourth sub-section discusses the conclusion of the research results).

2. Research Methodology

2.1. The Asynchronous Online Learning Module

This research was conducted only on developing and formative evaluation of asynchronous online learning modules for computer programming lessons. The asynchronous online learning module is stored on a computer server connected to the internet. Moodle LMS is used as a mediator for realizing the development of the online learning module in developing a programming course in this instructional development. The programming

language used to implement application programs in programming learning is the Visual Basic.Net (VB.Net) programming language. VB.Net computer programming language is one of the most popular visual programming languages in computer science and is known as an event-oriented programming language.

Figure.1. Scheme of the Relationship between Lecturers, Computer Server, Evaluators and Students in the Formative Evaluation of the Learning Module

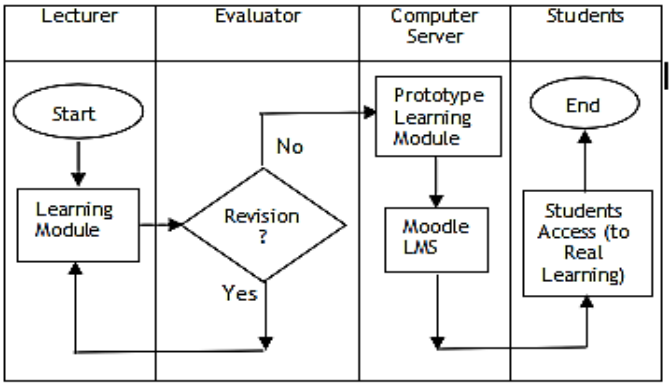
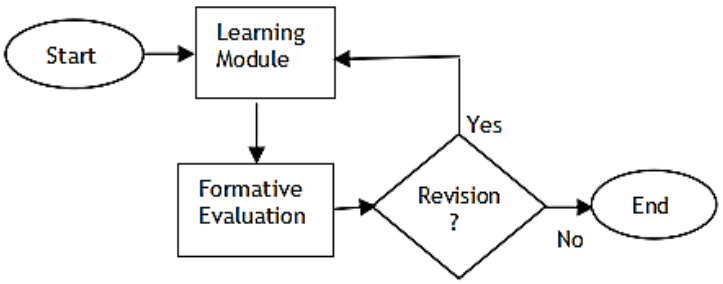


Figure 1 shows the relationship between the lecturer (module development person/teamwork), LMS in the server computer, asynchronous online teaching module, evaluator, and authentic learning in implementation learning module to students in this research.

The developed asynchronous online learning module is tested for its feasibility (effectiveness and quality) as a learning module before it is implemented in real learning in students by conducting formative evaluation (see figure 2).

Figure.2. Flowchart of the Formative Evaluation Process of the Developed Asynchronous Online Learning Module



2.2. Instructional Development

To realize the development of asynchronous online learning in programming, the first thing to do is to prepare a Semester Learning Plan. Semester Learning Plans contain general instructional objectives, several meetings, specific instructional objectives (essential competencies), learning outcome indicators, primary learning materials, sub-main discussion of learning, learning method, assessment, and reference books. Semester Learning Plans and programming course materials were adopted from face-to-face classroom lesson materials that have been conducted at Bumigora University, Indonesia. The primary material of the programming course consists of sub-topics: introduction to programming, an overview of related flow charts (rules for writing flow chart symbols), making flow diagrams and application programs (basic structure of programming), arrays, procedures, functions, recursive, sorting and searching techniques. The subject matter of the programming course refers to the Indonesian national qualification framework, which all universities must follow in Indonesia.

By referring to learning theory and the opinion of experts, learning style is an essential factor to be facilitated to significantly strengthens learning outcomes (Article, Kharb, Samanta, Jindal, & Singh, 2013). Therefore, the asynchronous online learning module that was developed consists of several window page sub-modules based on

the main subject or learning subject matter. Each window page contains an explanation of the sub-subject of learning in the form of text and a voice that explains the teaching material being explained as well as a pointer that points to the material being explained.

2.3. Data Collection and Research Method

Interviews were conducted with a number of structured questions to experts and several students related to the developed online asynchronous learning module. Qualitative data obtained from experts' opinions in the one-to-one evaluation and the opinions of some students in small group evaluation became the input for revision to complement and improve the developed online learning module. Then an opinion poll was conducted on some students in the field trial evaluation to collect qualitative data (written answers in the form of sentences). Triangulation was conducted to verify the poll answers (qualitative data) by conducting a survey and posttest on some other students in other classes to collect quantitative data (ordinal data and ratio data). The qualitative and quantitative results in the field trial evaluation are used as input for revisions to complement and improve the asynchronous online learning module. Until this step, the formative assessment has been completed; and the online learning module developed is a prototype of an online learning module that is ready to be implemented in actual online learning classes. Thus, ultimately, the sequence of steps carried out in the formative evaluation in this study includes:

- One-to-one evaluation with experts: ask for instructions from computer programming experts, Visual Communication Design experts, and educational technology experts, by first demonstrating the online learning module being developed, and explaining the meaning of each subsection of the asynchronous online learning module, then making improvements to the online learning module developed following the advice or direction of the expert.

- Small group evaluation with students who have studied programming lessons through conventional face-to-face classroom lessons was carried out by interviewing students' opinions about the asynchronous online learning module. The online learning module was demonstrated with explanations, then revising (perfecting) the online learning module that had been developed.

- Field trial evaluation with some students who have studied programming through conventional face-to-face classroom lessons was carried out. After the asynchronous online learning field trial, the module was carried out by polling students with written answers in sentences, surveying students with answers in the form of ordinal data from multiple choices, and posttests with answers in the form of ratio data from essay test. Then revision is carried out at this stage following suggestions for improvements / or deficiencies in the asynchronous online learning module.

The type of data collected in this study is in the form of sentence data and numbers (ordinal data and ratio data), which are then analyzed, so this research method combines qualitative and non-parametric and parametric quantitative research methods.

Figure 3 shows the stages of the evaluation process in Formative evaluation in this study.

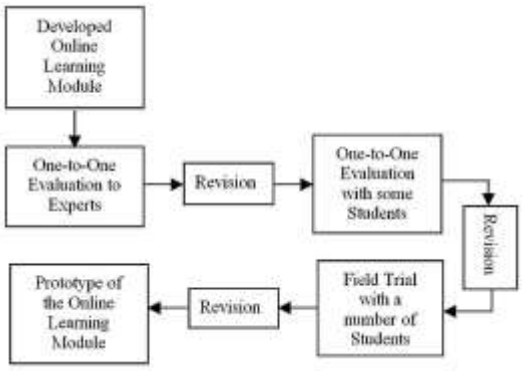


Figure.3. Formative Assessment of Online Learning Module

The one-to-one formative evaluation for Experts involves two programming experts, two multimedia experts, and two visual communication design experts. Meanwhile, the one-to-one formative evaluation on students was conducted on five students. The field trial formative evaluation was conducted on 30 students to collect qualitative data (data in sentence form). The sample data of 30 students were randomly selected from one of the five classes that contained 50 students. Field trial formative evaluations were also carried out on 30 other students to collect quantitative data (ordinal data for non-parametric statistical analysis and ratio data for parametric statistical analysis). A sample of 30 students to obtain this data was randomly selected from one of the other classes out of 5 existing classes, which consisted of 50 students. The data sampled were students of the third semester of the 2019/2020 academic year of Bumigora University.

In qualitative formative evaluation, two main questions are asked, namely: (1). whether the asynchronous online learning module developed for programming courses can produce satisfactory learning achievements; (2). in your opinion, what needs to be considered and needs to be added or revised in the asynchronous online learning module in programming courses that have been developed.

In quantitative formative evaluation to collect ordinal data, four questions (Q1, Q2, Q3, and Q4) are asked in the form of a Likert scale, namely: (1). Is the asynchronous online learning module (product) useful as independent or group (collaborative) learning? (2). how effective are synchronous online learning outcomes for computer programming courses? (3). Does synchronous online learning product has advantages that are not found in face-to-face learning? (4). Do you agree if asynchronous online learning is stand-alone learning? The survey instrument validity test was conducted using Product Moment Correlation.

Table.1. Validity Test Result of Survey Instrument

		Q1	Q2	Q3	Q4	Total
Q1	Pearson Correlation	1	.805**	.919**	.721**	.929**
	Sig. (2-tailed)		.000	.000	.000	.000
	N	30	30	30	30	30
Q2	Pearson Correlation	.805**	1	.782**	.851**	.936**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	30	30	30	30	30
Q3	Pearson Correlation	.919**	.782**	1	.661**	.901**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	30	30	30	30	30
Q4	Pearson Correlation	.721**	.851**	.661**	1	.901**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	30	30	30	30	30
Total	Pearson Correlation	.929**	.936**	.901**	.901**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	30	30	30	30	30

**. Correlation is significant at the 0.01 level (2-tailed).

The validity test result (as shown in table 1) shows that the Pearson correlation is 0.929, 0.936, 0.901, and 0.901, so it can be concluded that the research instrument used to collect data has high validity. The reliability test of the quantitative data survey instrument in this study used Cronbach's-Alpha. The results of the Cronbach's-Alpha test show the alpha coefficient of the survey instrument was 0.925 (as shown in table 2). The meaning instrument items have excellent internal consistency (where is reliability coefficients with a value greater than or equal to 0.6 are considered "acceptable" at scientific studies).

Table.2. Reliability Test Result of Survey Instrument

Cronbach's Alpha	N of Items
.925	4

In quantitative formative evaluation to collect ratio data, a posttest was carried out on students. The posttest data normality test's significant value with the Shapiro-Wilk statistical test was 0.404 (as shown in table 3), greater than 5% of the alpha value (significance level value); It means that the posttest data is normally distributed.

Table.3. Posttest data normality test results with Shapiro-Wilk

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Posttest	.162	30	.043	.965	30	.404

a. Lilliefors Significance Correction

3. Result and Discussion

The developed asynchronous online learning module for computer programming courses consists of several window page sub-modules based on the primary subject matter. Figure 4 shows a screenshot of one of the menu options available in the main window of the online LMS to run the online learning module on how to create a Pull down, Pop up, and Bar menu. Each window page contains an explanation of the main sub-topics of learning in the form of text, accompanied by a voice explanation following the displayed text and a pointer that points to the material being explained, and an animation image. Due to the presentation of material on the developed asynchronous online learning is not only presented in written text, but also accompanied by speech sounds, animated pointers, and animated images, as well as the dense involvement of students in online learning activities, so that all learning styles of students are provided in the developed asynchronous online module. Figure 5 showed a screenshot of the asynchronous online learning sub-window appearance when the Pull down submenu selection was executed.

Figure.4. Screenshot of Learning Menu Options Pull down, Pop up, and Menu Bar on the Asynchronous LMS Online Learning Module.

Figure.5. Screenshot of learning about the Pull down menu on the LMS Online Asynchronous Learning Module.

The formative evaluation results on programming experts conclude that the online learning module of computer programming provides learning outcomes that are not different from face-to-face learning. The online learning module has materials and explanations for teaching materials. It explains teaching materials that are not different from the material and descriptions when the lecturer teaches face-to-face learning. Programming experts recommend that a programming lesson module should involve every example of programming problem solving converted into a flowchart to produce a better online learning module. Programming experts also advise to shows how its implementation becomes an application computer program with a programming language. Hence, students know how to build computer application programs from each flowchart in online learning.

Multimedia experts argue that online programming modules become superior learning outcomes to face-to-face learning because being facilitated not only by text media and sound media but also images and pointers for explaining teaching materials. According to multimedia experts, to produce a better online learning module, it is recommended to supplement the explanation of teaching material with caricatures or moving images (animation) rather than still illustrations.

The formative evaluation results to educational experts concluded that a programming lesson's online learning design module would provide excellent learning results; because accompanied by text, audio, and pointer image like what the lecturer explained in face-to-face class learning. The educational experts also ascertained that it is recommended to complete online education with a chat forum to produce a better online learning module. So there is interactive communication between students and lecturers as well as between students and students.

Referring to several students interviewed one-to-one, it concluded that asynchronous online helped students in mastering learning material. Students no longer need to record subject matter and study at any time according to their time and length of learning time. In addition, it is advisable to include a video demonstrating how a flow chart is converted in a programming language into computer application program code.

According to some students in the field trial with an opinion poll, most students thought that the online asynchronous learning module built for programming subjects was perfect as a learning option for students to study independently or study in groups. Even though in asynchronous online learning, students can repeat reading explanations of certain learning materials anytime, no need to note course material, and can study anytime according to student time. However, students argue that online learning module in programming is no less effective when compared to face-to-face learning. Most students recommend that in addition to face-to-face class learning, students can also study independently online. It seems that students' expectations of the results of this study are in line with the affirmation of previous studies that learning activities do not solely rely on face-to-face classroom teaching but are very good when combined with asynchronous online education (Anggrawan, 2019).

The measurement scale used to determine some students' opinions on field trials with the survey method is a Likert scale with a value range of 1 to 5. The survey results on field trials regarding student opinions on whether students agree that the asynchronous online learning module is useful for students to study independently and in groups are shown in table 4.

Table.4. Student Opinions Whether Asynchronous Online Learning Module Is Useful As Independent or In Group Learning

	Very Useless	Useless	Quite Useful	Useful	Very Useful
Total	0	0	5	8	17
Percentage	0%	0%	16%	27%	57%

Student opinion that the asynchronous online learning module in programming subjects is useful as a learning option for students to study independently and in groups as follows: 57% of students think very useful, 27% of students think useful, and 16% think quite useful.

Furthermore, students think that the online learning module in programming subjects is no less effective when compared to face-to-face learning. It can be seen from the students' opinions in table 5 to the survey question how effective are synchronous online learning outcomes for computer programming courses; students who responded very effectively reached 37%, effective reached 50%, and quite effective at 13%.

Table.5. Student Opinions about the Effectiveness of Asynchronous Online Learning in Programming Subject

	Very Less Effective	Less Effective	Moderately Effective	Effective	Very Effective
Total	0	0	4	15	11
Percentage	0%	0%	13%	50%	37%

Based on a student opinion survey that the asynchronous online learning module has advantages that are not found in face-to-face classroom learning, most students (reaching 60%) strongly agree, 30% agree, and 10% quite agree, as shown in table 6.

Table.6. Student Opinion Survey about the Asynchronous Online Learning Module Has Advantages That Are Not Found In Face-To-Face Classroom Lesson

	Strongly Disagree	Disagree	Quite Agree	Agree	Strongly Agree
Total	0	0	3	9	18
Percentage	0%	0%	10%	30%	60%

Table.7. shows the students' opinions if asynchronous online learning is stand-alone learning. It was found that most students (up to 50% of students) disagreed if asynchronous online learning was stand-alone learning, 17% strongly disagreed, while 20% quite agreed, 10% agreed, and only 3% strongly agreed.

Table.7. Student Opinion If Online Learning Stands Alone.

	Strongly Disagree	Disagree	Quite Agree	Agree	Strongly Agree
Total	5	15	6	3	1
Percentage	17%	50%	20%	10%	3%

The two-tailed significance value of the t-test by value 70 for the posttest data was less than an alpha value of 0.05 (i.e. a value of 0.007, as shown in Table 8). It means the skill average of student computer programming is greater than 70% from the ideal number. So it can be concluded that the prototype of asynchronous learning R&D product for computer programming subjects proved to have a good impact on student learning outcomes.

Table.8. The results of the one-sample t-test of posttest data

	Test Value = 70					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Posttest	2.902	29	.007	6.00000	1.7708	10.2292

4. Conclusion

Programming experts recommend that programming lesson modules involve programming problem-solving examples in flowcharts and application computer programs. It means asynchronous online learning of programming courses should show the implementation of all problem-solving flowcharts into computer application programs so that students can change the flowchart to a computer application program. Both multimedia experts and educational experts agree that online learning creates optimal learning outcomes because

it supports student learning styles with multimedia (text, sound, image, and pointer). Furthermore, educational experts ascertained that online learning should have a chatting forum for interactive communication between students and lecturers and between students and students. Students argue that asynchronous online helps students in the mastery of learning material and suggests the need for instructional videos that show how to convert instructions on flowcharts into computer application program code. Students also argue that synchronous online programming learning is as effective as face-to-face learning. Most students (57%) think that the asynchronous online learning module is beneficial as a learning option for students to study independently or in groups. However, students argue, the online module of programming lesson definitely produce the excellent learning outcomes, if it is not only equipped by texts or still image but also equipped by sound or voices, moving images (animation image) as well as interactively chat forum between students and students and between students and lecturers. Most students agree that is up to 50%, and quite a lot strongly agree, that is up to 37%, that online learning in computer programming is no less effective than face-to-face classroom learning. Although most students thought, up to more than 60%, that asynchronous online learning had advantages not found in face-to-face classroom learning, most students suggested that conventional face-to-face class learning should be held in conjunction with asynchronous online learning. The average online learning achievement of asynchronous programming is 70% of the ideal number. This concludes that the findings or asynchronous online learning R&D products developed in the research article can be a prototype model in developing asynchronous online learning to achieve quality learning outcomes in real learning. The novelty of this research lies in the R&D product of the learning module developed by taking into account the learning needs of students and the quality of learning before being used in actual learning. Further research is needed for formative evaluation of lesson modules both on online learning and on the face of certain subjects so that the learning modules in real lessons support student needs in education and produce practical learning achievements. It is also necessary to carry out a formative evaluation accompanied by summative evaluation for specific subjects to prove whether the formative assessment results really support the success of student learning outcomes in real lessons in summative evaluation.

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