WATERFALL-ADDIE MODEL: AN INTEGRATION OF SOFTWARE DEVELOPMENT MODEL AND INSTRUCTIONAL SYSTEMS DESIGN IN DEVELOPING A DIGITAL VIDEO LEARNING APPLICATION

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Abstract

To date, researchers are still debating the poor instructional design for certain developed learning applications or courseware in supporting the flexibility to the student. The instructional design is vital in ensuring that learners obtain effective and meaningful to them for a better subject understanding. However, ignoring the functionality and bugs issues in a courseware development should not be practiced. The courseware developer should acknowledge the importance of instructional design and system development model to meet the user and system requirements. Given the resemblances between software development and instructional design phases, researchers could integrate certain importance techniques in software development model's phases into the ISD model to enhance the design solutions as well as the application technical parts. This paper highlights the integration of Waterfall model as the software development model with ADDIE model which is one of the established ISD models. The integration of Waterfall-ADDIE model was adopted to develop the digital video learning application for university students. A system testing and user acceptance testing were conducted to validate the courseware can meet the system and user requirements. This paper demonstrates all the phases involved in Waterfall model and ADDIE model are interrelated and practically being integrated to propose high-quality development of instructional design learning material.

Keywords: ADDIE model, instructional systems design, software development model, waterfall-ADDIE model, waterfall model

Abstrak

Sehingga kini, penyelidik masih membahaskan reka bentuk pengajaran yang lemah untuk aplikasi pembelajaran atau perisian kursus tertentu yang dibangunkan dalam menyokong fleksibiliti kepada pelajar. Reka bentuk pengajaran adalah penting dalam memastikan pelajar memperolehi pemahaman subjek yang lebih baik. Walau bagaimanapun, mengabaikan fungsi dan isu pepijat dalam pembangunan perisian kursus tidak harus diamalkan. Pembangun perisian kursus harus mengakui kepentingan reka bentuk pengajaran dan model pembangunan sistem untuk memenuhi keperluan pengguna dan sistem. Memandangkan persamaan antara fasa pembangunan perisian dan reka bentuk pengajaran, penyelidik boleh menyepadukan teknik kepentingan tertentu dalam fasa model pembangunan perisian ke dalam model ISD untuk meningkatkan penyelesaian reka bentuk serta bahagian teknikal aplikasi. Kertas kerja ini mengetengahkan integrasi model Waterfall sebagai model pembangunan perisian dengan model ADDIE yang merupakan salah satu model ISD yang telah ditetapkan. Penyepaduan model Waterfall-ADDIE telah diterima pakai untuk membangunkan aplikasi pembelajaran video digital untuk pelajar universiti. Ujian sistem dan ujian penerimaan pengguna telah dijalankan untuk mengesahkan perisian kursus boleh memenuhi keperluan sistem dan pengguna. Kertas kerja ini menunjukkan semua fasa yang terlibat dalam model Waterfall dan model ADDIE saling berkait dan secara praktikal disepadukan untuk mencadangkan pembangunan bahan pembelajaran reka bentuk pengajaran yang berkualiti tinggi.

Kata kunci: Model ADDIE, Model Pembangunan Perisian (ISD), Model Waterfall-ADDIE, model waterfall

1.0 INTRODUCTION

The current COVID-19 outbreak has demonstrated that a wide range of educators are prepared to use technology to aid students in learning. Additionally, Malaysia seeks to revolutionise the delivery of higher education by producing high-quality university graduates and globalised online learning made possible by technology. Because teens and young people have easy access to technology through gadgets, digital technology is now more prevalent in everyday life.

These individuals are classified as having intermediate digital competence. Even 21st-century digital natives need to be taught about and exposed to digital technology. The importance of digital video utilisation among university students in technical fields was also highlighted by McCaslin & Young (2015) as one of the evaluation approaches. Researchers

Huang et al. (2020) and McCaslin & Young (2015) investigated how the use of digital video by students can open up fresh opportunities for motivating them to focus on and successfully communicate what they are learning. According to McCaslin & Young (2015), digital video has grown to be a significant component of undergraduate courses as video report assignments for students from all academic backgrounds. Digital video was one of the assessment tools used to gauge the skills of university students. Additionally, they determined that given technological improvements, digital

However, McCaslin & Young (2015) and Rodgers & LaBoskey (2018) argued that in order to improve learning, students should be encouraged and given more exposure to camera use, editing, and video production skills. They noted that there has not been many research done to emphasise video production skills to pupils. Snelson et al. (2021) also talked about how little is known about how video creation has been used to promote content-based learning and coursework evaluation that is to be completed by the students.

Given the potential of digital video to be one of the most useful methods for evaluating student performance during a pandemic and the advent of new technologies, this project intends to advance the fundamental skills of video production through courseware. However, Bell & Bull (2010) noted that using digital video for learning calls for an efficient teaching and instructional approach. In a recent study, Castro-Alonso et al. (2021) discovered that the best practises for instructional design in creating successful instructional materials were based on the cognitive load theory and the Cognitive Theory of Multimedia Learning (CTML).

Moreover, the issue of conventional methods used in teaching and learning has long been a topic of discussion among educationists, academicians, and researchers. Every educationist, academician as well as researcher try to accommodate the teaching and learning processes by proposing numerous teaching modules, approaches, and techniques. However, there are still gaps occurred in the developed learning materials. Frequently, those gaps are not occurred due to the design of learning material but from the technical aspects or bugs appeared. In view of that some of the instructional designers are not only focusing on the training but developing a courseware, software, or mobile application with minimal computer or programming knowledge. Even though many of the application can be out-sourced or being built through drag-drop open-source software which require minimal technical skills, but designers cannot avoid from the technical issues to occur. Thus, it is important for them to have a basic knowledge in software development which can be complemented in designing an efficient instructional learning material. As been reviewed and highlighted in research

conducted by Adnan & Ritzhaupt (2018), instructional design is considered as appropriate, effective and systematic approach to design and develop instructional learning materials. Many researchers commonly focus on the learning theory and concepts of the instructional design when developing the instructional learning materials. However, several of studies have been conducted to investigate the importance of other software development model phases to complement the ISD models. In this paper, researcher aims to highlight the integration of Waterfall model and ADDIE model in developing the digital video learning application but still in the context of instructional design.

This paper highlights some goals to demonstrate that there are interrelation phases involve in both software development models and ISD models. First, this paper reviews and explains the existing software development model which is Waterfall model and ADDIE model. Next, the similarities of each phase in Waterfall model and ADDIE model are presented and researcher integrates the similar phases that existed in both models and demonstrates the integrated Waterfall-ADDIE model to be adopted in developing digital video learning application. The integration processes were not only to produce an effective instructional design material but to facilitate the digital new era in learning environment.

2.0 REVIEWS ON DIGITAL VIDEO

McCaslin & Young (2015) have emphasised the significance of employing digital video as a method of student evaluation, particularly in the 21st century. During Covid-19 pandemic scenarios and until now, lecturers tend to give instructions to the student for an assignment report in video format to mark undergraduate students' schoolwork, notably engineering and technical students (McCaslin & Young, 2015; Snelson et al. 2021). These situations may be able to engage students' interest and inspire them to learn more while also cultivating their digital competency by employing digital video (Huang et al. 2020; McCaslin & Young, 2015; Snelson et al. 2021). Furthermore, many studies have emphasised the importance of digital video in education, highlighting its positive effects on students' knowledge and achievement (Bell & Bull, 2010; McCaslin & Young, 2015; Rodgers & LaBoskey, 2018), fostering attention and motivation (Bell & Bull, 2010).

According to previous studies, it is seeming that the digital videos is crucial for both teaching and learning, but sadly, students find it challenging to manage technology and produce videos (Henderson et al. 2010; Hung et al. 2004). Hung et al. (2004) found that students who struggled to produce videos typically lacked confidence. Miller (2013) claims

that students do not even understand the fundamentals of digital video production which cause them to produce videos that are of lesser quality. Chen (2018) also emphasised the need for more thorough and appropriate instruction in video production, given the lack of student skill in producing videos (for example, by going through concepts and offering examples). Watt (2019) further claimed that more research is required since video production's importance in fostering digital competencies in university is undervalued. A recent study by Lin (2020) also shown that there has not been sufficient investigation into the topic of video. Therefore, more research is needed to determine how video production is used to promote content-based learning and evaluate university students' coursework using video (Rodgers & LaBoskey, 2018; Snelson et al. 2021).

Digital video is the processes and steps involve when creating a video content. It is quite like the filmmaking but the images used in producing the video are recorded digitally. The first person related to the digital video history is physicist called Joseph Plateau. In 1832, Plateau had invented Fantascope that also known as spindle viewer to simulate the motion. Then in 1869, John Wesley Hyatt developed a celluloid that was used as base for photographic film later. Muybridge came out with Horse in Motion in 1878 and Marey in 1880s had invented photographic gun that is similar with film shooting term. Technologies in video production keep emerging with the technologies developed by previous well-known and intelligent technologists and inventors. Thomas Edison and William Dickson developed a device to record movement on film called Kinetograph and constructed a device to view the film in 1892. Further history of video production in infographic illustrated by JLB Media Productions (2020) is summarised as in Table 1.

Table 1. A Summary of video production history timeline

Year	Founder/Physicist/Inventor	Invention/Innovation/Technology
1832	Joseph Plateau	Fantascope
1870	John Wesley Hyatt	Celluloid
1878	Edward Muybridge	Horse in motion
1880	Etienne-Jules Marey	Photographic gun
1891	William Dickson	Monkeyshines No. 1 (First motion picture)
1892	Thomas Edison & William Dickson	Kinetograph
1895	Lumiere brothers	The Cinematographe (first commercial and public exhibition)

1903	Edwin S. Porter	The process of film editing
1910	D. Griffith (the father of film)	Lighting and camera techniques experimentation
1929	Rouben Mamoulian	Double channel soundtrack
1936	Null	TV broadcasting began with BBC
1941	Null	First television commercial
1976	Garret Brown	Steadicam
2002	George Lucas	First major motion pictures shot using digital camera
2004	Nick Woodman	GoPro is introduced
2005	Chad Hurley, Steve Chen, and Jawed Karim	Youtube in launched
2013	Mark Zuckerberg	Facebook launches auto-play commercial
2013 – current	Null	Technology is rapidly emerging and most television channels and programs are delivered via internet.

There are three main stages of video production which are pre-production, production, and post-production. Pre-production normally involves every step taken before the filming begins such as planning, scheduling, script writing, task distribution among teamwork and others. The second stage is the production that is the crucial parts in producing a video. In this stage, the main part is a person should have at least a basic knowledge or skill of handling the equipment such as camera, tripod, external microphone, lighting, gimbal, and others. A videographer will use that equipment in order to capture the video contents such as any moving images or videography to be used in the next post-production stage. In post-production stage, a person who is in charge at this stage needs to selectively combine video clips from the production stage and edit it through video editing software before producing the product. Post-production also involves the live event setting that is also known as live production. The emergence of technologies make video production becomes more crucial in daily lives. This statement is supported by the video production history timeline where the devices become more advanced and intelligent. Nowadays, video production is not only related to the technology devices, but also with advanced technology software, application, technology marketing, educational technology and many more.

2.1 Digital Video as a Part of Education

A study conducted by Hampapur et al. (1995), defined video as a term of information storing and communicating. He highlighted that content and production style are the most crucial aspects of a video. The content means the information that is transmitted while production style is the content encoding into the medium of video. Hampapur et al. (1995) added that there are two major processes in producing a video which are production shots and editing. Research study done by Pandya & Low (2019) found that not only adults but even a children nowadays is aware and familiar with online environments especially with YouTube videos and dreaming to become a famous youtuber. Researchers added that it is essential for a teacher to recognise the important of digital video in actively involve the children in learning.

According to Hoe et al. (2019), nowadays students are interested in technology not only for the entertainment but they are seeking to use the technology in education. Therefore, the digital video is one of the subjects that meet all the requirements in enhancing students' competencies as well as integrating the technology in learning. Video can also be applied to conduct teaching and learning in virtual learning environments. A multimodal video in learning in HEIs is proved to increase motivation and create a positive emotions as well as enhancing the competencies among the students (Hoe et al. 2019). The emergence of new media is affecting not only on youth social interaction but as well as in the education. Findings from study conducted by Rosa (2017) highlighted that it is crucial to include media literacy skills in formal education curriculum. She also discussed that applying new media in a classroom environment can enhance students' communication and learning audio-visual styles through digital video production.

As digital devices such as laptops, tablets as well as smartphones are easily accessible for university students, developing a mobile application that scaffold the video production is achievable. The digital video production process can assist students and educators to carry open-ended video projects and expose a collaboration between educator with application developer in providing teaching-creativity resources (Rosa, 2017). Chen (2018) discussed his findings on video production that assisted students in developing their consciousness of digital empathy. Students realized the importance of having more empathy when communicating through online platform. The findings supported that video production in HEIs is matched with the multimodal approaches in literacy which has been drastically influenced with the emergence of digital devices and platforms. A comprehensive reviews is

done by Chen (2018) stated that the video production is crucial to foster the students' social skills and empathy civic managing.

Friesem (2016) sees that practicing the video production can assist the students on diverse features of media literacy. He also divided the process of video production into five phases which are script writing, pre-production, production, post-production and broadcasting. Hsu (2020) stated that the post-production of digital audio and video is considered as one of computer course in multimedia that adapt the technology. Hsu explained that the teaching pedagogies in video production courses must be in various such as having digital learning platforms, recording studio and others to ensure that students are not bored with the courses. Integrating the video production into the curriculum makes students realise what is digital literacy and the importance of it   into elementary teacher education not only greatly impacted teacher candidates' understandings of what counts as literacy. Numerous researches had proved and demonstrated that video production can make people enjoy, be happy, make teacher and student interacting in a fun ways and it could instil confidence in learning something through video (Hsu, 2020; Shelton et al. 2017). Most of the time, adults and children are watching video not only for fun but sometimes they are watching the video to learn and understand something. Nowadays, there is not only adults who is creating the video and post it online, but young adults and even children are becoming the content creator. Moreover, they started to realise that becoming a content creator not only for fun, but they can also gain profits from it like getting paid by the YouTube for a certain number of subscribers and viewers.

According to the comprehensive reviews done by Doerr-Stevens (2015), he found that digital video production is described as procreative process to explore and study the identities of an individual. It is because, every individual has different preferences and it can be shown with their interest in digital video production. Prasad et al. (2016) highlighted the importance of digital video production in increasing youths' ways to critically think, analyse and comprehend the media literacy and knowledge. He stressed out that educators in media and video production should inspire adults to learn about media production in knowing about themselves as well as the others. Digital video production is widely known as a platform of media literacy because it controls how the content was presented and audiences could be a producer or a viewer of their own created video. Generally, the content of video production is solely relied on how the writer or producer presented the information. Hence, the digital video production is widely be used by different age group of users especially among children and young adults.

The digital video becomes common among the young adults since they can freely share their views, ideas, thoughts, and experiences with others. The worldwide increment of digital video in social media among young adults can assist they to develop multinational culture, better lifestyles as well as increase the body of knowledge. The digital video production is crucial to be taught to the young adults to build their self-esteem in expressing views and ideas by themselves. Through these situations, the young adult who is majority coming from university students can apply skills in critical analysis, synthesis, evaluate knowledge as well as attitude when use the digital tools (Tyner, 2003). The experienced students that have the knowledge of digital video production might construct their own understanding through hands-on exploration that can nurture students' critical thinking skills, task reasoning and analysis and problem solving that reflect on the current issues.

According to Buckingham (2002) digital video is able to develop the creativity of the young adults and make them to freely voice out their ideas and beliefs globally. Hence, it can stimulate a democratic environment and comprehensive forms of digital media in the future. Through social media and online interaction, young adults are freely communicating with each other without limiting their preferences of cultures, races, and location. Thus, it will indirectly develop a better youth community that has better soft skills, thinking skills, problem-solving skills as well as communication skills.

2.2 Digital Video Education in Malaysia HEIs

Digital video in any of HEIs is commonly known as digital video production subject. According to Malaysian Education Curriculum, integrating technology in every subject can enhance students' competencies especially in communication, creation, collaboration, critical thinking and problem-solving. A multifaceted of problem-solving, creativity as well as critical thinking skills are the main competencies searched by employers in 2020 (World Economic Forum, 2020). Malaysia also take an action to urge universities in enhancing not only the knowledge, but need to focus on skills and competencies of a student (Ministry of Education Malaysia (MoE), 2015).

The present HEIs' educational quality evolution should focus more on the students' high-level competencies to meet the graduate requirements for employment. It is crucial to prepare the Malaysia's graduates specifically in TVET with these competencies to ensure they can adapt in a challenging digital world of workplaces. Referring to the Malaysia Education Blueprint, it is clearly realising that Malaysia is currently undertaking a drastic transformation in education to create a better generation of graduates. Malaysia is now focusing more on

producing creative, innovative as well as critical thinking graduates. Those aims indirectly urge universities to reorganise their curriculum to support more on student-centered learning and project-based learning.

There are quite a big number of digital video courses offered by universities in Malaysia. There are 20 public universities, 47 private universities, 34 private university colleges and 10 foreign university branch campuses in Malaysia. The program offered by each university and related digital video courses included in the program are identified through their official website. Those information shows that digital video are popular courses offered by university in Malaysia especially for media creative, multimedia, and art programs. Therefore, this study focusses to develop the digital video learning application to support the student-centred learning and indirectly build an effective learning environment.

3.0 MATERIALS AND METHODS

This section discusses the models that are frequently adapted in instructional design and software development studies which are Waterfall model and ADDIE model. Researcher found that it is important to focus on both user and system requirements which can be highlighted in instructional design. It is because, when designing a courseware specifically a digital video courseware, developer should not only aware about the technical issues of the development, but they also need to focus on the students' flexibility of the courseware for a better knowledge gain. The instructional design focus on the framework to discover more about the learners so that they can gain an effective learning environment when using the courseware. Therefore, by integrating both Waterfall and ADDIE model, researcher not only focus on the development side, but also the design phase where an effective design should be implemented suited with the learners' requirements. Seeing the importance of each model in their respective fields, both models have been studied in details and researcher found that there are several similar stages for both models that can be integrated in developing an instructional learning application.

3.1 Instructional Design and Development Model

The development of multimedia application should be based on a certain learning model and instructional systems design to produce a high quality of product. Instructional systems design is an iterative aspect process of preparing learning objectives, choosing instructional strategies, selecting media, resources as well as creating assessment (Huang et al. 2019).

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According to Huang et al. (2019), instructional systems design is characterised as a goal-oriented and learner-centered-oriented, concentrating on expressive performance, predicting and measuring results, procedures are based on empirical and experimental evidence, interactive, evaluation and self-correcting, as well as team effort (if required). There are several instructional design models can be adopted, and developers frequently adopt ADDIE model, which includes analysis, design, development, implementation, as well as evaluation. Learning theories and instructional design model should be a basis of guidelines in developing the multimedia application. However, after investigating and reviewing several research works related to the learning material software development, researcher found that the proposed co-model of Waterfall and ADDIE model by Eller (2015), is the appropriate research methodology model to be adapted. Thus, this paper adapted the co-model of Waterfall and ADDIE model and integrate the phases according to the requirements.

3.2 Reviews on Integrated Waterfall-ADDIE model

Study conducted by Eller (2015) highlighted the importance of both software development m odel, Waterfall and instructional design model, ADDIE in designing course development. The Waterfall model with six phases was integrated with the ADDIE model that has five phases a ccording to the functionality of each phase in developing digital video learning material applic ation. There are six phases involve in integrated Waterfall-ADDIE model which are analysis, design, develop, evaluation, testing, and implementation. The evaluation phase is involved in each of analysis, design and develop phases to ensure that the content of digital video learning material met the identified requirements from findings of preliminary investigation. Once the development phase is completed, then the developed digital video learning material will be tested and implemented to the real users.

The integrated Waterfall-ADDIE model was proposed by Eller (2015) to highlight the i mportance of software development model and instructional design model in developing syst em, application or software for learning. The ADDIE model is important to identify and create a suitable content and representation of a learning material for the students. While, the Wate rfall model is important in developing a software or application with better functionality and av oid bugs. Bugs can occur in any system, software, or application. The software bug is define d as an inaccuracy, error or mistake in a computer program, software, system, or application that causes it to generate an incorrect or unpredicted outcome, or to act in unintended ways. The integrated Waterfall-ADDIE model and each step involved in design and development were explained in details in the Waterfall-ADDIE model's phases respectively. Six phases in

integrated Waterfall-ADDIE (Analysis, Design, Development, Evaluation, Testing, Implementation) model as well as the macro and micro strategies were explained in the next section. Besides components in Gagne's nine events of instruction is applied as the teaching strategy while principles in CTLM are adapted as the instructional strategy for this digital video learning material application development.

Design and development of digital video learning application was carried out based on the integrated Waterfall-ADDIE model (Eller, 2015). The instructional design model is important to be adopted in any development of program, kit, courseware, application and many more which related to the teaching and learning (Branson et al. 1975; Kurt, 2018). Generally, ADDIE model is known as a conceptual framework that most frequently adopted instructional design framework to assist educators create a course or program (Asrial et al. 2020; Balanyk, 2017; Budoya et al. 2019; Mohd & Shahbodin, 2015; Nadiyah & Faaizah, 2015; Stapa & Mohammad, 2019; Usta & Güntepe, 2017; Woo, 2018). Meanwhile, the Waterfall model is well-known as the software development model but the integrated Waterfall-ADDIE model is still not widely applied even though the importance of having both ADDIE and Waterfall model in designing and developing learning material application had been discussed and highlighted in previous study. This model is flexible and allows researcher to design learning material according to individual needs and abilities as well as minimising the possibility of having software bugs in future.

There are six phases introduced in this model which are analysis, design, development, evaluation, testing, and implementation. Those phases are organised according to the level where a developer needs to complete one phase before moving to the next phase. However, evaluation phase is done for analysis, design, and development phases to ensure that developer had successfully completed a phase before moving to the next phases. The evaluation is the process involves to examine the program and identify any problems occur throughout those three phases. There are two types of evaluation involved; formative evaluation and summative evaluation. The formative evaluation is used for every phase while the summative evaluation is happened at the end phase which is after the implementation phase. The formative evaluation is also known as internal evaluation where the evaluation is happened during the program activities which focuses on the processes. The formative evaluation is crucial to identify the deficiencies in the program before offering it to the learners. Furthermore, in formative evaluation, prototyping is generally used to test each design aspect as well as the functions of the program or software developed. While the summative evaluation is conducted at the end of the program or course to assess the student's performance.

First, in the analysis phase, researcher investigated the problems and issues why this study was conducted. All information from the students' needs and project requirements are gathered through preliminary investigation, literature review, systematic reviews as well as expert reviews. Students need to agree against the expected results to achieve what are desired needs from the students. For this study, researcher focuses on the content related to the Digital Video Production syllabus subject conducted by a lecturer. Second, is design phase where in this phase, researcher needs to design the multimedia application. The designing tasks were done by referring and applying CTML, CT, Gagne's Model of Learning and other required multimedia principles, and concepts. Third is development phase where the researcher is starting to developed the multimedia application using identified software and hardware in the analysis phase. Researcher is encouraged to get the multimedia expert reviews once the multimedia application is completed before deliver it to the real users. Fourth is the evaluation where the researcher conducted the formative and summative evaluation to investigate the effects of multimedia application to the real users. Fifth is the testing phase where the developed digital video learning material application is tested to the intended user which is the university students. Sixth is implementation phase where in this phase, researcher begins the actual experiment and test the multimedia application to the real users in a real environment.

3.3 The Waterfall Model

A Waterfall model is known as the oldest Software Development Life Cycle (SDLC). It is widely used by the software developer when they want to develop the software or applications. Many research studies claimed that Waterfall model is coming from Royce (1970). However, according to the discussion by Toikkanen (2005), the Waterfall model is not standardised to be used as SDLC model but there are many research studies have depended on it and claimed the success of software or application development. Waterfall model is consisted of a set of serial development phases which are analysis, design, development, testing, implementation as well as maintenance. Each of the project member will be assigned to respective phase based on their expertise and they need to complete each phase before they can proceed to the next phase. The Waterfall model adopts linear approach where the team members need to complete one phase before moving to the next phase because the output from the previous phase will be used as the input to the following next phase. The analysis phase is known as the system requirement analysis where in this phase, researcher requires to clarify the users' needs in order to manage the expectations. Once the researcher identified all the requirements needed, then move to the next phase which is design phase.

The output from the analysis phase will be used as the input in designing the product. In this design phase, researcher will start designing the system or application that will be developed later. However, before start designing the application, researcher need to identify the system requirements needed such as hardware, software, expertise et cetera to ease the processes involve in design and development phases. Generally, the design phase is depended on the types of products that will be developed. For example, if researcher need to develop a system, he or she might need to create use case diagram, sequence diagram for database and wireframes or storyboard for the system interfaces and interactivity. Once the design is completed, researcher will move to the next phase which is the development. Basically, the development phase is started with the input from the design phase. The system or application will be developed module by module that is known as units. Each unit that was developed is tested for its functionality which is known as unit testing. Once all the units or modules are tested, then the developer will integrate all of them before move to the next testing phase. All the units or modules that have been integrated into a system or application then is tested for any faults or failures.

The completed product whether it is a system, software or an application is tested by conducting a system testing. The system testing can be done through functionality or non-functionality testing. The system testing is also considered as a black-box testing where the testing of software or system functionalities are conducted. The functionality of the completed software or system could be done without having knowledge of any internal code construction, details of the product implementation or system's internal routes. The black-box testing is utterly focusing on input, output, specifications and requirements of the system or software developed which can be known as behavioural testing. Once the testing phase is completed, the developer will move to the implementation phase where the completed software or system developed will be implemented to the real users. In this phase, an acceptance testing is conducted to measure users' acceptance level. The final phase of Waterfall model is the maintenance phase where the support services is provided by the developer that concern with any bugs occur in the software or any security issues arise by the users. Figure 1 shows the flow of Waterfall model.
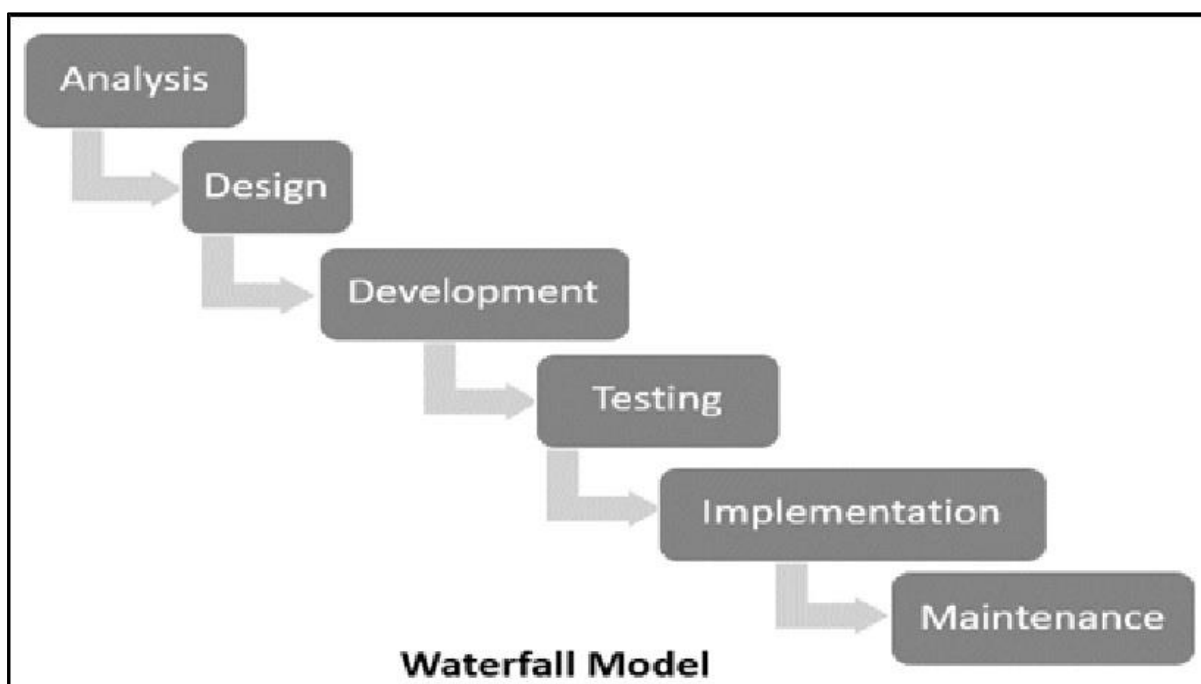
Figure 1. Flow of waterfall model

3.4 The ADDIE Model

The ADDIE model is an outline that illustrate general processes which have been done by instructional designer as well as training maker (Morrison et al. 2010). It defines and describes the processes involved in generating chapters of intentional learning. The ADDIE Model is simply an informal term applied to define and describe a systematic method to instructional development which is practically identical with Instructional Systems Development (ISD). The original ADDIE model was introduced and developed by Florida State University (FSU) that worked with a division of the U.S. Army and was later executed to all U.S. Armed Forces branches (Kurt, 2018). Numerous researchers adapted ADDIE model when designing and developing education software or mobile applications (Stapa & Mohammad, 2019). Furthermore, according to Wang & Hsu (2009), ADDIE model is generally applied as a guideline in software construction and learning material development which based on the user needs. The ADDIE model is known as generic processes and basic model to be applied when developing an instructional media. Stapa & Mohammad (2019) highlighted that ADDIE model can be applied to generate effective lesson plan and learning materials. Study conducted by Aldoobie (2015) stressed that ADDIE model is one of the well-known common methodology models adapted in instructional design researches. Aldoobie also stated that ADDIE model

assists instructional designer and educators in developing effective as well as efficient learning materials.

Balanyk (2017) discussed that ADDIE model was widely used for instructional design across various fields such as corporate training, military as well as in education since it was introduced in the late 1970s. He strongly suggested that ADDIE model is an infinitely organized yet flexible instructional design model. The ADDIE is coming from the acronym of five stages which are analyse, design, develop, implement and evaluate (Asrial et al. 2020; Mohd & Shahbodin, 2015; Thim-Mabrey, 2006). Aldoobie (2015) added that even though there are various existence of instructional design models, but generally most of them cover these five generic stages. Kurt (2018) stated that the five stages of ADDIE model is very useful for educator, training developer as well as instructional designer since those stages clearly facilitate them in designing learning materials or being applied as training tool. He also highlighted that ADDIE model was widely accepted and applied as an instructional design model. ADDIE model consists of five processes which are analysis, design, development, implementation, and evaluation. Figure 2 shows the flow of ADDIE model and phases involved as follow:

i.   Initial A: Analysis: to classify the possible details for the absence of presentation or performance as well as suggest key solution to it.

ii.   Initial D: Design: use the information from analysis phase to create and verify the chosen instructional strategies, presentations, and suitable testing approaches in achieving the instructional goals.

iii. Initial D: Develop: to create and validate the resources such as tools and processes required during development for each of the instructional modules.

iv.   Initial I: Implement: to set up the learning settings and participate the students.

v.   Initial E: Evaluate: to evaluate the quality of developed learning materials before and after the implementation phase. This phase also involves the formative and summative assessment which evaluates the approaches applied in developing the instructional learning material.
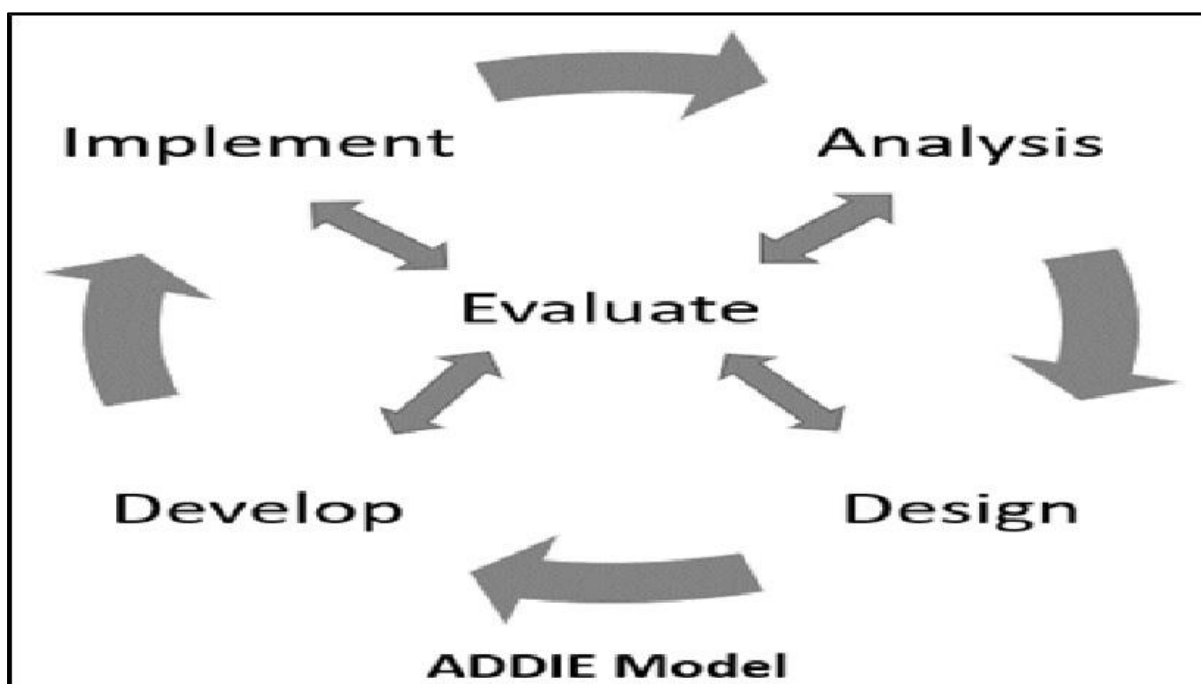
Figure 2. Flow of ADDIE model

4.0 THE INTEGRATED WATERFALL-ADDIE MODEL

Nowadays, designing and developing an instructional learning material are not only focusing on the content itself, but it requires the touch of technology parallel with the emergence of the technologies and the world of digital natives. Hence, when designing a learning material, specifically involving the use of technology, an instructional designer could apply the system or software development model instead of solely depending on the instructional design model. The developer also can integrate both instructional design model and software development model based on the requirements. It is because even though both models are coming from two different fields, but there are some commonalities and intersections between them. It is unavoidable that later or sooner, the instructional designer needs to enhance their learning material and a large scope of projects with huge number of learners, will require them to develop a large and efficient software to support the situations. Thus, the developer will need to adapt the software development model. This study integrates the Waterfall model as the software development model and ADDIE model as the instructional design model in developing the digital video learning material application.

The integration of both model generally was proposed by Eller (2015) which highlighted the importance of software development model, Waterfall to be hybrid with ADDIE model as

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the instructional design model. He had discussed in details the integration of Waterfall and ADDIE model could generate more collaborative processes between software and instructional designers. According to Eller (2015), the co-model of Waterfall and ADDIE models was proposed to design a course for an institution. However, to fit with the purposes of this study, researcher adapted the Waterfall and ADDIE models' steps accordingly. The Waterfall model which is a linear model that has six phases was integrated with the ADDIE model that has five phases. Figure 3 illustrates the how the Waterfall model was integrated with the ADDIE model and an integrated Waterfall-ADDIE model is shown as in Figure 4.
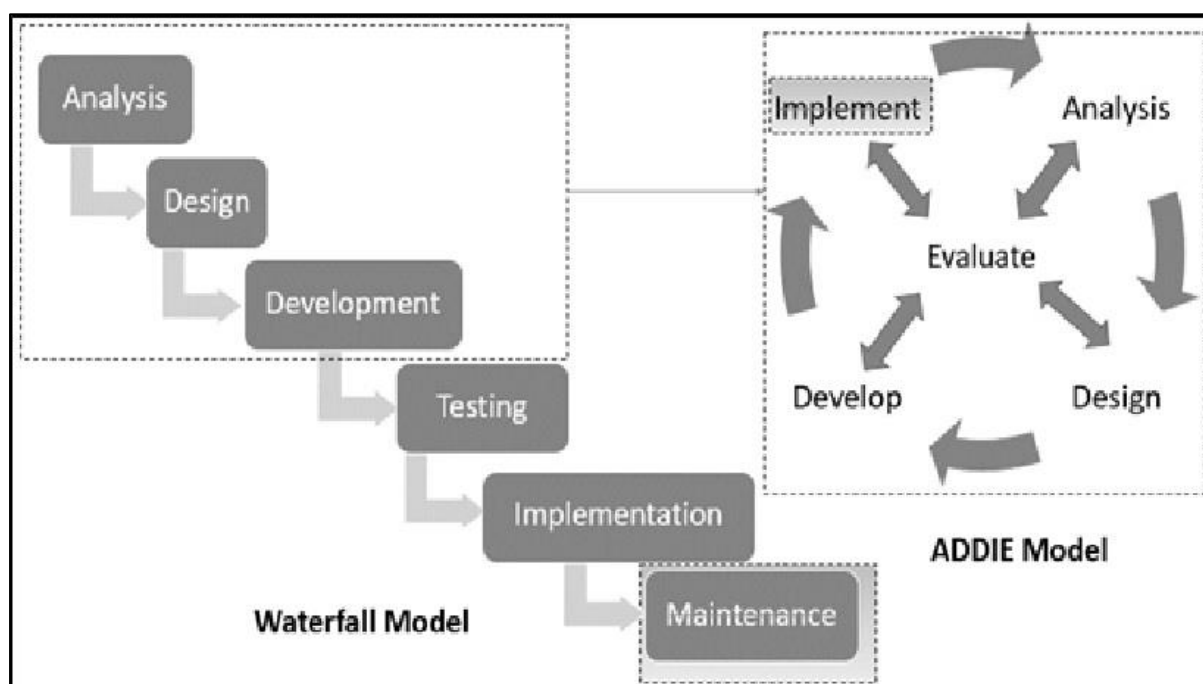

Figure 3. Flow of Integrated Waterfall-ADDIE model

The ADDIE model is a framework demonstrates the basic procedures that the training and instructional developers do when designing and developing an instructional multimedia. There are six main elements in integrated Waterfall-ADDIE model which has been described as shown in Figure 4.
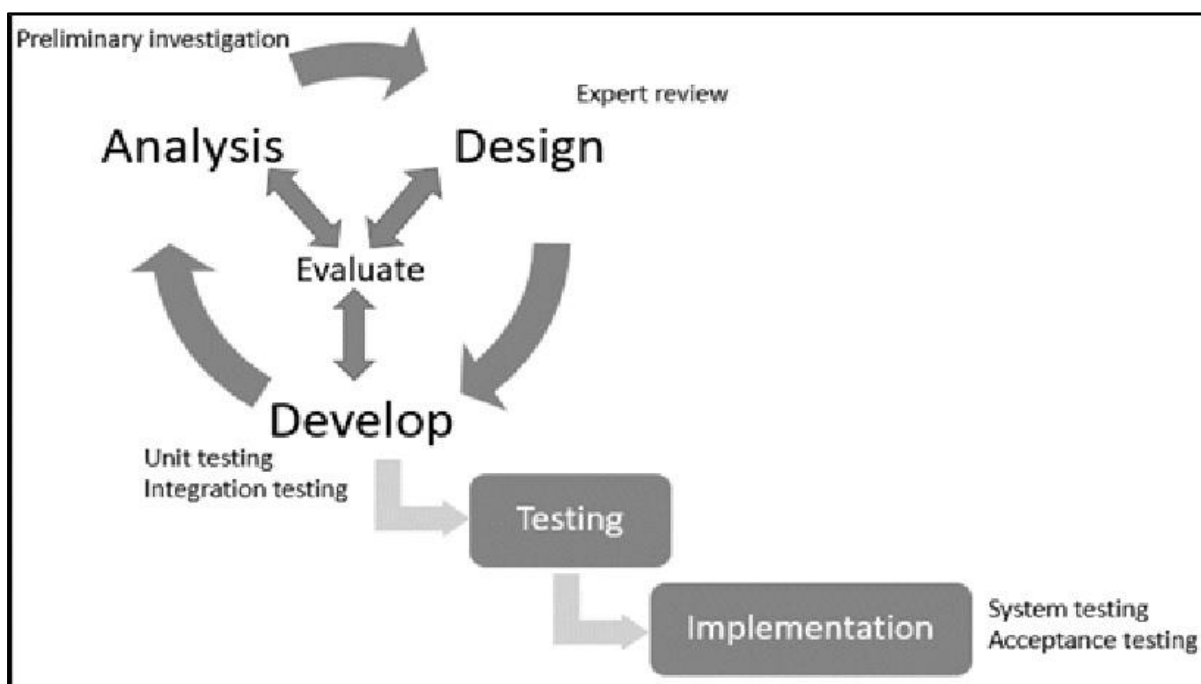
Figure 4. Integrated Waterfall-ADDIE model

Figure 4 shows the phases involved in integrated Waterfall-ADDIE model. The six phases of integrated Waterfall-ADDIE model are described as follow (Eller, 2015):

i.   Analysis phase is to analyse and discuss learning circumstances so that the digital video learning material aims, objectives as well as learner profile and requirements are identified.

ii.   Design phase is to plan digital video learning material approaches in addressing the learning issues.

iii. Development phase is to develop instructional applications/program that align with learning processes.

iv.   Evaluation phase is to assess the developed instructional system tackles the issues in learning situation.

v.   Testing phase is to test the developed instructional system tackles the issues in learning situation.

vi.   Implementation phase is to implement instructional system in the learning situation.

4.1 Analysis Phase

The analysis phase in integrated Waterfall-ADDIE model is like the function as adopted from ADDIE model. The analysis phase is to identify the proper requirements and explanations and propose some solution before do the designing. The analysis phase is crucial to determine whether the proposed learning material could bridge the gaps found in the systematic review and preliminary investigation. There are six standard procedures involve in the analysis phase as follow (Huang et al. 2019):

     i.   validate the identified gap;
    ii.   determine the goals;
   iii.   confirm the target user;
   iv.   identify required resources;
    v.   determine how to deliver the proposed learning material; and
   vi.   compose plan of project management.

4.2 Design Phase

Design is the second phase of the integrated Waterfall-ADDIE model, with the purpose to confirm the desired performances and appropriate testing approaches. Next, once completing the design phase, the developer should be able to close the performance gaps due to the deficit in knowledge and unskilled. The design phase can be completed after finishing the following tasks:

     i.   Conduct a task inventory
    ii.   Compose the performance objectives
   iii.   Generate testing strategies
   iv.   Calculate return on investment

4.3 Development

The development phase is the third phase in ADDIE model. According to Huang et al. (2019), there are six steps in development phase which are; i) produce content, ii) produce or choose supporting media, iii) produce guide for student, iv) produce guide for teacher, v) formative reviews, and vi) pilot test.

4.4 Evaluation Phase

The evaluation phase is conducted to assess the quality of multimedia application before and after the implementation. Researcher conducted evaluation phase to measure the students' ability to accomplish their new constructed knowledge of digital video. The evaluation phase involved two activities which are; i) to determine the criteria of evaluation, and ii) to select the evaluation tools. There are three criteria involved in evaluation forms which are evaluating the students' self-efficacy perception, the knowledge obtained and perceived motivation. Researcher selected survey, test, and interviews as the evaluation tools in this study.

4.5 Testing Phase

The testing phase is the fifth phase in integrated Waterfall-ADDIE model. Each component developed such as short video, animated image and sound will be added to the digital video learning material application. Once all the components are integrated, the functionality of the digital video application is tested. In this testing phase, there are two types of testing were conducted which are unit testing and integration testing. Unit testing was conducted during the development phase where every sub-component involves in the application such as video, animated image, sound, link, and button were tested to ensure that there is no problem occur before integrating all the sub-components. The unit testing was conducted by the developer before the sub-components are integrated. Then, once all the components are integrated, the developer conducted the integration testing to ensure that each of the sub-components can be connected to each other and no bug is found.

4.5.1 System Testing of Digital Video Courseware

The functionality of each component used in the courseware was tested individually through unit testing, and the integration of the components into the courseware modules was tested through integration testing. In order to prevent technical and bug issues, it is crucial to do integration testing. The researcher carried out the system testing after finishing the integration testing. System testing verifies that each integrated component or module is operating properly at the system level for any developed system or educational programme. System testing comes in a variety of forms, including functional, load, performance, and usability assessments. Before moving on to the user acceptance testing, the researcher did the usability test for this system using content expert evaluation. A Likert scale was used to generate the content expert rating. The content expert evaluation involves three topic experts and three instructional design experts from five different public universities. The results are

significant since they demonstrate that there are no disparities in the experts' opinions, and Table 2's mean value for the content expert evaluation is (x = 4.36). The researcher came to the conclusion that the digital video courseware is suitable and prepared for usage in user acceptance testing based on the mean value for content expert evaluation.

Table 2. Summary of descriptive statistics for content expert evaluation

Type of Analysis	Mean	Min	Max	Variance	N of Items
Content Expert Analysis	4.36	4.00	4.83	0.08	18

4.5.2 User Acceptance Testing

User acceptance testing, also known as UAT, is a sort of testing carried out by end users to confirm and validate the created system or educational material. After unit testing, integration testing, and system testing are complete, UAT is carried out as the last stage of functional testing. When there are two or more end users involved, UAT is referred to as black box testing. UAT can be divided into beta and alpha tests (Nadiyah & Faaizah, 2015).

Beta testing is carried out by actual users in a real environment, whereas alpha testing is a type of software testing carried out to find defects before a product is released to customers. In this paper, researcher focuses on the alpha test. Six multimedia professionals were asked to complete the usability heuristic evaluation checklist as part of the alpha test. The checklist for heuristic evaluation was modified from Erenler's (2018) translation of 10's Nielsen Heuristic. Descriptive statistics were used to analyse the heuristic evaluation. The results are significant since they demonstrate that there are no discrepancies in the experts' opinions, and Table 3's heuristic evaluation checklist's mean value is (x = 4.37). The researcher decided that the digital video courseware is suitable and appropriate based on the mean values for both evaluations.

Table 3. Summary of descriptive statistics for heuristic evaluation checklist

Type of Analysis	Mean	Min	Max	Range	Variance	N of Items
Heuristic Evaluation Checklist	4.37	3.50	4.83	1.33	0.09	36

The conclusion that can be drawn from the results of the expert evaluation is that digital video courseware can be used for the pilot testing, but only after the researcher makes some changes to the courseware. After re-examining the system and user requirements, those

adjustments were made in accordance with the advice and suggestions of the experts. Then, the researcher proceeded with the implementation phase where a pilot testing was conducted and discussed in details in future works.

4.6 Implementation Phase

The implementation is the sixth phase in integrated Waterfall-ADDIE model. Generally, most researchers who used Waterfall or ADDIE models are adopting the implementation phase in their research. According to Huang et al. (2019), the standard procedures for implementation phase are prepared for the lecturer and students. Researcher identified and arranged the activities of lecturer and students carefully to ensure that multimedia application is delivered successfully. Most researchers used implementation in integrated Waterfall-ADDIE model as the summative evaluation activities which are conducted to the real users. There are two tests are involved in this phase which are system testing and acceptance testing. The system testing was conducted by experts in the related fields which are the lecturers to ensure it is functioning well and bug free. While, the acceptance testing was conducted as a pilot study to the students to ensure that digital video learning material can be used by the real users without any problem.

5.0 CONCLUSION

As conclusion, even though the ISD model and software development model are two types of development model for different fields, but somehow, they have interrelated phases and techniques used. Designing and developing an efficient learning material is not just depending on the ISD model only, but the instructional designers should have creative solution when develop their materials. As the emerging of technology and more instructional learning materials should be developed accordingly, thus integrating the software development model with ISD model is needed. This study verified that the software development model and ISD model can be hybrid by integrating the Waterwall model and ADDIE model in developing the digital video learning application. This study foresees that when developing a learning material, the instructional designer should not solely depend on the ISD model, but they can integrate the model with other research development model that related to their study. Therefore, the developed learning material will not only have a better content and design but as well as can minimise the technical and bugs issues in future.

6.0 ACKNOWLEDGMENT

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