The Application of Information Processing Theory to Design Digital Content in Learning Message Design Course

I Komang Sudarma, Dewa Gede Agus Putra Prabawa, and I Kadek Suartama

***Abstract*—The development research being carried out has the aim of producing digital content developed based on information processing theory for the message design course in Educational Technology Study Program in Education Science Faculty of Universitas Pendidikan Ganesha. This is a development research in which the Hannafin & Peck model is used. The developed digital content is evaluated using formative evaluation techniques, including 1) expert validation, 2) one-to-one evaluation, and 3) small group evaluation. The subjects involved in this study were 2 experts, namely media experts and instructional design experts, 3 students in one-to-one evaluation, and 9 students in small group evaluation. The methods and instruments used to collect data in this study were observation and questionnaires. Based on the expert's judgment, the design aspect is in the good category, the media aspect is in the very good category. Students' responses at the one-to-one and small group evaluation stages are in the good categories. Thus, it can be concluded that the attractiveness of digital content is in the good category.**

***Index Terms*—Information processing theory, digital content, message design.**

I. Introduction

Learning is a system consisting of several components. The quality of the components in the learning may influence the quality of the learning process and outcomes. The learning components consist of: a) students, b) learning process, c) graduates with the expected competencies, d) educators, e) curriculum, and f) learning materials [1]. One of the important components in learning system that also influences the learning process and learning outcomes is teaching materials. Teaching materials are a set of materials containing learning materials or content designs to achieve learning objectives [2]. Teaching materials also refer to the existing materials and the specifically developed materials to achieve goals [3].

In today's digital era with unlimited access to various information, the demand for the provision of attractive and quality teaching materials is very important to address [4]. With the existence of information and communication technology, the teaching materials must be transformed according to the characteristics of the target or students [5]. It is known that students ranging from junior high school to undergraduate students are currently born in the range of 1995-2010 or known as Z Generation (Gen Z) range of 1997-2012. This generation is a transition from generation Y, which at that time, technology was still developing. Gen Z's mindset tends to be less complicated (instant and fast). Their lives tend to depend on information and communication technology. The characteristics of Gen Z are: think globally, communicate digitally, like to socialize, in mobile, familiar with technology, work at their own pace, and prefer visual in nature. Thus, it is not surprising that this generation prefers to be active through social media applications such as Facebook, WhatsApp, Instagram, YouTube, and so on [6], [7].

To find out the characteristics of students (Gen Z) of the Educational Technology Study Program in Education Science Faculty of Universitas Pendidikan Ganesha, especially with regard to the intensity of smartphone use and the type of content that is more accessible, an online survey was conducted on February 14, 2020, involving 71 respondents. The intensity of smartphone use by students is presented in Fig. 1.

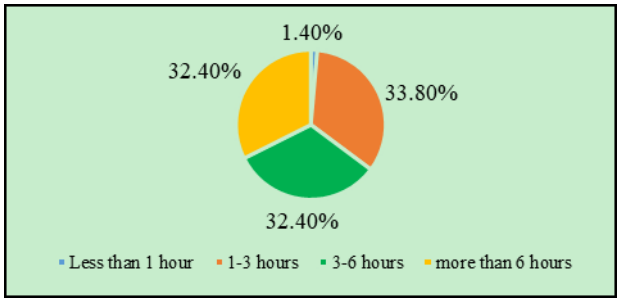

Fig. 1. Duration of smartphone use among students.

The survey results as presented in Fig. 1 show that 33.8% of students are on smartphones 1-3 hours a day, while 32.4% of the students spent 3-6 hours on their smartphones and 32.4% spent over 6 hours. This means that the students are very active digitally and indicates that the students are more interested in reading digitally. The result of the survey is in line with research result which shows that generation Z knows best about smartphones. Besides, smartphones are the most important part of their lives since they are on smartphone for more than four hours a day [8], [9]. Furthermore, the types of content that are frequently accessed by students are shown in Fig. 2.

Based on Fig. 2, of the 71 students surveyed, it turns out that 57.70% of students often access this type of video content. The results of this survey are in line with Rastati's

Manuscript received March 30, 2022; revised May 5, 2022. This work was supported by a Universitas Pendidikan Ganesha grant through DIPA BLU Number: SP DIPA-023.17.2.677530/2020 Revision 1 dated 16 March 2020 and in line with the Contract Number: 766/UN48.16/LT/2020.

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[10] research showing that Gen Z, especially male, tend to prefer videos as the sources of information. Meanwhile, image, text, and audio contents ranked second, third, and fourth respectively. This means that generation Z prefer the contents in digital format. This is in line with a study showing that presenting digital content through audios, videos, and music are more preferable and effectively increasing students' literacy [11], [12]. The results of the survey and research indicate that technological developments have changed the students' habits, learning methods, and interests in accessing learning resources. Gen Z tends to prefer an instant, practical, and straight to the points kinds of content.

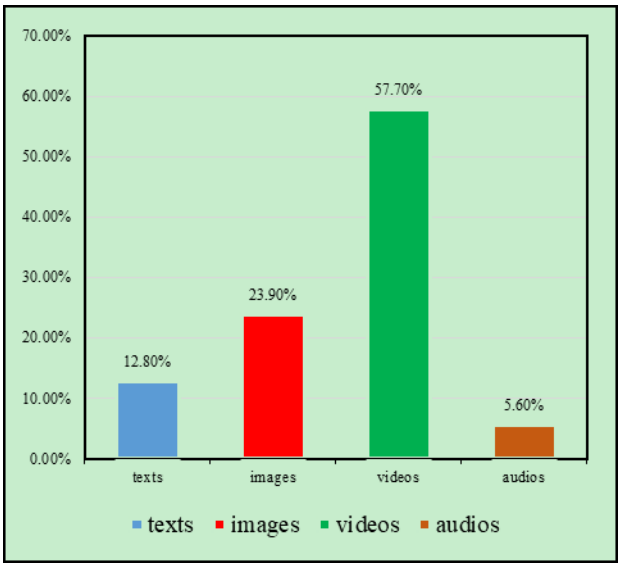

Fig. 2. Types of content accessed by students.

Based on the characteristics of Gen Z and the survey results, it can be said that the activities of thinking, interacting, and behaving in this generation involves more information and communication technology. The students' learning process has been influenced by the evolution of computers, networks, and multimedia technology [13], [14]. This generation also has the characteristic of rarely reading for long periods of time [15]. There are differences in the characteristics of generations or students in Educational Technology study program Universitas Pendidikan Ganesha, the effective learning strategies, methods and content for previous generations will generally be less effective if it is applied to Gen Z. Paying attention to these characteristics, the learning strategies to be applied need to consider several principles, namely: 1) delivering fast and instant contents and presenting them in a visual form (data, graphics or video); 2) involving more kinesthetic, experimental, problem solving, and direct activities; 3) searching information in less complicated way (fast, convenient, and with shortcut) meaning that the students can access it from anywhere at any time; 4) integrating multimedia; 5) giving multiple tasks (multitasking); 6) providing quick feedback, clear objectives, challenges, prizes; 7) delivering short material accompanied by breaks; 8) using trial/practice approaches; 9) using problem solving approach and not recalling; 10) focusing on group work; and 11) being flexible in learning teaching materials [16]. This strategy impacts the digital content design used in learning while still paying attention to the main thing in creating a content is how to present an easily understood information [17]. Besides, it is time for teachers, lecturers, or instructors to be digitally competence. Digital competence is the ability to use information and communication technology creatively, critically, and safely to achieve goals [18].

To facilitate the characteristics and students' needs, it is necessary to develop methods, strategies, and content that are in accordance with the characteristics of Gen Z. One of the efforts to facilitate this is by developing digital content that adopts information processing theory. Information processing theory was developed by George Miller in 1956. Information processing theory is oriented towards students' ability to process information from receiving, storing information, and re-expressing information that has been stored. This theory also focuses on activities related to activities processing or information processing to improve students' capabilities [19]. The application of information processing theory can give a significant impact on learning [20]. According to this theory, learning is seen as an attempt to process, obtain, and store information through short-term memory and long-term memory, in this case learning occurs internally in students. Information processing refers to how to collect/receive stimuli from the environment, organize data, solve problems, find concepts, and use verbal and non-verbal symbols. The results show that the application of information processing theory is able to provide clarity on a message and is effectively applied in reading activities [20], [21]. The shift from printed contents to digital contents is required especially in the 4.0 industrial revolution era. Digital contents are more effective compared to printed contents [22].

There are two basic theories in information processing theory, namely the concept of "chunking" and short-term memory capacity [23]. "Chunking" is concerned with rearranging or chopping information into large or small pieces. For example, students remember a telephone number by dividing the number into three digits to be easier to remember. Short-term memory capacity is related to the type of message received because students have a visual information processing system and verbal information processing; thus, so that the sound element will enter the verbal system and the picture or video message will enter the visual system [24]. By referring to this theory, the purpose of this study is to develop digital content using valid and interesting information processing theory.

II. Objectives of the Research

The objectives of this research is:

1) Describe the validity of digital content on aspects of learning media and learning design.
2) Describe student responses in using digital content in two stages, namely the individual test stage and the small group test.

III. Research Method

A. Research Design

This type of study is research and development (R&D) for

education. Hannafin & Peck [25] development model is used in this research. The model is shown in Fig. 3.

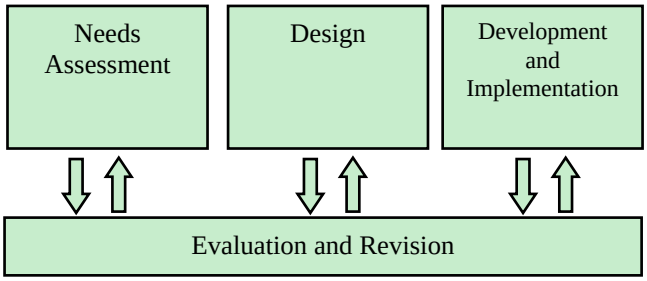

Fig. 3. Stages in Hannafin & Peck model [25].

The needs assessment stage is a needs analysis in developing a learning product. This is a very important first step because learning products that are in accordance with the circumstances and target characteristics will be obtained. The needs assessment phase includes the following activities: a) analyzing the learning process, b) analyzing the material, and c) analyzing the characteristics of the target.

The design stage is the second stage. An important step to consider in the design process is to determine a digital messaging strategy. The design stage focused on three activities, namely: a) selecting the material (theme), b) designing the type of digital content being developed, and c) creating digital content scripts by adopting information processing theory.

The development and implementation Stage is an activity to translate the design into physical form so that this activity results in a development product prototype in the form of digital content. Everything that has been done in the design stage, namely material selection, learning strategy selection, and media design are realized in the form of a prototype in the form of digital content. The results of the development in the form of digital content will then be continued to the implementation stage, which is validated by experts and tested by the target (students). Validation and trials aim to obtain input to correct deficiencies that still exist in learning media.

Evaluation and revision are carried out at every development step. At the needs assessment stage, an evaluation of the needs analysis result is carried out in order to determine the priority scale of problems found in the field. At the design stage, an evaluation of the framework or script is followed up with improvements to the script. In the development and implementation stages, an evaluation of digital content is carried out by experts and users (students) and is followed up with improvements according to input from experts and students. The type of evaluation in the development and implementation stages adopts the formative evaluation format by Dick & Carey [26].

B. Research Subjects

Product in the form of digital content was validated by two experts who are a media expert and a design expert. The validated content was then tested on three students in an individual test. The feedback from the individual test was used as reference to revise the digital content. Then, the digital content was tested to nine students in small groups.

C. Data Collection

The research data were collected using the method of observation and questionnaires. Both the observation method and the questionnaire were used when the preliminary study was conducted and the digital content was designed. The questionnaire was used to obtain data from experts, individual trials, and small group trials. To ensure the validity of the questionnaire, grid tables, and writing instruments were carried out. The product validity test instrument grid is presented in Table I.

TABLE I: PRODUCT VALIDITY TEST INSTRUMENTS GRID

Formative Evaluation Stages	Aspects	Total
Media expert validation	Typography Graphic Audio Systematics	10
Validation of learning design experts	Learning design Message delivery strategy Display design	10
Individual test	Clarity Attractiveness Legibility Language The ability to motivate Technical Quality	10
Small group test	Clarity Attractiveness Legibility Language The ability to motivate Technical Quality	10

D. Data Analysis

The data were collected using instruments in the form of questionnaires and observation sheets. The questionnaire produced two types of data, namely quantitative and qualitative data. The quantitative data in the form of scores given by experts and students were analyzed using quantitative descriptive analysis technique. The qualitative data in the form of feedbacks, comments, and suggestions for improvement were analyzed using qualitative descriptive technique. The observation sheet produced qualitative data which was used as a reference in designing digital content. The results of quantitative statistical analysis in the form of scores were then converted using the scale that can be seen in Table II.

TABLE II: GUIDELINES FOR CONVERSION OF ACHIEVEMENT LEVELS WITH A SCALE OF 5

Achievement Rate (%)	Qualification	Information
90-100	Very Good	No need to revise
75-89	Good	A little revision
65-74	Enough	Sufficient revision is needed
55-64	Poor	Many things should be revised
0-54	Very Poor	Re-create the Product

Based on Table II, if all of the experts and students give an score in the range 90 – 100, then the revision for the digital content is not needed.

IV. Result and Discussion

A. Result

The research results are presented based on the development stages used, namely by using the Hannafin & Peck [25] model which includes 3 stages, such as 1) needs analysis, 2) design, and 3) development and implementation. In the need analysis stage, an assessment of the course material of the product (digital content) had been carried out. The course developed is Message Learning Design course. There are 5 topics included in the digital content product, namely, 1) the concept of message and communication design, 2) aesthetics of graphic or visual design, 3) principles of learning message design, 4) analytical study of textbook message design, and 5) analytical studies in presentation media. Based on these learning activities, the types of objects/contents used to convey learning messages can be mapped as shown in Table III.

TABLE III: Mapping of Digital Content Objects

No	Learning Activities	Sub-Topic	Types of Digital Content Objects
1	Message and communication design concepts	Understanding Message Design The Nature of Communication Types of Communication Visual communication design Multimedia Communication	Text, image, audio
2	Graphic or visual design aesthetics	Definition of aesthetics Graphic Design Theme Nirmana in Graphic Design	Text, image, audio
3	Learning message design principles	The principle of motivation Principle of Perception Principles of Memory Principles of Learning Concepts	Text, image, audio, video
4	Analytical study of textbook message design	Typography or Letter Studies in Textbooks Principles of Text Display Design Designing Text to Be Easy to Understand Graphic Design Elements in Textbooks Printing Considerations	Text, image, audio, video
5	Analytical studies in presentation media	Concepts of Media, Multimedia, and Learning Presentation Media The Role of Visuals in Learning Visual Design Principles Visual Media Presentation Design Rules Analytical Study of Presentation Media Message Design	Text, image, audio, video

The results of the mapping in Table III are used as references for drafting digital content scripts. Each subject has a different type of media and depends on the level of complexity of the material. At the design stage, a storyboard or media script was made. Media manuscripts were used as a reference to produce digital content. Media manuscripts used the third column, namely numbers, visuals, and audio.

At the development stage, the script was implemented into a real visual display of digital content. The creating process was done using software such as adobe flash, filmora, powtoon, etc. At this stage, materials were also collected and produced according to the mapping results in the needs analysis stage. Objects used in digital content were text, images, video, animation, sound. These objects were arranged based on the types and characteristics of learning activities. Fig. 4 shows some of the displays in digital content.

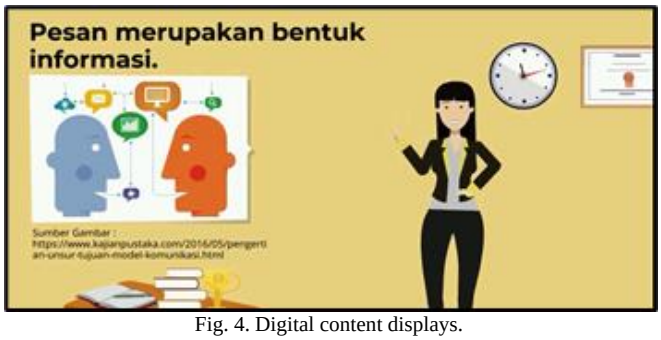

Fig. 4. Digital content displays.

In the evaluation stage, testing is carried out by experts and by users (students). The test results are as shown in Fig. 5.

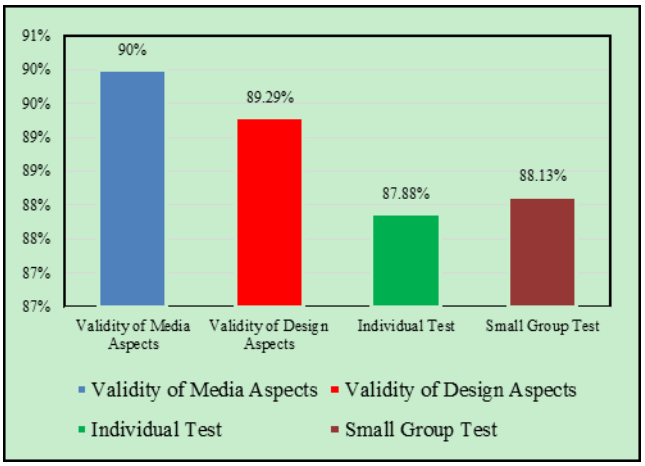

Fig. 5. Experts and users' testing results.

Based on Fig. 5, the validity of the media aspects is in the very good category, the validity of the learning design aspects is in the good category, and the attractiveness of digital content based on student testing at the individual and small group stages is in the good category as well. The subjects used in this study were only up to a small group so that the results of this study can also be used on subjects who have the same characteristics in this study.

B. Discussion

The validity and attractiveness of the digital content being developed cannot be separated from the information processing theory used. Content visualization in digital content is carried out based on information processing theory. This theory states that the process of receiving information is then processed to produce output in the form of learning outcomes. According to this approach, children gradually develop the capacity to process information, and therefore gradually can acquire complex knowledge and skills [27]. Thus, the role of visuals in digital content is very important and well designed, considering that digital content is more dominant in visuals in the form of text, images, and videos.

Well-designed visuals will improve understanding and help students to choose, organize, and integrate important information [28]. Visuals can also help to focus students' attention, present message better, and reduce errors [29].

The application of information processing theory cannot be separated from cognitive theory so that digital content has been arranged according to its level of urgency. If the text is the main focus, it will be positioned on the left and the image on the right. If the image is the main focus, the image is positioned on the left and the text is on the right. Text is a prominent content in a visual display. The presence of text in videos has a positive impact on students' understanding [30]. Some images are also attached with an explanation in the form of audio; thus, the audience can have a better understanding of the image being presented. Some contents in the form of sentence text which is considered complex and abstract are also clarified with video impressions so that it becomes more concrete. Long text content is broken up into small pieces so that they are easy to understand. Likewise, unrelated information is removed so as not to create a cognitive load [28].

The application of the principles of information processing theory is also intended so that the audience does not experience cognitive load because they have to listen to a lot of information on the screen. Information processing process is closely related to cognitive load. Cognitive load is a major consideration in designing digital or multimedia contents [31]. Cognitive load theory emphasizes on the importance of delivering material in an easy and interesting way; thus, the material can be stored in long-term memory [32]. Cognitive load theory also emphasizes that all initial information received will be processed through limited working memory and then stored in unlimited long-term memory [33].

The presentation of tight materials burdens students' cognitive capacity [34]. One thing that can be used is segmentation principles. The material in digital content has been presented using the principle of segmentation, namely large material is broken down and presented in the form of material points. Through this technique, students will be easier to find material keywords. The results showed that this principle can improve students' learning outcomes and ease the students to organize and integrate complex knowledge [11], [35], [36]. Thus, the students' cognitive will not be burdened. The material presentation by paying attention to students' cognitive capacities was able to reduce cognitive load and was able to improve their learning outcomes [13]. By paying attention to this theory, visual digital content becomes more organized, attracts attention, and eases the students to understand and remember the contents or materials.

Aspects of attention are things that need to be focused on in designing visual. This aspect becomes fundamental for students when viewing information so that they can store the information in memory, manage, and recall the information [37]. Information processing theory demands to attract the students' interest and attention [38]. This indicates that the content must be designed to be attractive so that it can attract the attention of the audience. The developed digital content has included relevant images, animations, colors, and appropriate typography; thus, it can attract the students' interest. Content design is not only to attract students' attention and interest, but more importantly is to be able to provide understanding of the concepts for students. To achieve this goal, digital content has been designed by using relevant and concrete images, presenting content in clear and unambiguous words, and presenting message in points that are clarified with narrative voice. This result is supported by research results showing that the role of visuals can improve conceptual understanding, improve higher-order thinking skill and the learning can be more effective [39]–[41]. The visualization that is presented in an integrated and relevant manner will provide a complete understanding to students.

The developed digital content has attractiveness in the good category based on student assessments. Digital content was considered attractive by students based on questionnaires given online in the individual trial and small group trial stages. Students gave feedback that the selection of text, the use of colors, images, animations, and videos can attract attention and provide clarity of materials. This finding is supported by other research showing that digital content that makes multimedia elements such as text, images, sound, video, animation and proper coloring can foster a comfortable atmosphere, attract attention, and please students [42]–[45]. Material presentation in the form of audio-visual or video provides a clear understanding. Video has been proven to be an effective strategy in improving students' learning outcomes [46].

V. Conclusion

Digital content produced in this research was developed using the Hannafin & Peck model. Based on the results of expert testing, that the validity of digital content on the media aspect is in the very good category and the content validity on the learning design aspect is in the good category. The attractiveness of digital content based on user or student ratings at the individual and small group trial stages is in the good category. Thus, it can be concluded that the importance of applying information processing theory in designing digital content can produce digital content that is valid, interesting, and easy to understand and remember by students. The application of information theory in designing digital content can reduce the cognitive load when students listen to the content presented. The limitation of this research is that it is only at the small group trial stage, so it needs to be tested at another time to determine the effectiveness of the content in learning by involving more respondents. The results of this study can be a reference for other researchers in creating digital content that is in accordance with information processing theory.

Conflict of Interest

The authors declare no conflict of interests.

Author Contributions

All authors have contributed in designing products in the form of digital content based on information processing theory. Next, the authors build the product and conduct trials on experts and users.

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