

## **DESIGN OF WEB-BASED DIGITAL MODULE FOR IMPROVING STUDENT UNDERSTANDING AND SKILLS IN GRAPHIC DESIGN LESSONS IN VOCATIONAL SCHOOL**

ZAKARIAS SUKARYA SOETEJA\*,  
GALIH JATU KURNIA, YUKKI SETIAWAN

Universitas Pendidikan Indonesia, Bandung, Indonesia

\*Corresponding author: zakarias@upi.edu

### **Abstract**

This study aims to produce a web-based digital module that can improve the knowledge and skills competencies of graphic design students of vocational high school. The method used is the ADDIE research and development model which consists of five stages: analysis, design, development, implement, and evaluation. Data was collected through observation, interview, documentation, pre-test, and post-test. The results showed an increase in students' understanding and skills in graphic design subjects. This increase in understanding is due to the use of digital modules in learning that integrate theoretical and practical knowledge materials, as well as module features that make it easy to get practical guidance and real-time feedback. Increased understanding and skills in graphic design will have an impact on improving the quality of competence as a visual communication product designer and increasing the competence of graphic designers in the industrial world.

Keywords: Design, Digital module, Graphic design, Learning, Vocational school.

## 1. Introduction

In today's digital era, the integration of technology in education is very important to improve the quality of learning students' understanding and skills. One innovation that can be applied is the use of web-based digital modules designed and developed specifically for graphic design subjects at vocational high schools (VHS). Many reports regarding VHS have been well-documented in Table 1.

**Table 1. Previous research on vocational high schools.**

No.	Title	Ref.
1	A bibliometric analysis of vocational school keywords using VOSviewer	[1]
2	How to make a cognitive assessment instrument in the Merdeka curriculum for vocational high school students: A case study of generating device materials about the Stirling engine.	[2]
3	The relationship of vocational education skills in agribusiness processing agricultural products in achieving sustainable development goals (SDGs)	[3]
4	Ergo design of mentoring in the national ecosystem of vocational education in the period of the 10th technological order.	[4]
5	Adaptive strategies for technical and vocational education and training (TVET) science educators: Navigating online home-based learning.	[5]
6	Barriers limiting the use of google classroom for learning vocational and entrepreneurship courses	[6]
7	Current issue in the technical vocational education and training (TVET) instructor.	[7]
8	Literature review: Technical and vocational education and training (TVET) in Malaysia.	[8]
9	Interactive multimedia design of motion graphics using a project-based learning approach for vocational education students: Experiments in cooking taliwang chicken.	[9]
10	Portfolio-based assessment in research methodology course students in vocational education.	[10]
11	Bibliometric analysis on artificial intelligence research in Indonesia vocational education.	[11]
12	Competency index of technical vocational education and training (TVET) instructors for 4.0 industrial revolution.	[12]
13	Methodology for investigating competency index of technical vocational education and training (TVET) instructors for 4.0 industrial revolution.	[13]

Here, this module is expected to overcome various challenges in conventional learning, such as limited teaching materials and less interactive learning media. By using a web-based digital module, students can access the subject matter anytime and anywhere, facilitating more flexible and independent learning. The module is also equipped with various interactive features that can enhance students' conceptual understanding and practical skills in graphic design. The implementation of this module is expected to not only improve students' learning outcomes but also prepare them with relevant skills for today's creative industries.

This research focuses on the process of designing, developing, and evaluating web-based digital modules, as well as their impact on improving students' understanding, skills, and learning achievements in the field of graphic design. Previous reports related to digital modules and learning are shown in Table 2.

**Table 2. Research on the use of digital modules in learning.**

No.	Article Title	Description/Findings	Ref.
1	E-modul matematika berbasis problem based learning bermuatan pengetahuan budaya lokal untuk meningkatkan kemampuan pemecahan masalah	The use of e-modules in learning Mathematics with a problem-based learning method based on local content improves students' ability to solve problems and understand abstract concepts more easily.	[14]
2	Pengembangan e-modul biologi berbasis problem based learning untuk meningkatkan literasi sains siswa	The results showed a significant increase in science literacy after the use of problem-based learning-based biology e-modules.	[15]
3	Pengembangan modul elektronik seni grafis untuk peserta didik SMA	The research results are in the form of an electronic module prototype containing graphic arts learning materials. Electronic modules overcome some of the limitations in the learning process.	[16]
4	Pengembangan modul digital pembelajaran matematika berbasis science, technology, engineering, mathematic untuk calon guru sekolah dasar.	The research results are in the form of STEM-based mathematics learning digital modules used by prospective elementary school teachers to improve their competence in teaching mathematics.	[17]
5	Pengembangan modul digital fisika berbasis discovery learning pada pokok bahasan kinematika gerak lurus.	The findings of this research are in the form of developing digital modules for learning physics based on discovery learning for understanding the subject matter of straight motion kinematics.	[18]
6	Pengembangan modul digital berbasis STEM menggunakan aplikasi 3D FlipBook pada mata kuliah sistem operasi.	This research produces a STEM-based digital module in the form of a flip book developed using the 3D FlipBook application which is used in learning in the Operating System course.	[19]

The purpose of this research is to design a web-based digital module to improve students' understanding and skills in graphic design subjects at vocational schools to design a web-based digital module to improve students' understanding and skills in graphic design subjects at VHS. The web-based interactive digital module is designed for graphic design learning in VHS in major visual communication design

(VCD), focusing on the integration of multimedia elements and a gamification approach. The module uses video tutorials, textual guides, and realistic simulations to explain graphic design concepts visually and practically. The novelty in this research is (i) the use of media in graphic design learning to provide a more dynamic learning experience compared to traditional methods such as books, slide-based electronic modules, or simply video tutorials, which have proven to be less interactive and effective, (ii) gamification with rewards such as ratings and certificates for each student's achievement increasing student motivation and involvement in learning, and (iii) a flexible combination of asynchronous and synchronous learning which is rarely done in graphic design learning. Thus, students can access the material anytime and anywhere, and get real-time feedback through the digital platform. The module features discussion forums for quick communication between students and teachers, facilitating effective collaboration and problem-solving. The modular and structured design of the learning materials, along with step-by-step guidance for practical projects, ensures students can understand and master each component of graphic design competency gradually and purposefully. Thus, this research offers an innovative solution that combines digital technology, multimedia, and gamification to improve the quality of graphic design learning in VHS VCD.

## 2. Literature Review

### 2.1. Digital module

A digital module is a learning tool or media that is available in digital form, often in the form of electronic files that can be accessed through computers, tablets, or other mobile devices. They are designed to present information, learning materials, and learning activities in a structured and interactive way to learners [20-22]. Usually, digital modules are equipped with various multimedia elements such as text, images, audio, and video to clarify and enrich the learning experience [23, 24]. Their main purpose is to facilitate independent and interactive learning, where students can learn flexibly according to their own pace and learning style. Digital modules can also be customized to suit the specific needs of certain subjects and educational levels [20, 23, 25-28].

Digital modules can be categorized as learning media. Digital modules are a form of learning media that uses digital technology to deliver information, learning materials, and learning activities to students. These modules are usually designed interactively with various features such as text, images, audio, video, and interaction that allow students to learn independently [29]. The advantages of digital modules include ease of access, flexibility of time and place, and the ability to present material in a way that is interesting and easy for students to understand. Studies have also shown that the use of digital modules can improve student learning outcomes and provide a more rounded learning experience [30]. Digital modules have several characteristics that make them suitable for modern learning needs:

- (i) Interactive: Digital modules are often equipped with interactive features such as videos, animations, and interactive quizzes to increase student engagement in learning;
- (ii) Easily accessible: Can be accessed anytime and anywhere through electronic devices such as computers, tablets, or smartphones;

- (iii) Flexible: Allows students to learn independently according to their own pace and learning style;
- (iv) Multimedia: Uses various media such as text, images, audio, and video to clarify the concepts being taught;
- (v) Self-contained: Provides all the information required for learning in one package, allowing students to learn independently without direct guidance from the teacher [31-35].

Digital modules or e-modules are teaching materials that are arranged systematically and attractively and equipped with various multimedia features to support a more interactive learning process [36]. The use of digital modules in learning has been proven effective in increasing student motivation and understanding [37]. In the context of vocational education, digital modules are very relevant because they can provide up-to-date and practical content following industry needs [38]. Research and development of learning modules, especially digital-based ones, follows several models, one of which is the ADDIE model. This model consists of four stages: define, design, develop, and disseminate. These stages are designed to ensure that the developed module is relevant, effective, and can be implemented well in the learning process [39-41].

Based on several studies, it was found that the availability of teaching materials specifically for graphic design subjects in VHS is still limited. Many teachers rely on general textbooks that do not specifically discuss graphic design in depth. This causes difficulties for students in understanding the material and developing the necessary skills [42]. Interactive learning media, including digital modules, have been shown to improve student engagement and learning outcomes [43]. Interactive features such as video tutorials, animations, and practice questions included in digital modules can help students understand concepts better and practice the skills learned [44].

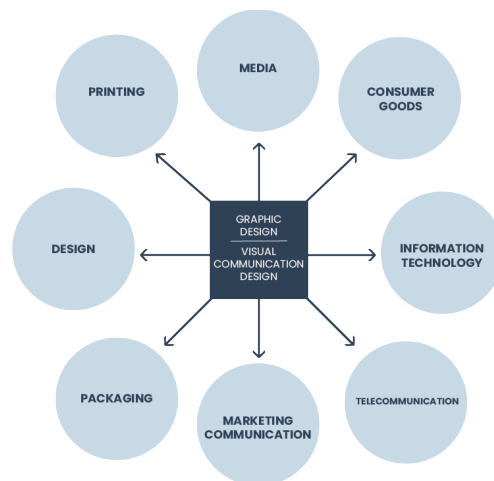
Based on interviews and observations at VHS, teachers and students are in dire need of relevant and practical learning resources to support graphic design learning. Digital modules are seen as a solution that can overcome the limitations of textbooks and other learning resources. In addition, the use of e-modules can help students learn independently and develop the skills needed for the world of work.

## **2.2. VCD education and graphic design learning**

VCD is a discipline that focuses on the use of visual elements such as images, colours, and typography to effectively convey messages to an audience. VCD not only covers aesthetic aspects but also considers the communicative and functional context of each design work. The main goal of VCD is to create works that are not only visually beautiful but can also influence the viewer in the desired way [45]. Graphic design is an integral part of VCD, focusing on the use of visual elements such as images, text, colour, and layout to convey messages effectively and attractively. VCD itself is a discipline that studies visual communication concepts and creativity in designing visual messages. Graphic Design in this context bridges creative ideas from VCD and practical techniques in creating designs that can be produced, such as posters, brochures, logos, and company visual branding [46].

The close relationship between graphic design and VCD lies in the use of graphic techniques applied in the process of designing visual communication. graphic design utilizes the latest software and technology to create visual works that are professional and responsive to the needs of modern audiences [47]. This includes the proper use of typography, image manipulation, as well as the arrangement of visual elements to achieve the desired communication objectives. Thus, graphic design not only embellishes the visual message but also ensures that the message is conveyed and appealing to its audience. The main goal of VCD is to communicate ideas or information in an attractive, effective, and efficient way through visual elements such as images, text, and colours [48]. In education, VCD covers various aspects such as typography, illustration, photography, graphic design, and multimedia [49-51]. VCD learning in vocational schools is designed to prepare learners with the skills needed in the creative industry. According to the National Education System Law (Law No. 20 Year 2003), vocational education aims to produce a workforce that is ready to work, has specialized skills, and is able to adapt to technological developments and industry needs. Therefore, the VCD curriculum in VHS must include theory and practice relevant to the design industry [52, 53]. The relationship between the industrial world and graphic design/VCD can be seen in Fig. 1.

Professional fields in the graphic design or VCD industry cover various aspects of life, including political, economic, social, and cultural fields [54]. In the related industry map, various industries that generally require the presence of a graphic designer or visual communication are depicted. In these industries, the services of graphic designers or visual communication are needed, be it in design studios, creative boutiques, advertising agencies, as freelancers, or as in-house designers. The need for competent designers is great to support these industries, especially with the ASEAN free market within the framework of the ASEAN Economic Community (AEC). Therefore, standards are needed that can be used as a reference for workers in this profession, both for determining career paths and in planning supporting education. The aim is to ensure continuity between education and industry in providing competitive human resources [55, 56].

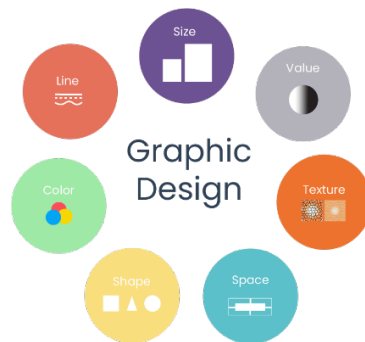


**Fig. 1. Industry map related to the field of graphic design/VCD.**

VCD learning methods at the vocational secondary level are diverse and can include project-based learning, problem-based learning, and the use of technology and digital media. Project-based learning allows learners to be directly involved in the design process, from research, and concept, to production. This method is effective in developing learners' practical and creative skills [57]. Problem-based learning is also applied to develop students' analytical and problem-solving skills through case studies and real project simulations [58].

Technology plays an important role in VCD learning. The use of graphic design software such as Adobe Photoshop, Illustrator, and InDesign is standard in the design industry and therefore an integral part of the VCD curriculum. These technologies allow students to produce design work to a professional standard and understand digital workflows [59]. In addition, AR and VR technologies are starting to be integrated into learning to provide a more immersive and interactive experience [60]. One of the main challenges in learning VCD in VHS is the limited resources and adequate facilities. Some schools may not have the latest software and hardware needed to support optimal graphic design learning [61]. In addition, the shortage of teachers who are competent in design technology is also an obstacle to the effective implementation of the VCD curriculum.

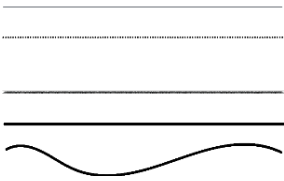
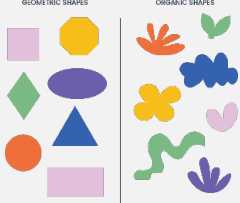
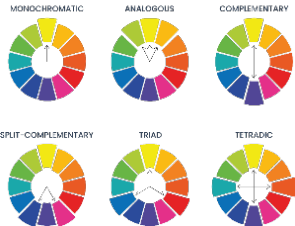
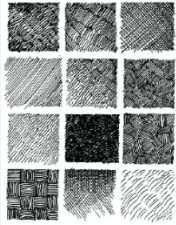
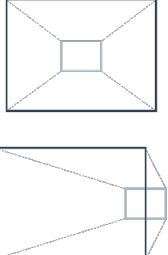
Graphic design is the art and practice of designing and composing visual content to communicate messages. The history of graphic design can be traced back to the prehistoric era when humans first started using symbols and images to communicate. However, modern graphic design developed rapidly in the 20th century with the advent of printing techniques and computer technology [62, 63]. Graphic design as a material in VHS, contains the management of graphic elements such as line, shape, colour, texture, and space. In addition, learners need to master design principles such as balance, contrast, emphasis, movement, rhythm, and unity, used to organize these elements effectively and aesthetically [64-67]. Graphic elements that are closely related to graphic design can be seen in Fig. 2.



**Fig. 2. Graphic design and graphic elements.**

Scientific studies in the psychology of perception and cognition have shown how the human brain processes and responds to these visual elements influences how humans interpret and understand information in a graphic design. These studies help designers create work that is more effective, aesthetically pleasing, and in line with how humans naturally perceive and process visual information. A solid understanding of design elements and principles is fundamental for any graphic designer. Graphic elements can be seen in Table 3.

**Table 3. Graphical elements.**

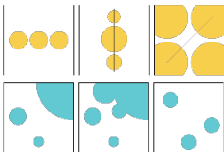

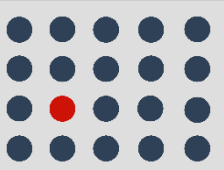
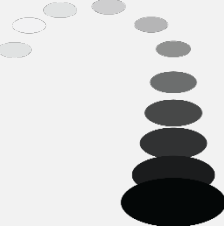
No.	Element	Description
1	Line 	According to the psychology of perception, lines can direct the gaze, form patterns, and express emotions. For example, straight lines tend to give a sense of firmness and stability, while curved lines are more dynamic and softer. Visual physiology studies on how the human eye follows lines and patterns can provide insight into the importance of line direction and thickness in creating visual focus.
2	Shape 	Basic shapes such as circles, triangles, and squares have certain psychological perceptions. Circles are often associated with warmth and inclusion, while triangles can suggest direction and dynamism. Gestalt theory, which explains how humans tend to see shapes as a whole rather than separate parts, is an important basis for understanding how shapes are used in design.
3	Color 	In scientific studies, colour is determined by the wavelengths of light reflected or emitted by objects. The science of the light spectrum and pigment interactions provides the scientific basis for colour. Psychologically, colours have emotional and psychological effects. For example, red is often associated with energy and urgency, while blue is more calming. The study of colour preferences and their effects on human behavior is part of perceptual psychology.
4	Texture 	Psychologically, texture can create the perception of a sense of touch or dimension in design. Rough textures can give the impression of being rough or unsmooth, while smooth textures can give the impression of elegance and cleanliness. Sensory Analysis shows how texture is processed by the senses of touch and sight providing insight into the use of texture in design to create visual and tactile effects.
5	Space 	The use of positive space (space occupied by objects in black) and negative space (empty white space around objects) psychologically creates a visual perception of dimension or depth. In digital design, space also relates to the layout of elements on the screen. Algorithms and layout theory help in the management of space to ensure readability and visual comfort.




Scientific studies have helped provide a basis for understanding how graphic elements affect human perception and how to use them effectively in graphic design. With a scientific approach, designers can make more informed decisions and create more effective and engaging work.

Apart from graphic elements, principles for organizing these elements are also required, known as graphic design principles. The principle of setting these elements can be seen in Table 4.

**Table 4. Graphic design principles.**

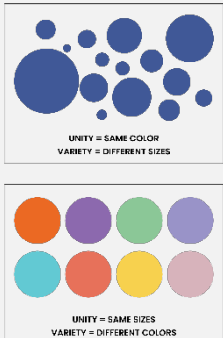
No.	Principle	Description
1	<p>Balance</p> 	<p>Balance in design is concerned with how visual elements are distributed to create visual stability. Research in psychology shows that humans tend to seek visual balance, which can improve comfort and readability.</p> <p>Scientific analysis can be conducted to measure people's preference for balanced versus unbalanced designs, using methods such as eye tracking to see how visual attention is diverted.</p>
2	<p>Contrast</p> 	<p>Contrast helps in distinguishing visual elements and attracting attention. The psychology of visual perception suggests that high contrast (such as between black and white) can improve readability and focus. Through scientific studies it is possible to measure visual response and reaction time to elements that have high contrast compared to low contrast, using techniques such as neural response measurement or fMRI.</p>
3	<p>Emphasis</p> 	<p>Emphasis is used to draw attention to a particular part of the design. This principle relates to the theory of selective attention in psychology, which examines how and why our attention is drawn to certain objects.</p> <p>Scientific analysis of eye tracking and viewing time measurements can be used to determine which areas of a design attract the most attention in the first place.</p>
4	<p>Movement</p> 	<p>Based on the psychology of perception study, the impression of movement in a design leads the eye to follow a certain path. Theories on motion perception in psychology explain how our brains detect and follow motion.</p> <p>Scientific studies on eye tracking can show how people follow visual paths in design, while reaction time experiments can measure the speed of motion detection.</p>

5 **Rhythm**



Rhythm in design creates patterns and repetition that can provide a sense of order and harmony. Perceptual psychology shows that regular patterns are more easily processed by the brain. Experiments can measure responses to regular versus random visual patterns, to find out how this affects visual engagement and comfort.

6 **Unity**



Unity or harmony in design creates a perceived sense of connectedness between visual elements. Gestalt theory in visual psychology explains how our brains tend to see things as a whole rather than as separate parts. Scientific analysis can be used for eye-tracking and physiological response measurement to see how cohesive design affects overall perception and visual satisfaction.

With a scientific approach, these design principles can be measured, analysed, and understood more deeply, providing insight into how visual elements interact with the brain and influence human perception.

Graphic design learning has a central role in the VCD Education curriculum at VHS. This program aims to develop students' abilities in understanding visual communication concepts and mastering modern graphic design techniques. This course not only introduces the basic principles of graphic design, but also trains students to use the latest software and technology such as Adobe Photoshop, Illustrator, and CorelDRAW. The use of this software not only improves students' technical skills but also expands their creativity with the various features offered by each program [68].

Graphic Design in the context of VCD Education at Vocational Schools prepares students for various careers in the creative industries [69]. They are trained to become professional graphic designers who can produce visual works that meet industry standards. With a focus on mastering visual techniques and creativity, students are also encouraged to develop their portfolios during their education, which is an important asset when entering the world of work [70].

Learning Graphic Design at Vocational Schools does not only emphasize technical aspects but also students' conceptual and creative abilities. They are taught to integrate design concepts in practical projects that include visual identity, product design, and promotional media. This aims to prepare graduates to be able to face the demands of an increasingly competitive job market in graphic design and other creative fields [71].

Graphic design is one of the most important subjects in the VHS curriculum, especially for the VCD study program. According to the Minister of Education and Culture Regulation number 70 of 2013 and RI Minister of Education and Culture Decree No. 262/M/2022, this subject aims to equip students with the technical and creative skills needed in the industrial world. Graphic design competency includes

the ability to use design software, understanding design principles, and the ability to create effective and aesthetic visual works.

The development of graphic design learning materials must be adapted to technological developments and industry needs. The teaching materials used must cover the latest aspects of graphic design, such as UI/UX design, animation, and web design. The learning modules developed must also be interactive and easily accessible to students, including through the use of electronic modules that can be accessed online [72].

### 3. Method

This research uses the Research and Development (R&D) method, an approach with a systematic process for creating, testing, and improving new products or systems through a series of research and development activities. Research and Development are carried out to develop new products or improve existing products through systematic steps, through data collection, analysis, design, development, and evaluation. R&D is used to develop teaching materials, learning methods, or curricula that are innovative and suit the needs of students and the latest educational trends. This process usually involves stages such as identifying needs, design planning, testing, and revisions based on test results to ensure the resulting product has high quality and relevance [73-75].

In its implementation, Research and Development in the context of developing this Digital Module uses the ADDIE model, namely a systematic approach used in learning design, which consists of five stages: Analysis, Design, Development, Implementation and Evaluation [76]. An image of the ADDIE model can be seen in Fig. 3.

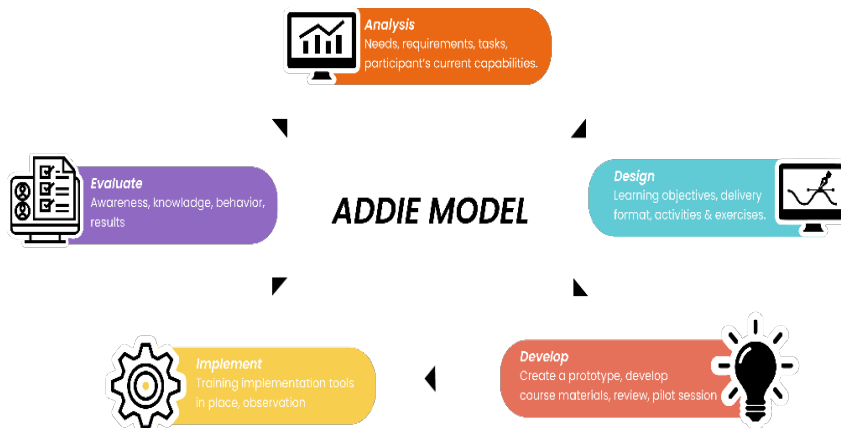


Fig. 3. ADDIE model work flow chart.

Each stage in this model has a specific goal that helps the overall success of the development process. The Analysis stage involves identifying needs and analysing problems to determine learning objectives. The Design stage focuses on designing learning strategies and material structures in digital modules. The development stage includes creating and testing prototypes or teaching materials. The implementation stage involves applying the material or program in a real

environment [77]. Finally, the evaluation stage involves assessing the effectiveness and efficiency of the material or program to make necessary improvements.

ADDIE model not only provides a clear structure for instructional development but also the flexibility to adapt and improve learning materials based on feedback received during the evaluation process. The iterative approach of the ADDIE model supports developers to continuously improve the product until they achieve the desired results [78-80].

### **Module development process**

At this stage, researchers identify students' needs, learning objectives, and learning context. This analysis includes data collection through interviews, questionnaires and observations to understand the needs and gaps in graphic design learning at VCD Vocational School.

The design stage consists of planning the module structure, determining content, learning strategies, and selecting the media to be used. At this stage, researchers create a structure and blueprint for digital graphic design modules for VCD Vocational School students, which are packaged in website format with multimedia elements to be included such as text, images, video and interactive interactions.

The development stage enters the stage of creating a graphic design module based on the design that has been created. These include content preparation, multimedia development, interaction coding, and internal testing to ensure module functionality and accuracy. At this stage, researchers make revisions based on initial feedback from experts or colleagues. At the implementation stage, digital modules were integrated into the learning process for several samples of vocational school students in the VCD study program. The researcher instructed students to use the module and provided the necessary technical support. This implementation is also a trial to measure the effectiveness of the module in a real context.

Evaluation is carried out to ensure the quality and effectiveness of the module. Formative evaluation is carried out during the development stage, while summative evaluation is carried out after implementation to assess the impact of the module on student learning outcomes. This evaluation uses pre-test and post-test methods.

## **4. Results and Discussion**

### **4.1. Analysis**

The analysis process was carried out using observations and interviews involving teachers and students at Vocational High Schools which have a VCD study program. The resource persons and respondents consisted of teachers and students from several vocational schools. The percentage in Table 5. is calculated from the total number of respondents who experienced VCD or expressed certain problems during the analysis process.

The data in Table 5. is a reference for examining the categories that have been analysed, with the following results learning problem analysis, graphic design learning methods are still dominated by the use of textbooks and presentation slides. Teachers stated that the media was less interactive and unable to meet students' practical skills needs. Students also find it difficult to understand graphic design

concepts only through textbooks and presentations. Apart from that, there is the problem of limited class meeting time which is inadequate for achieving practical skills. Asynchronous learning activities carried out at home are also poorly monitored by teachers, so students have difficulty getting fast and timely feedback.

**Analysis of Learning Results.** Student learning results show that the majority of students have not achieved the expected competencies in graphic design. Teachers indicated that students often had difficulty understanding and applying basic graphic design concepts. The results of interviews with several teachers revealed that the lack of interactive learning media and limited meeting time were the main factors influencing low student learning outcomes.

**Learning Process Analysis.** The graphic design learning process at VCD Vocational School tends to be one-way, with the teacher as the information centre and students as passive recipients. Observation of teacher documents shows that the learning methods used are still conventional, with minimal use of technology and interactive media. The results of interviews with teachers also revealed that they found it difficult to monitor individual student learning progress, especially in asynchronous learning activities.

**Table 5. Category of graphic design learning problems.**

<b>Category of Graphic Design Learning Problems</b>	<b>Indicators</b>	<b>Respondent</b>	<b>Percentage (%)</b>
<b>Learning methods</b>	Use of textbooks and slide presentations	8/10	90%
	Less interactive media	7/10	80%
	Limited class meeting time	7/10	80%
	Asynchronous activities are less monitored	8/10	70%
<b>Learning outcomes</b>	Students have not achieved the expected competencies	7/10	70%
	Difficulty understanding the basic concepts of graphic design	8/10	80%
	Low learning outcomes due to lack of interactive media	7/10	70%
<b>Learning Process</b>	One-way learning process	7/10	70%
	Lack of use of technology and interactive media	8/10	80%
	Difficulty monitoring student learning progress	7/10	70%
<b>Learning Materials and Media</b>	Use of textbooks and slide presentations	9/10	90%
	Media is not effective in aiding practical understanding	9/10	90%
	No realistic simulations or practical exercises	8/10	80%
	Student learning outcomes are not optimal	8/10	80%

Analysis of Learning Materials and Media. Analysis of learning materials and media shows that the graphic design materials used in vocational schools are still limited to textbooks and presentation slides. This learning media is not only less interactive but also less effective in helping students understand graphic design concepts practically. The learning media used is not able to provide realistic simulations or opportunities for practical training required in the field of graphic design. As a result, student learning outcomes in graphic design subjects are still not optimal.

Data analysis shows that the majority of respondents experienced or expressed problems in each category that was analysed, thus supporting the argument regarding the need to develop graphic design learning modules that are more interactive and effective.

#### 4.1.1. Design

Based on the results of the analysis of problems in learning, several aspects that are considered to be addressed by using web-based digital modules. Several aspects of problems in learning that will be addressed using this web-based digital module are then categorized and a plan for solving the problem is made. Problem categories and problem resolution plans can be seen in Table 6.

**Table 6. Graphic design learning problems.**

<b>Graphic design learning problems</b>	<b>Digital module design for problem solving</b>
<b>Learning methods</b>	Provide video tutorials and animations that visually illustrate graphic design concepts. Provides practical exercises in realistic simulations using graphic design software.
<b>Learning outcomes</b>	Provide real-time feedback through digital learning platforms. Use interactive quiz features and design challenges to test student understanding.
<b>Learning process</b>	Facilitate two-way interaction between students and teachers through discussion forums and chat features. Implement gamification by rewarding student achievement.
<b>Learning materials and media</b>	Separate learning materials into small modules with a focus on specific skills. Integrate step-by-step guidance in the use of graphic design software

Problem resolution plans include, (i) overcoming the problem of learning methods so that they become more interactive to meet students' practical skills needs, overcoming the problem of limited meeting time in class which is inadequate to achieve the expected practical skills; (ii) Students can immediately get feedback

even if they are not accompanied by a teacher when learning outside the classroom; (iii) Students have more free time to study basic graphic design concept material outside class hours, so they can optimize face-to-face meetings with teachers in the classroom; (iv) Apart from students getting feedback more quickly, teachers in graphic design learning using web-based digital modules can immediately provide feedback and assist students outside of classroom learning; (v) Learning materials and media used through web-based digital modules are expected to be more varied and interactive, providing motivation to create independent learning opportunities during classroom hours.

#### **4.1.1.1. Conceptualizing the design**

To solve the problems faced in learning graphic design at VHS VCD, the following are the characteristics of digital modules that can be implemented to minimize each category of problems:

- (i) Interactive. Provides video tutorials and animations that visually illustrate graphic design concepts. This will help students understand theory and practice better [81]. The module has clear instructions. Thus, students can practice and try out various graphic design techniques in a realistic simulation on the software they have.
- (ii) Asynchronous and Synchronous. Provides access to learning materials that can be accessed at any time, such as texts, reference images, and video tutorials.
- (iii) Real-time Feedback. Using a digital learning platform that allows students to upload assignments and get immediate feedback from teachers [82]. It also provides discussion forums and chat/command features for quick communication between students and teachers.
- (iv) Gamification. Rewarding badges, ratings, or certificates for each student's achievement in the module, can increase student motivation and engagement [83]. Provide engaging and industry-appropriate interactive quizzes and design challenges to test student understanding and provide immediate feedback.
- (v) Modular and Structured. Divide the learning material into small modules that focus on one specific topic or skill. Provide a clear lesson plan with learning objectives, steps, and expected outcomes.
- (vi) Contains easy-to-implement project guidelines. Provides exercises integrated with commonly used graphic design software (such as Adobe Photoshop, Illustrator, CorelDRAW). Provides step-by-step tutorials that can be directly applied to the design software used by students [84].

To be able to have the above characteristics, the digital module is designed web-based to provide a more interactive and interesting learning experience. The module will utilize various multimedia elements such as text, images, videos, and interactive interactions to help students understand graphic design concepts more comprehensively and practically [85]. The advantages of web-based digital modules are the flexibility of access that opens up opportunities for students to learn anytime and anywhere, and interactive features with the utilization of navigation and digital buttons can facilitate and increase student involvement and motivation in learning [86, 87].

#### 4.1.1.2. Form of digital module

This digital module will take the form of an interactive web with the following page sections and features. Web-based modules are considered to make it easier for users to access via links anywhere and anytime. A web display with optimized features and navigation guides can make it easier for users to explore all available pages. Web-based modules also make it possible to embed various multimedia content in the form of text, images, videos, animations, and even redirect to other web platforms. The design of the digital module can be seen in Fig. 4.

- (i) Landing Page. The main page contains navigation of the module content, student identity, module identity, and a dashboard to review the status and progress of module work.
- (ii) Module Page. Contains materials following graphic design competencies, including guidelines for using digital modules, understanding graphic design, and practical project guides consisting of several projects to obtain all components of graphic design competencies. Module pages are integrated with theory and technical guidance videos for each sub-material. The sub-material page is equipped with a Project Collection System feature, which is a feature for collecting practical tasks that students have done. as well as a Quiz feature, a feature for assessing student knowledge through interactive quizzes.
- (iii) Project Collection Page. The Project Collection page is a section that contains all projects from competency module activities, where students and teachers can review all student projects that have been submitted.
- (iv) Evaluation Page. Contains a learning outcome report to determine the numerical results of module work that can be accessed by students and provide feedback on student learning outcomes [88].

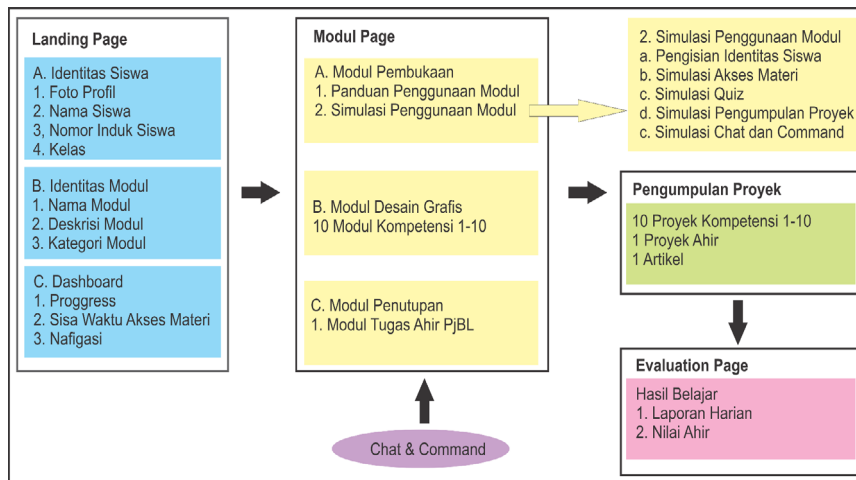


Fig. 4. Design of form digital module.

#### 4.1.1.3. Module digital content

The contents of the digital web module are designed taking into account the needs of student teachers and competency achievement, will contain explanations of



expected competency achievement, learning materials, technical guides for graphic design projects, interactive video tutorials about graphic design theory and practice, descriptions of exercises, assignments, quizzes and how-tos. all of this is collected or presented to get feedback in the form of responses or grades from the teacher. The detailed contents of the digital module can be seen in Table 7.

**Table 7. Module digital content.**

No.	Competency	Material	Project Technical Guide	Interactive Video Tutorial	Additional
1	Understanding graphic design	Introduction to graphic design definition and history of graphic design principles and elements of graphic design roles and responsibilities of graphic designers	Wordmark Logo Design Creation	Create a wordmark logo using Adobe Illustrator or Coreldraw	Project Collection, Quiz
2	Mastering tracing and imaging techniques	Definition of tracing and imaging Tools and software used	Logo Pictorial Image Tracing	Tracing technique using Adobe Illustrator or Coreldraw	Project collection, Quiz
3	Mastering colour and field processing	Basic colour theory. Field processing techniques in graphic design	Color processing in logo abstract design	Processing Color and Field with Adobe Illustrator or Coreldraw	Project collection, Quiz
4	Mastering typography processing	Types and uses of typography Principles of text placement	Typography in letter form logo design	Processing Typography with Adobe Adobe Illustrator or Coreldraw	Project collection, Quiz
5	Mastering texture processing	Definition and types of textures. Texture processing techniques.	Application of texture in logo emblem	Processing Texture with Adobe Photoshop, Adobe Illustrator or Coreldraw	Project collection, Quiz

**Table 7 (Continue). Module digital content.**

No.	Competency	Material	Project Technical Guide	Interactive Video Tutorial	Additional
6	Mastering shading processing	Definition and function of shading. Manual and digital shading techniques	Shading application on mascot logo	Shading Techniques with Adobe Illustrator & Photoshop	Project collection, Quiz
7	Mastering illustration processing and application	Definition and types of illustrations. Illustration creation and application techniques	Application of illustration in Logo Design	Illustration Techniques with Adobe Illustrator	Project collection, Quiz
8	Mastering Layout Processing	Basic layout principles Layout processing techniques	Layouting on business card design	Layouting techniques with Adobe Illustrator or Coreldraw	Project collection, Quiz
9	Mastering branding design	The concept and importance of branding elements in branding design	Branding Design for Office Tools	Branding Design Techniques with Adobe Illustrator or Coreldraw	Project collection, Quiz
10	Understanding graphic designer attitudes and work ethics	Professional ethics in graphic design. Good work attitude	Case Study and reflection on work ethics	Discussion on work ethics in graphic design	Project collection, Quiz

#### 4.1.1.4. Module utility

The digital module will be web-based with intuitive and user-friendly UI/UX. The landing page will be integrated with the dashboard page, which provides easy access to the module, theory, and practice sub-modules, project submission page, evaluation page, and comment/discussion page. The UI/UX design will be

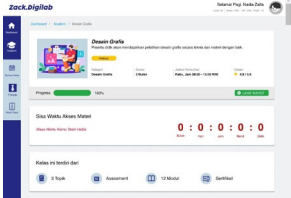
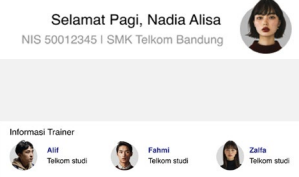

designed. Thus, students can easily navigate and use the module, and get a fun and effective learning experience[89].

**4.1.2. Development**

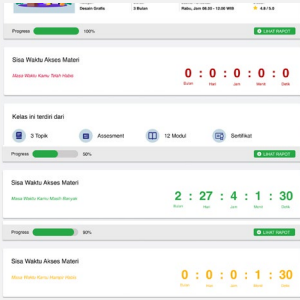

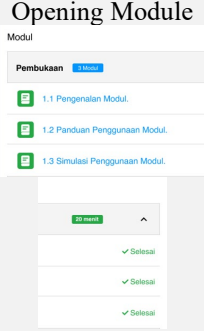
**4.1.2.1. Stages of design asset creation**

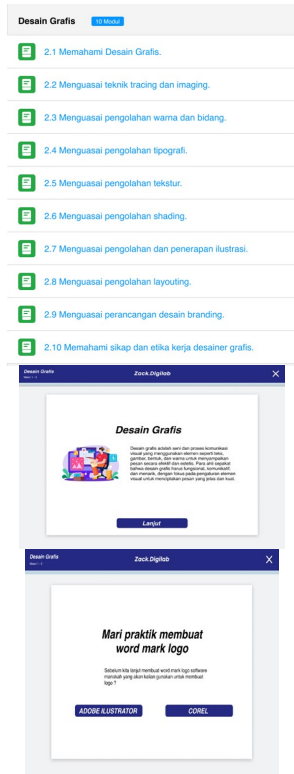
After the design stage in the ADDIE sequence, the next stage is the development stage. At this stage, appropriate software is selected to develop the design created in the previous stage. Adobe Illustrator software is used to design assets that will be used in the module, which can be seen in Table 8. Each asset is created based on the needs of the page and the features found on each page. Image assets are created in vector image format so that the resolution can still be adjusted to various output formats for mobile and print applications. The table explains the various assets designed, namely, landing page, student identity, module identity, dashboard, module page, project collection, and evaluation page. Each design asset is designed with consideration of the layout and management of design elements which makes it easier for users to interact with the page with the help of the available images.

**Table 8. Design assets.**

No.	Asset	Description
1	Landing Pages 	Landing Page is the main page contains navigation of the module content.
2	Student Identity 	Student identity contains Student Name and School Name, this component is located in the header section at the top right on the Landing Page. Student identity is inputted by the student and can be changed with the change profile feature. Students can also add an optional profile photo.
3	Module Identity 	The module identity contains the module name, module description and module category. The module identity is designed for the possibility of this digital module platform being populated by other material modules other than Graphic Design. The module identity is displayed in one section with the dashboard component.

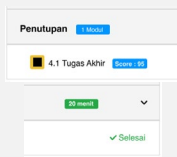
**Table 8 (Continue). Design assets.**

No.	Asset	Description
4	 <p>The dashboard displays progress bars for various modules, such as 'Progres' at 100% and 'Assesment' at 80%. It also features countdown timers for 'Sisa Waktu Akses Materi' (Remaining Access Time) and 'Kelas ini terdiri dari' (This class consists of) with 3 Topik, 12 Modul, and 1000 Soal. The dashboard is designed to provide a clear overview of the student's progress and remaining time for each module.</p>	<p>The dashboard contains graphs and percentages of module completion progress, module completion deadlines in countdown time display, and navigation to other pages. The dashboard is designed so that students can easily find out the achievement of module completion and encourage module completion according to the specified time, so that graphic design learning can be carried out according to the mapping of the availability of teaching hours at school.</p>
5	 <p>The module page features a sidebar with navigation options like 'Beranda', 'Materi', 'Penugasan', and 'Ujian'. The main content area displays a list of modules with details such as 'Materi', 'Penugasan', and 'Ujian'. The page is designed to provide a structured and easy-to-navigate learning environment.</p>	<p>Module Page. Contains materials following graphic design competencies, including guidelines for using digital modules, understanding graphic design, and practical project guides consisting of several projects to obtain all components of graphic design competencies.</p>
6	 <p>The opening module page shows a list of activities under the heading 'Pembukaan' (Introduction). The activities include '1.1 Pengenalan Modul', '1.2 Panduan Penggunaan Modul', and '1.3 Simulasi Penggunaan Modul'. A progress indicator shows '30 menit' (30 minutes) and 'Selesai' (Completed) for each activity.</p>	<p>The Module Opening contains 3 activities, namely, Module Introduction, Module Usage Guide, and Module Usage Simulation. This component is a facility to understand how the module works by learning by doing, so that students can independently master the features and functions of the module components. The module usage guide contains technical guidance in the form of text and images that provide an understanding of the module, while the simulation of module usage is packaged in the form of gamification to try out various functions, components and features of the module.</p>
7	<p>Graphic Design Module</p>	<p>This section is the main part of the digital graphic design learning module. contains 10 sub modules according to the competencies that need to be achieved in learning graphic design, [90] namely:</p> <ul style="list-style-type: none"> <li>Understanding Graphic Design</li> <li>Mastering tracing and imaging techniques</li> <li>Mastering colour and field processing</li> <li>Mastering typography processing</li> <li>Mastering texture processing</li> </ul>



Mastering shading processing  
 Mastering the processing and application of illustrations  
 Mastering layout processing  
 Mastering branding design  
 Understand the attitude and work ethics of graphic designers  
 Each competency is obtained through material and practice of making various types of logo designs (Word mark, Pictorial, Abstract, Letter Form, Emblem, Mascot) and office tools such as business cards and letterheads. each submodule consists of 4 activities namely material, practice guide, project collection and quiz.

**8** Closing Module



The Closing Module is a final project guide with the Project Base Learning method with the task of re-branding the MSME logo. The project begins with finding MSME partners in the home or school environment that are considered to have logos that can still be developed. then students evaluate existing logos, then develop them based on the results of research on business characteristics, products, and target markets. From the research results, students carry out redesigns from the sketching and digitization stages. the output of this project is in the form of work documentation, three new logo options, and an infographic poster that displays the process and results of re-branding.

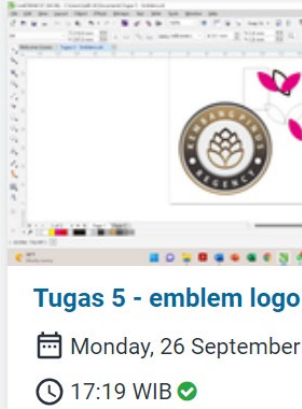
**9** Project Collection



The Project Collection page is an integrated section with all sub-module pages through the buttons available at the end of each technical guidance activity in each competency module. Students and

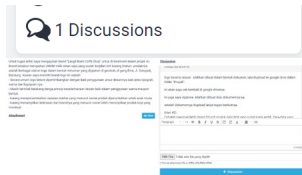
teachers can review all projects on this page.

**10** Review and competency project identity 1-10



Each project that is collected will be saved on the project collection page with the project display, project name, and description of the collection time. At the end of the learning there will be 12 projects consisting of 10 competency projects, 1 final assignment project and 1 graphic design article creation project.

**11** Project Discussion



Each project on this page is equipped with a discussion feature to facilitate communication between students and teachers in the process of working on and evaluating projects that have been worked on. Teachers can provide feedback in the form of input or revisions. Students can follow up on feedback or ask about obstacles and technical issues. This feature is useful for discussions taking place in asynchronous mode.

**12** Evaluation Page

No	Target	Attendance	Jwb Pkny	Laporan	Lain-lain	Rata-rata
1	100%	100%	100%	100%	100%	100%
2	100%	100%	100%	100%	100%	100%
3	100%	100%	100%	100%	100%	100%
4	100%	100%	100%	100%	100%	100%
5	100%	100%	100%	100%	100%	100%
6	100%	100%	100%	100%	100%	100%
7	100%	100%	100%	100%	100%	100%
8	100%	100%	100%	100%	100%	100%
9	100%	100%	100%	100%	100%	100%
10	100%	100%	100%	100%	100%	100%

Evaluation Page. Contains a learning outcome report to determine the numerical results of module work that can be accessed by students


**13** Daily Report

The daily report contains a history log on the module and a report on the completion of each module activity. Each activity will produce a score in the form of a 0-5 scale rating. Rating is an accumulation of discipline, knowledge quiz results and practical project results for each

Rating Rate-Rata 3.03				
Jam Datang	Jam Pulang	Laporan Bangun	Laporan Sore	Rating
07:07	18:56	TEKNIK ANAK2	TEKNIK ANAK2	★★★★☆
07:26	18:56	TEKNIK ANAK2	TEKNIK ANAK2	★★★★☆
07:50	20:31	TEKNIK ANAK2	TEKNIK ANAK2	★★★★☆
08:45	18:56	TEKNIK ANAK2	TEKNIK ANAK2	★★★★☆
11:34	18:56	TEKNIK ANAK2	TEKNIK ANAK2	★★★★☆
08:56	20:31	TEKNIK ANAK2	TEKNIK ANAK2	★★★★☆
07:19	18:56	TEKNIK ANAK2	TEKNIK ANAK2	★★★★☆
07:03	21:30	TEKNIK ANAK2	TEKNIK ANAK2	★★★★☆
07:14	18:56	TEKNIK ANAK2	TEKNIK ANAK2	★★★★☆
08:56	18:56	TEKNIK ANAK2	TEKNIK ANAK2	★★★★☆

competency module. This rating does not really affect the final score. However, it has a function to be reflected in class or motivate students to be more active in learning and using the module [91].

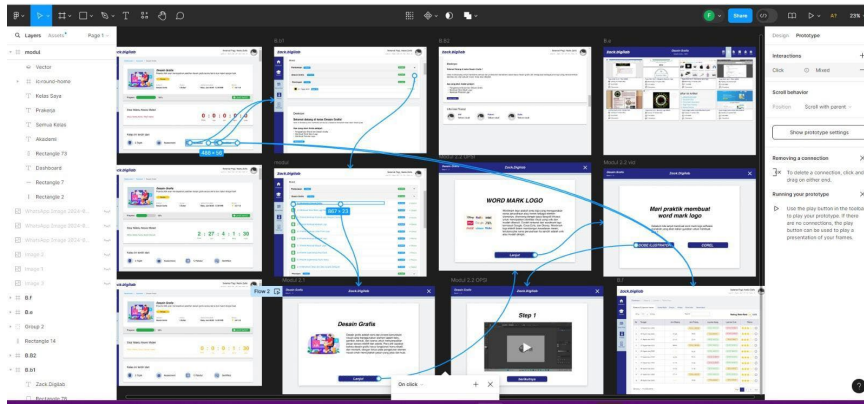
**14** Final Score



The Final Score is the accumulated score obtained by students at the end of all activities in the digital graphic design module.

**4.1.2.2. Asset management**

Figma software is used to manage and organize design assets interactively. Figma is a collaborative web application for interface design, which also provides offline features through its desktop application for macOS and Windows. Figma's feature set focuses on user interface (UI) and user experience (UX) design, emphasizing real-time collaboration. The application leverages various vector graphic editors and prototyping tools. The Figma mobile app for Android and iOS allows users to view and interact with Figma prototypes in real-time on mobile devices and tablets [92]. In this module, all assets, including page designs and navigation buttons, are integrated. Users can navigate from one page to another through the available buttons, with the configuration and relationships between pages shown in Fig. 5.



**Fig. 5. Manage and organize design.**

**4.1.2.3. Integration with Coding**

The digital modules are integrated with a WordPress-based web platform to ensure optimal functionality and accessibility.

### 4.1.3. Implementation

The implementation of the digital graphic design learning module was carried out online for 20 grade 12 students from various vocational schools in Bandung, Bekasi, Tasikmalaya and Banjar. The students involved were Student 1 and Student 2 from Public VHS 9 Bandung; Student 3 and Student 4 from Public VHS 14 Bandung; Student 5 and Student 6 from Public VHS 4 Bandung; Student 7 and Student 8 from VHS 3 Bandung; Student 9 and Student 10 from VHS Merdeka Bandung; Student 11 and Student 12 a from VHS Bakti Nusantara 666; Student 13 and Student 14 from Telkom Vocational School; Student 15 and Student 16 from Public VHS 9 Bekasi; Student 17 and Student 18 from Public VHS 3 Tasikmalaya; as well as Student 19 and Student 20 from Public VHS 1 Banjar.

The implementation stage of the ADDIE method in module design aims to test the modules on users. so we can observe how the product works and get feedback from users [93]. Students are given access to the module via a web link and given three months to complete the module. The learning process is carried out asynchronously. Thus, students can study according to their respective schedules but still within the specified time limits. With this approach, students can learn independently but still get support from the teacher.

### 4.1.4. Evaluation

The module evaluation process uses pretest and posttest methods, to measure understanding and skills. The pretest was carried out at an early stage after the observation process [94]. The pretest was carried out by filling in 50 questions which were arranged based on graphic design competency. The implementation was carried out on 20 students from 10 different vocational schools that have VCD study programs in the West Java region. The implementation of this pre-test is aimed at seeing how far the graphic design competence of VCD study program students, especially class According to Ozyurt et al. [95], the teaching and learning process which is preceded by using the pre-test method and ends with a post-test aims to see the extent of cognitive development in students with the material that will and has been taught.

After implementing the digital module as an application of technology in improving VCD students' understanding and graphic design competency skills, a post-test was carried out to determine the level of success of the implementation. The post-test was carried out on the same sample, namely 20 students from 10 different vocational schools that have a VCD study program with the same questions or questions as those carried out in the pre-test phase. posttest is one of the important steps in the research process [96], is a test carried out to find out whether all material that is classified as important has been mastered as well as possible by students.

#### 4.1.4.1. Pretest results

Pretest Results Before the implementation begins, using digital modules as an application of pre-action analysis technology is carried out in the form of observations and tests as a basis for implementation and is also useful as a basis for information and assessment of the fine arts knowledge and skills possessed by VCD students to improve understanding and skills in graphic design competency.



The results of the pre-test conducted on 20 students from 10 different vocational schools. Based on the results of the pretest analysis before implementation using digital modules as a technology application, the average is in the Fair and Low categories.

#### **4.1.4.2. Posttest results**

Post-class implementation is an important stage in this series of research, where it can evaluate the effectiveness of implementation using digital modules on the understanding and graphic design competency skills of VCD students that have been implemented and identify changes or results achieved. Evaluation of implementation results is an important component, in collecting data regarding the achievement of graphic design competencies in improving VCD students' understanding and skills. This evaluation process includes analysis of individual student performance, as well as evaluating the results of VCD student achievement.

As a proactive step in understanding students' needs in improving graphic design competence as the main data for this research, this data collection was carried out through post-tests which were taken by the same 20 students from the same 10 schools with pre-tests as the target of action. This data can be the basis for answering research problems.

By analysing the results of this posttest and collecting data from the posttest results, researchers can ensure that learning to improve the graphic design competence of VCD students using digital modules as an application of technology can be achieved.

Based on the evaluation results, improvements were made to the module to improve its quality and effectiveness. The results of the pretest and post-test are used to optimize existing features and add elements deemed necessary to improve the learning experience.

## **4.2. Discussion**

Based on the results of implementation and evaluation, using digital modules as an application of technology in graphic design learning for VCD students has a significant positive impact on student learning outcomes. The designed web-based digital module provides access flexibility that allows students to learn anytime and anywhere. The use of various multimedia elements such as text, images, videos, and interactive animations helps students understand graphic design concepts more comprehensively. Interactive multimedia, such as video tutorials and simulations, has proven effective in increasing understanding and retention of learning material [97]. In this way, students can more easily understand graphic design theory and techniques through concrete and applicable visual demonstrations, especially in increasing understanding and skills. Through proper motivation and appreciation, students are successfully directed to the learning material with focus and enthusiasm. With learning facilities using digital modules plus effective support provided by teachers, including assessments that provide constructive feedback, it can have a positive impact on students' systematic mastery of competencies.

The learning outcomes of VCD students who achieved a good average score at the graphic design competency mastery stage are reflected in the excellent implementation success during the module implementation stage. In this way, the

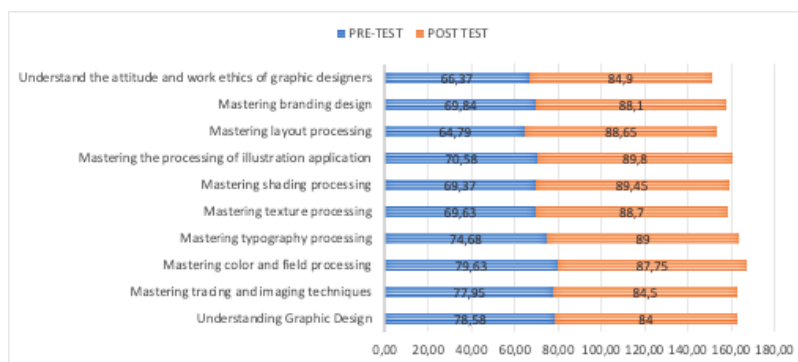
positive influence of implementing learning using digital modules as an application of technology in learning significantly improves the quality of learning achievement and increases the understanding and skills of VCD students [98]. The increase in student competence after implementing learning using digital modules can be seen in Table 9.

**Table 9. Condition of graphic design competency of VCD students before and after using digital modules.**

No.	Competencies	Category	
		Pre-use	Post-use
1	Understanding graphic design	Enough	Very good
2	Mastering tracking and imaging techniques	Enough	Very good
3	Mastering colour and field processing	Enough	Very good
4	Mastering typography processing	Enough	Very good
5	Mastering texture processing	Not enough	Very good
6	Mastering shading processing	Not enough	Very good
7	Mastering the processing of illustrations	Enough	
8	Mastering layout processing	Not enough	Very good
9	Mastering designing branding designs	Not enough	Very good
10	Understanding the attitude and work ethics of graphic designers	Not enough	Very good

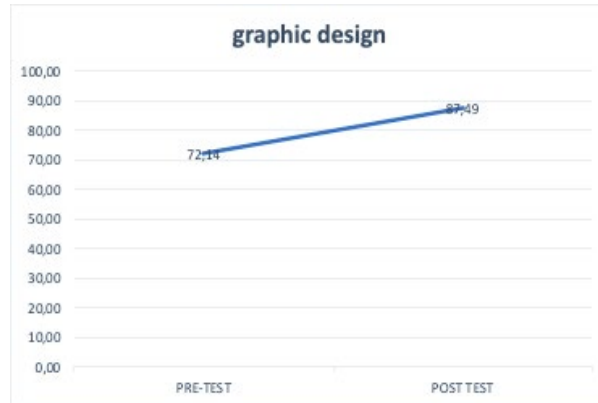
Data before using the digital module shows that aspects of graphic design competency tend to be poor on average, but after using it shows a significant increase in VCD student learning outcomes regarding graphic design competency, each competency has increased from poor to fair to very good. This increase can be seen from the understanding of the competencies mastered.

The condition of VCD students' graphic design competency after and before implementing the digital module is shown in the following Fig. 6. The picture above shows an increase of around 1-2 points in each competency. This means that each post-test participant showed an increase in 10 graphic design competencies, namely, understanding graphic design, mastering tracing and imaging techniques, mastering colour and field processing, mastering typography processing, mastering texture processing, mastering shading processing, mastering the processing and application of illustrations, mastering layout processing, mastering branding design, and understanding the attitude and work ethics of graphic designers.



**Fig 6. Graphic design competency after and before implementing the digital module.**

The condition of VCD students' learning conditions after and before implementing the digital module is shown in the following Fig. 7. In the graphic image you can see the average pre-test score is 72.14 which is in the sufficient category, while the average post-test result is 87.49 in the very good category. This shows an increase in DKV student learning outcomes in graphic design subjects by 15.35 points and an increase in the category from fair to very good.



**Fig 7. VCD students' learning conditions after and before implementing the digital module.**

The increase in learning outcomes is influenced by the intuitive and user-friendly UI/UX design of digital modules which is very important in supporting the learning process. An easy-to-navigate and visually appealing interface helps students access materials and assignments more easily and quickly. Studies show that a good user interface can increase student engagement and make it easier for them to understand the material presented [99]. In the context of digital graphic design learning modules, effective UI/UX design encourages students to focus on learning content without having to experience technical difficulties in navigation.

Dividing learning material into small modules that focus on one particular topic or skill helps students learn graphic design in a gradual and structured manner [100]. Modules integrated with practical exercises and step-by-step video tutorials allow students to immediately apply what they have learned. Research shows that structured, module-based learning can improve students' understanding and retention of subject matter.

The implementation of digital modules with good UI/UX design and interactive features has proven to have a positive impact on increasing students' understanding and graphic design skills [101]. Students can learn more effectively through multimedia interactions, get fast feedback, and be motivated by gamification elements. As a result, student learning outcomes improved significantly, as seen from increased assignment and project grades as well as a deeper understanding of graphic design concepts. So in general, efforts to improve the graphic design competence of VCD students by using digital modules as an application of technology have succeeded in creating positive synergies in helping students develop knowledge and skills. This paper also adds new information in the education, as reported elsewhere [102, 103].

## 5. Conclusion

Based on the research results, it is known that web-based digital modules designed and developed using the ADDIE approach have produced digital module products that can overcome problems in the graphic design learning process at VCD Vocational High Schools. The resulting web-based digital module provides various multimedia elements such as text, images, videos, and interactive animations, has a user-friendly UI/UX design, and an interface that is easy to navigate and visually attractive. With flexible access, this web-based digital module has helped students obtain material and assignments more easily and quickly, supporting the learning process. Thus, they can understand graphic design concepts more comprehensively. In general, the implementation of learning using web-based digital modules significantly improves the quality of students' understanding and skills which has implications for increasing their learning achievement in graphic design.

## References

1. Al Husaeni, D.N.; and Nandiyanto, A.B.D. (2023). A bibliometric analysis of vocational school keywords using VOSviewer. *ASEAN Journal of Science and Engineering Education*, 3(1), 1-10.
2. Fiandini, M.; Hoffifah, S.N.; Ragadhita, R.; and Nandiyanto, A.B.D. (2024). How to make a cognitive assessment instrument in the Merdeka curriculum for vocational high school students: A case study of generating device materials about the Stirling engine. *ASEAN Journal for Science Education*, 3(1), 65-86.
3. Gemil, K.W.; Na'ila, D.S.; Ardila, N.Z.; and Sarahah, Z.U. (2024). The relationship of vocational education skills in agribusiness processing agricultural products in achieving sustainable development goals (SDGs). *ASEAN Journal of Science and Engineering Education*, 4(2), 181-192.
4. Glushchenko, V.V. (2022). Ergo design of mentoring in the national ecosystem of vocational education in the period of the 10th technological order. *Indonesian Journal of Educational Research and Technology*, 2(3), 223-236.
5. Hashim, S.; Luta, G.R.A.; and Nincarean, D. (2024). Adaptive strategies for technical and vocational education and training (TVET) science educators: Navigating online home-based learning. *ASEAN Journal for Science Education*, 3(2), 113-128.
6. Joshua, A.B.; Olabo, O.O.; Ochayi, O.A.; Musiliu, A.A.; and Aderogba, O.A. (2022). Barriers limiting the use of google classroom for learning vocational and entrepreneurship courses. *ASEAN Journal of Science and Engineering Education*, 2(1), 61-74.
7. Minghat, A.D.; binti Mustakim, S.S.; and Shahroni, N. (2023). Current issue in the technical vocational education and training (TVET) instructor. *ASEAN Journal of Science and Engineering Education*, 3(2), 119-128.
8. Minghat, A.D.; Mustakim, S.S.B.; and Shahroni, N. (2022). Literature review: Technical and vocational education and training (TVET) in Malaysia. *ASEAN Journal for Science Education*, 1(2), 89-102.
9. Nurani, A.S.; Mahmudatussa'adah, A.; Karpin, K.; Juwaedah, A.; Setiawati, T.; and Muktiarni, M. (2024). Interactive multimedia design of motion graphics using a project-based learning approach for vocational education

- students: Experiments in cooking taliwang chicken. *ASEAN Journal of Science and Engineering Education*, 4(2), 163-174.
10. Nurhayati, A.; Patriasih, R.; Mahmudatusaadah, A.; and Muktiarni, M. (2024). Portfolio-based assessment in research methodology course students in vocational education. *Indonesian Journal of Multidisciplinary Research*, 4(1), 155-162.
  11. Rahmiyanti, H. (2024). Bibliometric analysis on artificial intelligence research in Indonesia vocational education. *ASEAN Journal for Science Education*, 3(2), 183-192.
  12. Shahroni, N.; Minghat, A.D.; and Mustakim, S.S.B. (2022). Competency index of technical vocational education and training (TVET) instructors for 4.0 industrial revolution. *ASEAN Journal of Educational Research and Technology*, 1(2), 155-162.
  13. Shahroni, N.; Minghat, A.D.; and Mustakim, S.S.B. (2022). Methodology for investigating competency index of technical vocational education and training (TVET) instructors for 4.0 industrial revolution. *ASEAN Journal for Science Education*, 1(1), 49-62.
  14. Putri, L.S.; Setiani, Y.; and Santosa, C.A.H.F. (2023). E-modul matematika berbasis problem based learning bermuatan pengetahuan budaya lokal untuk meningkatkan kemampuan pemecahan masalah. *Jurnal Education FKIP UNMA*, 9(2), 880-890.
  15. Hidayanti, N.; Supratman, S.; and Noviati, W. (2023). Pengembangan e-modul biologi berbasis problem based learning untuk meningkatkan literasi sains siswa. *Jurnal Kependidikan*, 8(1), 213-220.
  16. Rinaldo, J.; and Sukmayadi, Y. Pengembangan modul elektronik seni grafis untuk peserta didik SMA. *Gorga Jurnal Seni Rupa*, 12(1), 154-161
  17. Hendri, S.; Handika, R.; Kenedi, A.K.; and Ramadhani, D. (2021). Pengembangan modul digital pembelajaran matematika berbasis science, technology, engineering, mathematic untuk calon guru sekolah dasar. *Jurnal Basicedu*, 5(4), 2395-2403.
  18. Febrianti, K.V.; Bakri, F.; and Nasbey, H. (2017). Pengembangan modul digital fisika berbasis discovery learning pada pokok bahasan kinematika gerak lurus. *WaPFI (Wahana Pendidikan Fisika)*, 2(2), 18-26.
  19. Suryani, K.; Utami, I.S.; Khairudin, K.; Ariska, A.; and Rahmadani, A.F. (2020). Pengembangan modul digital berbasis stem menggunakan aplikasi 3D FlipBook pada mata kuliah Sistem Operasi. *Mimbar Ilmu*, 25(3), 358-367.
  20. Huang, C. (2005). Designing high-quality interactive multimedia learning modules. *Computerized Medical Imaging and Graphics*, 29(2-3), 223-233.
  21. Ismail, M.N.K.; Supeno, S.; and Rusdianto, R. (2024). Development of web-based modules to improve digital literacy and learning outcomes in science learning. *Jurnal Paedagogy*, 11(3), 451-461
  22. Bai, H.; Aman, A.; Xu, Y.; Orlovskaya, N.; and Zhou, M. (2016). Effects of web-based interactive modules on engineering students' learning motivations. *American Journal of Engineering Education*, 7(2), 83-96.
  23. Barron, A. (1998). Designing web-based training. *British Journal of Educational Technology*, 29(4), 355-370.

24. Ong, S.K.; and Mannan, M.A. (2004). Virtual reality simulations and animations in a web-based interactive manufacturing engineering module. *Computers & Education*, 43(4), 361-382.
25. Mehdipour, Y.; and Zerehkafi, H. (2013). Mobile learning for education: Benefits and challenges. *International Journal of Computational Engineering Research*, 3(6), 93-101.
26. Brown, M.; Dehoney, J.; and Millichap, N. (2015). The next generation digital learning environment. *A Report on Research. ELI Paper. Louisville, CO: Educause April*, 5(1), 1-13.
27. Fernández-López, Á.; Rodríguez-Fórtiz, M.J.; Rodríguez-Almendros, M.L.; and Martínez-Segura, M. J. (2013). Mobile learning technology based on iOS devices to support students with special education needs. *Computers & Education*, 61, 77-90.
28. Xie, K.; Kim, M.K.; Cheng, S.L.; and Luthy, N.C. (2017). Teacher professional development through digital content evaluation. *Educational Technology Research and Development*, 65(4), 1067-1103.
29. Song, S.J.; Tan, K.H.; and Awang, M.M. (2021). Generic digital equity model in education: Mobile-assisted personalized learning (MAPL) through e-modules. *Sustainability*, 13(19), 11115.
30. Smart, K.L.; and Cappel, J.J. (2006). Students' perceptions of online learning: A comparative study. *Journal of Information Technology Education: Research*, 5(1), 201-219.
31. Abi Hamid, M.; Aribowo, D.; and Desmira, D. (2017). Development of learning modules of basic electronics-based problem solving in Vocational Secondary School. *Jurnal Pendidikan Vokasi*, 7(2), 149-157.
32. Salim, S.; Rahmad P.; La M.; and Hendra N.S. (2022). Development of interactive digital modules based on augmented reality. *AL-ISHLAH: Jurnal Pendidikan*, 14(4), 5069-5078.
33. Fahmi, A.N.; Yusuf, M.; and Muchtarom, M. (2021). Integration of technology in learning activities: e-module on Islamic religious education learning for vocational high school students. *Journal of Education Technology*, 5(2), 282-290.
34. Nabayra, J.N. (2020). Video-based e-module for mathematics in nature and students' learning experiences in a flipped classroom. *Journal of Science & Mathematics Education in Southeast Asia*, 43(1), 1-21.
35. Tarigan, W.P.L.; Sipahutar, H.; and Harahap, F. (2021). The effect of interactive digital learning module on student's learning activity and autonomy. *BIOEDUKASI: JPB*, 14(2), 196-208.
36. Johan, R.C.; Rullyana, G.; and Ardiansah, A. (2022). Hyper content e-module in information behavior course with the assistant of screencast. *Journal of Education and Learning (EduLearn)*, 16(2), 210-218.
37. Delita, F.; Berutu, N.; and Nofrion, N. (2022). Online learning: The effects of using e-modules on self-efficacy, motivation and learning outcomes. *Turkish Online Journal of Distance Education*, 23(4), 93-107.
38. Jovanović, V.; Kuzlu, M.; Popescu, O.; Katsioloudis, P.; Vahala, L.; Wu, M.; dan Addison, M. (2022). Digital educational modules development for the

- career and technical cybersecurity pathways during the COVID-19 pandemic. *Technology Interface International Journal*, 22(2), 22-34
39. Rusli, R.; Talib, A.; Musa, H.; Rahman, A.; and Ismail, N.I. (2023). The development of web-based e-modules in class xi marching materials on SMA Negeri 11 Pinrang. *ARRUS Journal of Social Sciences and Humanities*, 3(5), 695-701.
  40. Spatioti, A.G.; Kazanidis, I.; and Pange, J. (2022). A comparative study of the ADDIE instructional design model in distance education. *Information*, 13(9), 402.
  41. Wirahyuni, K.; Suandi, I.N.; Martha, I.N.; dan Sudiana, I.N. (2021). Validity and reliability of a digital-based affective evaluation instrument on Indonesian MPK learning at Ganesha University of Education. *International Journal of Early Childhood Special Education*, 13(2), 1138-1145.
  42. Kurniawan, A. (2018). Tantangan dan solusi dalam pembelajaran desain komunikasi visual di SMK. *Jurnal Pendidikan Vokasi*, 8(2), 157-170.
  43. Yap, W.L.; Neo, M.; and Neo, T.K. (2014). Impact of learner-centred teaching environment with the use of multimedia-mediated learning modules in improving learning experience. *Jurnal Teknologi (Sciences and Engineering)*, 68(2), 65-71.
  44. Neo, M.; Park, H.; Lee, M.J.; Soh, J.Y.; and Oh, J.Y. (2015). Technology acceptance of healthcare e-learning modules: a study of Korean and Malaysian students' perceptions. *Turkish Online Journal of Educational Technology-TOJET*, 14(2), 181-194.
  45. Yang, C.M.; and Hsu, T.F. (2017). New perspective on visual communication design education: an empirical study of applying narrative theory to graphic design courses. *International Journal of Higher Education*, 6(2), 188-198.
  46. He, F. (2017). Industrial product graphic design based on visual communication concept. *Acta Technica CSAV (Ceskoslovensk Akademie Ved)*, 62(1), 269-278.
  47. Lu, L.; and Huang, L. (2022). Exploration and application of graphic design language based on artificial intelligence visual communication. *Wireless Communications and Mobile Computing*, 2022(1), 9907303.
  48. Schill, D. (2012). The visual image and the political image: A review of visual communication research in the field of political communication. *Review of communication*, 12(2), 118-142.
  49. Kelly, M. (2015). Visual communication design as a form of public pedagogy. *Australian Journal of Adult Learning*, 55(3), 390-407.
  50. Nugrahani, R.; dan Wibawanto, W. (2019). Visual communication design learning in educational institution: has it been disrupted?. *PEOPLE International Journal of Social Sciences*, 4(3), 1039-1055.
  51. Jiawei, W.; and Mokmin, N.A.M. (2023). Virtual reality technology in art education with visual communication design in higher education: a systematic literature review. *Education and Information Technologies*, 28(11), 15125-15143.
  52. Zhang, C.; and Zhao, Y. (2023). Design and application of multimedia technology - based curriculum for visual communication majors. *Advances in multimedia*, 2023(1), 1-11.
  53. Shing-Sheng, G.U.A.N.; and Lu, A.P.D.L.S. (2012). A study on curriculum structure and industry requirement of design education in Taiwan.

- International Journal on New Trends in Education & their Implications (IJONTE)*, 3(3), 27-37.
54. Barnhurst, K.G.; Vari, M.; and Rodríguez, Í. (2004). Mapping visual studies in communication. *Journal of Communication*, 54(4), 616-644.
  55. Marzaman, A. (2013). Indonesia's Creative Industry towards the ASEAN Economic Community. *Journal of World Trade Studies*, 4(1), 67-79.
  56. Palla, J.; and Kainoa S. (2021). Efforts to improve the creative economy during the COVID-19 pandemic in ASEAN countries. *Journal of Asian Multicultural Research for Economy and Management Study* 2(1), 49-53.
  57. Chen, S.Y.; Lai, C.F.; Lai, Y.H.; and Su, Y.S. (2022). Effect of project-based learning on development of students' creative thinking. *The International Journal of Electrical Engineering and Education*, 59(3), 232-250.
  58. Simanjuntak, M.P.; Hutahaean, J.; Marpaung, N.; and Ramadhani, D. (2021). Effectiveness of problem-based learning combined with computer simulation on students' problem-solving and creative thinking skills. *International Journal of Instruction*, 14(3), 519-534.
  59. Guan-Chen, L.; and Ko, C.H. (2021). Photoshop and illustrator use in instructional design: a case study of college visual communication course design. *The International Journal of Design Education*, 15(1), 119-130
  60. Creativani, K. (2023). Exploring the potential of visual communication design education: transforming education paradigm. *Visual Heritage: Jurnal Kreasi Seni dan Budaya*, 5(2), 281-289.
  61. Kurniawan, D. (2018). Analisis kebutuhan bahan ajar desain grafis di SMK Negeri 2 Yogyakarta. *Jurnal Pendidikan Vokasi*, 8(1), 45-56.
  62. Meyers, F. (2007). Engineering design graphics: Into the 21st century. *The Engineering Design Graphics Journal*, 71(3), 20-34
  63. Enniful, E.K.; and Boakye-Amponsah, A. (2022). The influence of technology education on the graphic design programme at Takoradi Technical University. *International Journal of Education, Learning and Development*, 10(2), 30-47.
  64. Parrish, P.E. (2005). Embracing the aesthetics of instructional design. *Educational Technology*, 45(2), 16-25.
  65. Kınık, M.; Topaklı, A.; and Özkan, H. (2016). The evaluation of web design education materials used in vocational education in the aspect of graphic design education. *Uluslararası Beşeri Bilimler ve Eğitim Dergisi*, 2(1), 144-153.
  66. Kimball, M.A. (2013). Visual design principles: An empirical study of design lore. *Journal of Technical Writing and Communication*, 43(1), 3-41.
  67. Riyanti, M.T.; Erwin, T.N.; and Suriani, S.H. (2017). Implementing project based learning approach to graphic design course. *Journal of Education and Practice*, 8(15), 173-177.
  68. Siregar, B. (2019). Penggunaan perangkat lunak desain dalam pembelajaran desain grafis di SMK. *Jurnal Pendidikan Vokasi*, 11(3), 104-115.
  69. Carey, C.; and Naudin, A. (2006). Enterprise curriculum for creative industries students: An exploration of current attitudes and issues. *Education+ Training*, 48(7), 518-531.



70. Dur, B.I.U. (2014). Data visualization and infographics in visual communication design education at the age of information. *Journal of arts and humanities*, 3(5), 39-50.
71. Yang, M.Y.; You, M.; and Chen, F.C. (2005). Competencies and qualifications for industrial design jobs: implications for design practice, education, and student career guidance. *Design studies*, 26(2), 155-189.
72. Sutrisno, A. (2020). Pengembangan materi pembelajaran desain grafis untuk SMK. *Jurnal Inovasi Pendidikan*, 8(2), 34-47.
73. Gustiani, S. (2019). Research and development (R&D) method as a model design in educational research and its alternatives. *Holistics (Hospitality and Linguistics): Jurnal Ilmiah Bahasa Inggris*, 11(2), 12-22.
74. Umar, U.; Purwanto, M.B.; and Al Firdaus, M.M. (2023). Research and development: as the primary alternative to educational research design frameworks. *Journal of English Language and Literature*, 8(1), 73-82.
75. Rahardjanto, A.; and Husamah, H. (2022). Publication trend of R&D in the journal of biological education in Indonesia (Sinta 2: 2017-2021): A systematic literature review. *Prisma Sains: Jurnal Pengkajian Ilmu dan Pembelajaran Matematika dan IPA*, 10(1), 21-35.
76. Najuah, N.; Sidiq, R.; and Lukitoyo, P. S. (2021). The development electronic module of history using ADDIE model. *International Journal of Educational Research & Social Sciences*, 2(6), 1658-1663.
77. Stapa, M.A.; and Mohammad, N.A.Z.E.R.I. (2019). The use of Addie model for designing blended learning application at vocational colleges in Malaysia. *Asia-Pacific Journal of Information Technology and Multimedia*, 8(1), 49-62.
78. Ghani, M.T.A.; and Daud, W.A.A.W. (2018). Adaptation of ADDIE instructional model in developing educational website for language learning. *Global Journal Al-Thaqafah*, 8(2), 7-16.
79. Peterson, C. (2003). Bringing ADDIE to life: Instructional design at its best. *Journal of Educational Multimedia and Hypermedia*, 12(3), 227-241.
80. Adeoye, M.A.; Wirawan, K.A.S.I.; Pradnyani, M.S.S.; and Septiarini, N.I. (2024). Revolutionizing education: Unleashing the power of the ADDIE model for effective teaching and learning. *JPI (Jurnal Pendidikan Indonesia)*, 13(1), 202-209
81. Weiss, R.E.; Knowlton, D.S.; and Morrison, G.R. (2002). Principles for using animation in computer-based instruction: Theoretical heuristics for effective design. *Computers in Human Behavior*, 18(4), 465-477.
82. Revere, L.; and Kovach, J.V. (2011). Online technologies for engaged learning a meaningful synthesis for educators. *Quarterly Review of Distance Education*, 12(2), 113-124.
83. Ortega-Arranz, A.; Er, E.; Martínez-Monés, A.; Bote-Lorenzo, M.L.; Asensio-Pérez, J.I.; and Muñoz-Cristóbal, J.A. (2019). Understanding student behavior and perceptions toward earning badges in a gamified MOOC. *Universal Access in the Information Society*, 18(3), 533-549.
84. Ametordzi, S.; and Olalere, F.E. (2024). The effect of digital technology on graphic design ideation output. *IDA: International Design and Art Journal*, 6(1), 144-156.

85. Noetel, M.; Griffith, S.; Delaney, O.; Harris, N.R.; Sanders, T.; Parker, P.; and Lonsdale, C. (2022). Multimedia design for learning: An overview of reviews with meta-meta-analysis. *Review of Educational Research*, 92(3), 413-454.
86. Virtanen, M.A.; Kääriäinen, M.; Liikanen, E.; and Haavisto, E. (2017). The comparison of students' satisfaction between ubiquitous and web-based learning environments. *Education and Information Technologies*, 22(5), 2565-2581.
87. Menkhoff, T.; Tze Yian, T.; Yue Wah, C.; and Yue Kee, W. (2011). Engaging knowledge management learners through web - based ICT: an empirical study. *Vine*, 41(2), 132-151.
88. Logan, R.M.; Johnson, C.E.; and Worsham, J.W. (2021). Development of an e-learning module to facilitate student learning and outcomes. *Teaching and Learning in Nursing*, 16(2), 139-142.
89. Ramli, R.; Sahari, N.; Noor, S.M.; Noor, M.M.; Majid, N.A.; Dahlan, H.; and Wahab, A.A. (2022). Assessing usability of learning experience prototype. *International Journal of Emerging Technologies in Learning (iJET)*, 17(9), 20-36.
90. Beverland, M.B. (2005). Managing the design innovation–brand marketing interface: Resolving the tension between artistic creation and commercial imperatives. *Journal of Product Innovation Management*, 22(2), 193-207.
91. Ames, C. (1992). Classrooms: Goals, structures, and student motivation. *Journal of educational psychology*, 84(3), 261.
92. Albassam, A.; and Zaharudin, R. (2023). Development of a mobile learning app for the Arabic grammar course for third-intermediate students in Saudi Arabia. *International Journal of Academic Research in Progressive Education and Development*, 12(3), 1520-1536.
93. Budoya, C.; Kissaka, M.; and Mtebe, J. (2019). Instructional design enabled agile method using ADDIE model and feature driven development method. *International Journal of Education and Development using ICT*, 15(1), 35-54.
94. Darmuki, A.; Nurkamto, J.; and Saddhono, K. (2017). Evaluating information-processing-based learning cooperative model on speaking skill course. *Journal of Language Teaching & Research*, 8(1), 44-51.
95. Ozyurt, M.; Kan, H.; and Kiyikci, A. (2021). The Effectiveness of understanding by design model in science teaching: A quasi-experimental study. *Eurasian Journal of Educational Research (EJER)*, 94, 1-24.
96. Rausch, J.R.; Maxwell, S.E.; and Kelley, K. (2003). Analytic methods for questions pertaining to a randomized pretest, posttest, follow-up design. *Journal of Clinical Child and Adolescent Psychology*, 32(3), 467-486.
97. Mayer, R.E. (2017). Using multimedia for e - learning. *Journal of computer assisted learning*, 33(5), 403-423.
98. Jethro, O.O.; Grace, A.M.; and Thomas, A.K. (2012). E-learning and its effects on teaching and learning in a global age. *International Journal of Academic Research in Business and Social Sciences*, 2(1), 203.
99. Asri, F.H.M.; Singh, D.; Mansor, Z.; and Norman, H. (2024). A review of cross-cultural design to improve user engagement for learning management system. *KSII Transactions on Internet and Information Systems (TIIS)*, 18(2), 397-419.

100. Sung, K.; Hillyard, C.; Angotti, R.L.; Panitz, M.W.; Goldstein, D.S.; and Nordlinger, J. (2010). Game-themed programming assignment modules: A pathway for gradual integration of gaming context into existing introductory programming courses. *IEEE Transactions on Education*, 54(3), 416-427.
101. Hasugian, L.P.; and Rusmana, D.A.L.I.H. (2021). Development of UX Orbit design online courses platform in the field of user interface (UI) and user experience (UX). *Journal of Engineering Science and Technology*, 16(3), 2454-2463.
102. Susilawati, A.; Al-Obaidi, A.S.M.; Abduh, A.; Irwansyah, F.S.; and Nandiyanto, A.B.D. (2024). How to do research methodology: From literature review, bibliometric, step-by-step research stages, to practical examples in science and engineering education. *Indonesian Journal of Science and Engineering*, 10(1), 1.
103. Solihat, A.N.; Dahlan, D.; Kusnendi, K.; Susetyo, B.; and Al-Obaidi, A.S.M. (2024). Artificial intelligence (AI)-based learning media: Definition, bibliometric, classification, and issues for enhancing creative thinking in education. *ASEAN Journal of Science and Engineering*, 4(3), 349-382.