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Application of Instructional Design Models by Prospective Teacher Students

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Abstract

Calon mahasiswa guru banyak terlibat dalam penelitian pengembangan bahan ajar berbasis teknologi informasi dan komunikasi (TIK). Permasalahan yang ada sampai saat ini sering menemui kendala dalam penerapan model desain sistem pembelajaran yang tepat. Penelitian ini dimaksudkan untuk merumuskan model desain sistem pembelajaran yang dapat dipilih siswa sesuai dengan karakteristik bahan ajar berbasis TIK yang dikembangkan. Penelitian ini menggunakan pendekatan ex post facto dengan metode deskriptif. Sebanyak 528 laporan penelitian mahasiswa periode 2017-2021 menjadi populasi dan sampel penelitian. Observasi dilakukan terhadap laporan penelitian untuk mengumpulkan data, baik kuantitatif maupun kualitatif. Data kuantitatif dianalisis secara deskriptif, sedangkan data kualitatif dianalisis dengan teknik Miles, Huberman, dan Saldana. Hasil penelitian menemukan bahwa terdapat enam model desain sistem pembelajaran yang terpilih, di antaranya model ADDIE yang paling banyak dipilih (37,50%), diikuti oleh ASSURE (20,45%), Dick & Carey (19,32%), Four-D (14,39%)., Rapid Prototyping (6,82%), dan model Kemp menjadi model yang paling tidak dipilih (1,52%). Alasan utama pemilihan model adalah kepastian langkah, kemudahan penggunaan, dan user friendly, sementara banyak langkah yang tidak diperhatikan. Hasilnya, model ADDIE, ASSURE, Dick & Carey, dan Four-D banyak dipilih, sedangkan model fleksibel seperti Kemp dan Rapid Prototyping tidak banyak dipilih karena memerlukan pertimbangan dalam memulai dan mengakhiri pengembangan. Pengalaman membawa mereka kompetensi untuk memilih model desain sistem pembelajaran yang tepat.

Keywords: *Model, desain, instruksional, ex post facto, deskriptif.*

Abstract

Prospective teacher students have been heavily involved in research on developing information and communication technology (ICT)-based teaching materials. The problems that exist until now often encounter obstacles in applying the right instructional system design model. This study is intended to formulate an instructional system design model that students can choose according to the characteristics of the ICT-based teaching materials developed. The study used an ex post facto approach with a descriptive method. A total of 528 student research reports in the 2017-2021 period became the population and the research sample. Observations were made on research reports to collect data, both quantitative and qualitative. Quantitative data were analyzed descriptively, while qualitative data were analyzed using the Miles, Huberman, and Saldana technique. The study found that there were six selected instructional system design models, of which the ADDIE model was the most chosen (37.50%), followed by ASSURE (20.45%), Dick & Carey (19.32%), Four-D (14.39%), Rapid Prototyping (6.82%), and the Kemp model being the least chosen model (1.52%). The main reason for choosing the model is the certainty of steps, ease of use, and user friendly, while many steps are not considered. As a result, the ADDIE, ASSURE, Dick & Carey, and Four-D models were widely chosen, while flexible models such as Kemp and Rapid Prototyping were not widely chosen because they require consideration in starting and ending development. Experience brings them the competence to choose the right instructional system design model.

Keywords: Model, design, instructional, ex post facto, descriptive.

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1. INTRODUCTION

When traced to its history, the use of computers in education has been going on for quite a long time. Taylor formulated a taxonomy of computer use in education as a tutor, tool, and tutee (Taylor, 1980). As a tutor, the computer is used to teach students, while a computer tool is used to help handle academic tasks, and as a tutee, the computer is taught by students by creating programs. PLATO (Programmed Logic for Automatic Teaching Operations) was

the first electronic learning system developed by Donald Bitzer in 1959 (S. Aslan & Reigeluth, 2011; Valentine, 2014). The learning system that used advanced technology in the 1970s was TICCIT (Time-shared Interactive Computer-Controlled Information Television) (Merrill, 2013; Reigeluth, 1979). Both PLATO and TICCIT operate mainframe computers. Two other learning systems developed in the mid-1960s, namely SOCRATES and CLASS. SOCRATES (System for Organizing Content to Review and Teach Educational Subjects) is a tutorial-based learning system. At the same time, CLASS (Computer-based Laboratory for Automation of School Systems) is a drill-based learning system (Sinem Aslan & Reigeluth, 2020).

Around 1970, American schools began to use microcomputers for learning, educational administration, and other applications (Cotton, 1991). Learning systems have also begun to utilize microcomputers, including micro-PLATO (Merril et al., 1996) and Algebra produced by Edu-ware (Merrill, 2013). Algebra is a game-based learning system. Microcomputers getting cheaper made computer-based learning develop rapidly around 1980 (Molnar, 1997). There were two competing microcomputer companies then, Apple II and IBM. Apple II is mostly used for learning because of its graphics capabilities and courseware availability, while IBM is mostly used for business and industrial purposes (S. Aslan & Reigeluth, 2011). The microcomputer era has made computer-based learning more rapid because teachers can develop their application of teaching materials to help the learning process of their students. There are many terms for the use of computers in learning, such as computer-assisted instruction (CAI), computer-based education (CBE), computer-based instruction (CBI), computer-based training (CBT), computer-assisted learning (CAL) (Fourie, 2001; Nazimuddin, 2014; Zahniser, 1983). Each term has its focus but essentially refers to using computers for learning. Computer-based education (CBE) and computer-based instruction (CBI) are the broadest terms and can refer to almost any type of use of computers in education, including exercises and practicals, tutorials, simulations, instructional management, supplementary exercises, programming, database development, writing using a word processor, and other applications. Computer-managed instruction (CMI) refers to the use of computers by school staff to organize student data, make instructional decisions, evaluate student test performance, and keep records of student progress.

Computer-assisted instruction (CAI) is a narrower term referring to the exercises and practices, tutorials, or simulation activities offered, either alone or as a complement to traditional teacher-directed instruction. Initially, CAI was linear, dominated by drill and practice (Nazimuddin, 2014). The development of artificial intelligence encourages experts to use it in learning, thus developing intelligent computer-assisted instruction (ICAI), intelligent computer-based instruction (ICBI), intelligent tutoring system (ITS), and so on (Baker, 1991; Duchastel & Imbeau, 1988; Greg, 2013; Mingming et al., 2022; Scandura et al., 1988). In 1999, e-learning began to refer to computer applications for teaching and, at the same time to facilitate communication between teachers and students (Kandori, 2015). The Bologna Declaration (1999) became an important milestone in the development of e-learning (Dašić et al., 2012). The next development of e-learning has entered the era of animation and combined sound, images, and video into multimedia (A.Pavithra et al., 2018; Verma et al., 2020). Even after the official World Wide Web (WWW) service was implemented on the internet, hypermedia as a combination of hypertext and multimedia has begun to develop. The World Wide Web was pioneered in 1989 by Berners-Lee and his colleagues (Sendall, 1996) to create a single user interface that could easily access and add various types of information (Berners-Lee et al., 1992). Various forms of e-learning material were then developed, both applied offline and online. The Covid-19 pandemic that has hit the world since the end of 2019 until now has indirectly spurred the development of e-learning. It is due to the learning-the-home policy because students and teachers cannot meet face-to-face in class. In addition

to software companies, teachers, student-teacher candidates, and education practitioners are heavily involved in the development of e-learning. Instructional system design (ISD) is intended for the development of functional learning systems (Uzunboylu & Kosucu, 2020), which is a behavior-oriented model (Hamdani et al., 2011). This study tries to describe the application of the ISD model among prospective teacher students. The description includes the frequency of model application and the rationale for model selection. Many instructional design models can be used in e-learning development. One of the popular ones is ADDIE, an acronym for the five phases of development in it, namely analysis, design, development, implementation, and evaluation (Aldoobie, 2015; Branch, 2010; Drljača et al., 2017). The five phases are the main components in the development of teaching materials. Each phase in the ADDIE model is interrelated and interacts with each other. Therefore, ADDIE is a very systematic and well-organized model of instructional design development. Empirical data show that teaching materials created by following the ADDIE model can be used in any environment, either online or face-to-face. If it is based on student needs, ADDIE will be better (Tegeh & Kirna, 2013; Tu et al., 2021).

The ADDIE model is one of the most commonly used models in the field of instructional design as a guide for producing effective designs. Instructional designers can use the ADDIE model to develop teaching materials for unlimited materials. A teacher can develop efficient and effective instructional products for the material he is responsible for by applying the ADDIE model. The ADDIE model was first developed in 1975 by the Center for Educational Technology at Florida State University for the US Army (Branson et al., 1973; Budoya et al., 2019). The initial form of the ADDIE model is linear (waterfall), which consists of 19 stages and is divided into five phases, called Florida State University Five Phase of ISD. ADDIE is considered relevant to learning, design, and technology standards (Sahaat et al., 2020). Russel Watson later revised the initial ADDIE model in 1981 to be more dynamic, no longer linear as it was in the beginning. Watson's revised ADDIE model still uses five phases: Analyze, Design, Development, Implementation, and Evaluation and control. The first four phases are linear, but the fifth phase (evaluation) is carried out continuously on the previous four phases. The United States Armed Forces 1984 released a more dynamic ADDIE Model. All phases in the model are interrelated. Nothing is separate. One phase affects the other. Not all phases are carried out linearly, but several can be carried out simultaneously. The most widely used ADDIE model is dynamic ADDIE, with evaluation consisting of five phases: analysis, design, development, implementation, and evaluation (Branch, 2010). Evaluation is carried out at the end of each phase, called formative evaluation, and at the end of development, called summative evaluation.

The ASSURE learning model was developed by (Jiwak Raj Bajracharya, 2019). The ASSURE learning model is a simple learning model that can create efficient and effective learning (J. R. Bajracharya, 2019; Hameed et al., 2019). The stages in the ASSURE model refer to the stages of learning, which calls the event of learning (Gagne, 1988). In his research, Gagne revealed that well-designed learning begins with the passion of students' interests, moves on to the material, engages students in practice with feedback, assesses their understanding, and ends by following up on learning activities that have taken place. The ASSURE model incorporates the learning events resulting from Gagne's research. ASSURE is an acronym for the steps in the development model: analyze the learner, state objectives, select methods, media, and materials, utilize media and materials, require learner participation, and evaluate and revise. This model uses media and technology to create the desired learning processes and activities. The ASSURE model requires a systematic and holistic step-by-step application to provide optimal results. However, various limitations often force developers only to be able to carry out some of the steps systematically and holistically. Limited time allocation and limited resources are the main obstacles to

implementing the complete ASSURE development model. Another instruction system development model that is also widely used is the four-D (4-D) (Tegeh et al., 2019; Thiagarajan, 1974). Four D stands for four stages in the development of teaching materials, namely define, design, develop, and disseminate. The define stage often called the analytical stage, involves five steps: front-end analysis, student analysis, task analysis, concept analysis, and setting instructional goals. The results of the define stage were developed into a learning design prototype through tests, textbooks, media, and computer-based teaching materials. The design stage consists of four steps, criterion-referenced tests construction, media selection, format selection, and composing the initial design. At the development stage, the teaching materials' prototype is modified after being assessed by experts and field trials. Finally, a summative evaluation was carried out at the dissemination stage and continued with packaging, copyright release, and diffusion.

Initially, the Four-D model was used in training the development of teaching materials for special education teachers. The trainee teachers must demonstrate competence in compiling a valid and effective learning program. A learning program is effective if it demonstrates that it plays an important role in producing permanent changes in student behavior (Thiagarajan, 1974). These changes are a function of the experience the developed learning program provides. The objectives of the learning program must be formulated in the form of behavior, and the objectives must be by the initial behavior of students to meet the criteria for effectiveness. The program should describe and demonstrate the critical defining attributes of the training procedure so that replication can be ensured. Furthermore, the program must produce objective evidence for achieving learners' goals. In other words, a learning program is considered effective if it can demonstrate that it has fulfilled its objectives as a function of a clearly defined set of experiences.

Another model that is also widely used is the rapid prototyping model, which was originally a software engineering model but is now being adopted as a model for developing systems and learning products. The IEEE defines prototyping as a development model that prioritizes prototyping early in the development process to obtain feedback to support further development (Booth & Kurpis, 1993). A prototype is an executable system model that accurately reflects a subset of system properties, such as display format, expected results, or response time (Kordon & Luqi, 2002). Customers can quickly provide feedback on prototypes. Therefore, prototypes are very useful for formulating and validating requirements, solving technical design problems, and identifying software and hardware components to support the developed system. The prototype may not meet all the constraints on the final version of the system, as other constraints are added during iteration as needed. The rapid prototyping concept starts with rapid prototyping and then uses the spiral development concept to produce the final product. Generally, rapid prototyping models involve students and subject matter experts interacting with prototypes and instructional designers in a continuous cycle of evaluation and revision. In other words, prototype development is practically the first step. At the same time, front-end analysis is reduced and replaced with an interactive process during development between learners, materials experts, and learning designers. Rapid prototyping models as “design in progress” because the initial development of small-scale prototypes are used to test the key features that are most useful in large-scale systems (Sentz et al., 2019). Rapid prototyping models should be used only by experienced instructional designers. They also criticize the model as yielding to the demands of time (Edmonds et al., 1994). The instructional design model also popular is the Kemp model, often called the Morrison, Ross, and Kemp model (J. R. Bajracharya, 2019). Kemp's model is innovative, with a circular or circular structure, not linear (Akbulut, 2007). This model adopts the multiplicity of various disciplines, so instructional design with an innovative approach is based on its non-linear structure and interrelated stages (Kaufman &

Wandberg, 2014). Kemp's model has nine stages with a circular structure that are interdependent, not independent (J. R. Bajracharya, 2019). The nine stages in Kemp's model are instructional problems, learner characteristics, task analysis, instructional objectives, content sequencing, instructional strategy, message design, instructional delivery, and evaluation instruments. Its nine stages make Kemp's model a detailed one, but that does not mean it is complicated. The circular design makes the Kemp model highly flexible (Kurt, 2016). In contrast to other models, developers do not have to start from one specified stage, then move linearly to the next stages. Learning design developers can freely start the design process from any nine stages in Kemp's model. Several elements may be performed simultaneously, and several design stages may still need to be performed (Kurt, 2016). The interrelated development stages make it possible to carry out the development stages iteratively. Thus, the developer can make revisions on an ongoing basis. Such a process ensures the suitability of the learning design to the needs of students to achieve more optimal learning outcomes.

2. METHODS

This study describes the development of digital teaching materials by prospective teacher students. Therefore, a descriptive method is applied to reveal this phenomenon and its characteristics (Nassaji, 2015). Data were collected through observation and surveys (Adiyanta, 2019; Gall et al., 2007; Ponto, 2015). Research reports on teaching materials produced by prospective teacher students at the Ganesha University of Education are collected. Furthermore, identification of the development model used. Research reports are limited to the last five years. Triangulation of data was collected by involving two observers to avoid data bias due to personal perception factors. Thus, the data obtained from different perspectives can help validate the data (Wüthrich, 2004). Observers collect data by not intervening with each other. The results obtained are discussed in the focus group discussion.

Quantitative data obtained from observations are presented in the form of a frequency table, and then the interpretation of the data is carried out. Data from interviews complement qualitative data obtained from observations. Interviews were conducted with accessible developers and several experts engaged in developing digital teaching materials. This approach is used to determine whether the information from the two sources is convergent (Creswell, 2015). Qualitative data were analyzed using the (Ridder, 2014) technique. The analysis begins with data condensation to select keywords so that the data is simpler and more focused on the research objectives. Furthermore, the data display is carried out to organize the data so that the information is properly arranged to facilitate concluding. The data set is made more explicit with visual displays to help the inference process (Verdinelli & Scagnoli, 2013).

After looking at the series of information, drawing and verifying conclusions are then carried out. It is possible to review the display data results and re-analyze them if the initial conclusions obtained are still considered weak. Even work can be returned from data condensation if it is necessary to strengthen the conclusion. If the data that has been collected is considered insufficient, then data collection can be done again, either through observation or interviews. The process takes place iteratively until the conclusions obtained are considered good. So that the conclusions obtained are stronger, following the recommendations (Farquhar & Michels, 2016), the conclusions obtained are verified through theoretical triangulation, namely by interpreting based on the perspectives of several theories.

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3. RESULTS AND DISCUSSION

Result

Many models for developing digital teaching materials vary greatly in complexity. Each development model has advantages in certain respects. However, the data shows prospective teacher students choose only five digital development models at the Ganesha University of Education: ADDIE, ASSURE, Four-D, Rapid Prototyping, and Dick and Carey. Early observations at the Central Library of the Ganesha University of Education found 528 research reports on developing digital teaching materials written by students from 19 study programs in the 2017-2021 period. The related research reports exceed the data, but due to various obstacles, including file corruption and incomplete information about the model used, only 528 reports were analyzed. The frequency distribution of the selected development model is listed in Table 1.

Table 1. Frequency of Selected Development Model

Development Model	Frequency	Percentage
ADDIE	198	37,50
ASSURE	108	20.45
Dick and Carey	102	19.32
Four-D	76	14.39
Rapid Prototyping	36	6.82
Kemp	8	1.52
Total	528	100.00

The data in Table 1 shows that the ADDIE development model is the most widely used by 37.50% of researchers. The ASSURE model is in second place, where users reach 20.45% of researchers. The Dick and Carey model was used by 19.32% of researchers and was in third place. In fourth place is the Four-D model used by 14.39% of researchers. Furthermore, the prototyping model is a model that has not have many users, which is only 8.33%. Finally, the Kemp model has the fewest users, at only 1.52%. After the development model is identified, the next observation is carried out on the completeness of the steps of the selected model. Not all researchers apply all the steps in the selected model. Table 2 contains information about the completeness of implementing the steps of the selected model.

Table 2. Completeness of the Implementation of the Steps of the Selected Model

Development Model	User Frequency	Implementation of Steps			
		All		Not All	
		f	%	f	%
ADDIE	198	10	5.05	188	94.95
ASSURE	108	8	7.41	100	92.59
Dick and Carey	102	6	5.88	96	94.12
Four-D	76	5	6.58	71	93.42
Rapid Prototyping	36	6	16.67	30	83.33
Kemp	8	0	0.00	8	100.00
Average			6.93		93.07

Table 2 shows that a very small percentage of researchers have fully implemented the development steps. On average, only 6.93% of researchers fully implemented the development steps. That is, as many as 93.07% of researchers still need to complete the

development steps. The results of further scrutiny show that the most neglected step is evaluation, especially summative evaluation. More than 98% of researchers conducted a formative evaluation, but the implementation varied widely. Validity tests are generally carried out with a qualitative approach, and some also include quantitative testing. Usability tests are carried out in various ways. It is common for researchers only to carry out formative evaluations at the end of development and only make limited observations in small groups.

Discussions

After finding quantitative information about the development model used, further scrutiny is made on the rationale for selecting the model. Not all research reports include the rational choice of development model. Familiarity is the most common reason for choosing a development model. Familiar terms, in this case, are still open for debate because these reasons appear in several different development models selected. Familiarly referred to in this case is already widely used by other developers. This reason makes sense because the developer is a student who needs more experience developing teaching materials. As a first step, novice developers tend to choose a commonly used development model (Basu, 2018). Also, familiarity was the main reason for choosing the model for developing online teaching materials (Khodabandelou & Samah, 2012). The second reason many researchers also put forward in choosing a development model is systematic. Systematic is meant here, among others, is easy to use because it has fixed steps. Ease of operation is one of the considerations in choosing a development model (Elgazzar, 2014). If the development steps are fixed, then the developer only follows the steps that have been set. The concept of systematic product development has been chosen since the beginning of the instructional design community (Branch, 2010). On the other hand, development models that give developers the freedom to take the first step and determine the next step have received less attention. Again, this condition makes sense in the context of still students or novice developers without much experience organizing development steps.

ADDIE is the most preferred development model. The reason for familiarity is relevant because ADDIE has become the preferred model in many publications. Previous research has also found that ADDIE is the most widely used development model (Khodabandelou & Samah, 2012; Mora Marín et al., 2019). Besides being commonly used, ADDIE is widely chosen for systematic reasons. This reason is relevant to the statement that ADDIE is a systematic model (Branch, 2010). ASSURE is the second model after ADDIE. The reasons for the ease of use and familiarity are the reasons the researchers put forward. In addition, similar to ADDIE, the steps in the ASSURE development model are relatively fixed. Therefore ASSURE is considered systematic (Yildiz & Uzunboylu, 2018), so ASSURE has become a strong rival in the selection of teaching materials development models (Mora Marín et al., 2019).

The Dick & Carey model is the model that is in the third position behind ADDIE and ASSURE. The other researchers also found that the Dick and Carey model was the most chosen (Khodabandelou & Samah, 2012). Indeed, the steps of the Dick and Carey model are long, which is ten steps. However, this model is widely chosen because it is considered to be commonly known by students. In addition, students assessed that the Dick & Carey model was easy to use because the steps were fixed. The clarity in explaining the stages of the model is seen as an advantage of Dick and Carey's model (Yildiz & Uzunboylu, 2018). All the steps in the Dick and Carey model are interrelated, and none can be skipped (Nagpal & Kumar, 2020). One surprising finding was the Four-D model chosen by 14.39% of researchers. There are few publications related to applying the Four-D model, but the fact shows that the model is widely chosen. The researcher considers a systematic model with only four steps. In addition, most studies that chose the Four-D model developed teaching

materials for lower-grade students, such as grades 1-3 of elementary and special school students. The Four-D model initially developed the model for special school teachers (Lawhon, 1976). As usual, students, because there are seniors who use it first, the next student tends to choose. The prototyping model is simple, and the steps are few, but there are few choices. Return to the systematic reasons or determination of steps put forward by students. Indeed, as an instructional design, rapid prototyping is iterative, so it is more flexible in handling complex problems in learning (Daugherty et al., 2007). During iterations, discovering new problems results in modifying tentative objectives or creating new ones, so the rapid prototyping process is restarted (Tripp & Bichelmeyer, 1990). Conditions like this are difficult for students to follow as novice developers. They need help to develop dynamically. The final prototype is relatively difficult to achieve, so there is an opportunity for the development process to take a long time. The short steps have yet to be the basis for the consideration that the model was chosen, such as the prototyping model. Another consideration is the researcher's hesitation in assessing the final product to stop the development process. In line with the reasons mentioned above, the Dick & Carey development model, although the development steps are quite long, is relatively widely chosen by researchers. The development steps in the Dick & Carey model are linear and easy to follow. Although the resulting product is not optimal, the development steps have been followed well. Of course, this is very positive for making them professional developers of teaching materials.

Another relatively flexible model is the Kemp model, which has yet to be widely chosen. As is well known, the Kemp model gives researchers the freedom to choose one stage to start the development step. Even Kemp's model opens up the opportunity to perform several stages simultaneously. Therefore, although the Kemp model has a fairly long development step, it can be completed by researchers in relatively the same time as other models. However, since most researchers are novice researchers, they need help determining which steps can be carried out simultaneously. As a result, Kemp's model is not widely chosen because it is considered less systematic, and there are dependencies between stages (Mora Marín et al., 2019). There is a tendency for researchers to imitate the model used by their predecessors. Imitating, in this case, does not mean plagiarizing. They tend to choose a development model widely used in previous studies. It can be read from the writing pattern in the development steps. However, this is not a negative thing that should be highlighted. As a novice developer, imitation is a great starting point for learning. In line with their experience, they will try to innovate and be creative to find the right development model. The accuracy of the development model does not mean consistency in using the model but the compatibility of the model with the material and form of teaching materials that are implemented.

This research has found that most researchers still need to carry out complete development steps in developing digital teaching materials. It happens because the researcher is still a student in the position of completing the study. As a result, the time of conducting the research became their main reason for limiting the steps of their research. An acceptable reason is that they want to complete their studies in a not-too-long time without compromising the final project's quality. Another reason revealed from the research was their limited competence regarding development research, especially the development of digital teaching materials. As a result, they do more imitation of the development model carried out by their predecessors. Unfortunately, the imitation process is not accompanied by efforts to explore the model, so the existing errors continue without any improvement. Apart from the above findings, the efforts made to develop digital teaching materials by prospective teacher students should be appreciated. However, digital teaching materials are a reference for future learning. The flexibility of use time and access time is a big advantage of digital teaching materials. In addition, the representation of digital teaching materials that can be made varied

is very beneficial because it can be made to accommodate the different characteristics of students. Thus, learner control can run more optimally. Students can manage their learning process properly according to their respective characteristics. This learning process is believed to improve learning outcomes optimally. In addition, using digital teaching materials opens up wide opportunities for students to interact globally with a varied learning environment. Thus, their creativity and innovation can develop properly. This research focuses on identifying the development model used and the completeness of the stages carried out. This research does not look at the quality of development research. The assumption is that the quality of research and development is improving with complete stages, so the resulting product is also improving. In line with technological developments and reference developments, research on the development of digital teaching materials is believed to be increasing, both in quantity and quality. Therefore, on another occasion, research is needed to examine the quality of research on developing digital teaching materials by students. Of course, the development model used also needs to be examined. The research findings will be a reference for students researching the development of the next digital teaching material.

Continuous processes such as the above can improve the quality of research processes and products for developing digital teaching materials. However, the use of digital teaching materials is increasing in line with future learning paradigm changes. The learning process tends to be more adaptive, adjusting to the characteristics of students. Digital teaching materials are very flexible, making them easier to adapt to the varied characteristics of students. In addition, future learning tends to occur in various modes, both synchronous and asynchronous. Thus, the learning process can be separated from the attachment to place and time so that students can learn anywhere and anytime according to their opportunities. This learning approach strongly supports the concept of lifelong learning. Moreover, professions that develop in the future are rapidly changing, thus demanding that workers must continuously be able to adapt to technological advances. The existence of digital teaching materials in such conditions is certainly very helpful.

4. CONCLUSION

Prospective teacher students use six instructional development models: ADDIE, ASSURE, Dick and Carey, Four-D, Rapid Prototyping, and Kemp. The most users used ADDIE, namely 37.50%, while ASSURE was used by 20.45% of users, Dick and Carey by 19.32%, Four-D by 14.39% of users, Rapid Prototyping by 6.82% of users, and the least was Kemp model only used by 1.52% of users. The main reasons put forward by users as the basis for selecting the development model are ease of use, familiarity, and consistency of steps. The models that have been widely used, the models that are easy to use, and the models that are consistent with the steps tend to be chosen by the users. Indeed, there is a tendency for students to imitate models that have been widely used. This condition is understandable because novice developers are still looking for models. The development steps of the selected model need to be completed. On average, only 6.93% of developers implemented the development model steps completely, while the remaining 93.07% still needed to complete the steps. Limited time and limited skills are the main reasons.

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