Learning the Basic Skills in Digital Electronics Technology: An Interactive Web-based Application for Pre-Service Technical-Vocational Educators

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Abstract. The utilization of interactive web-based learning has gained popularity as an effective tool in the academe. This method combines online platforms, multimedia resources, and interactive activities to enhance the learning experiences of the learners. Interactive web-based learning enables the student to actively engage with educational content in dynamic and immersive ways, leading to a more profound understanding of the subject matter, and offers flexibility in terms of time and location, allowing students to access learning materials and participate in activities at their own pace and convenience. This research is focused on the Development and Assessment of Interactive Web-based Application for Digital Electronics Technology (IWA – DET) under the degree of Bachelor of Science in Industrial Education. This program is related to Technical and Vocational Education (TechVoc) Track of the K-12 curriculum. The study utilized a Descriptive-Developmental research design using ADDIE model for the Instructional design. IWA-DET is evaluated by the IT experts, Pedagogical Experts, Digital Electronics Technology Professor, ten (10) teachers, and thirty (30) BSIE students. The design of the developed IWA-DET come up with the set of criteria for application standard and accessibility of website platform as reflected to its components. After analysing and tabulating the responses, the researcher found that no modifications were required for the development and assessment of IWA-DET. The Digital Electronics Technology Professor commended the functionality of IWA-DET, as it offers a higher degree of learning for students by demonstrating their activeness during implementation. Students enjoyed using IWA-DET, as it helped them acquire the knowledge and skills, they needed in their Digital Electronics Technology subject. They expressed interest in utilizing IWA-DET due to its ability to demonstrate various learning activities and approaches that can increase their knowledge and skills in the subject. IWA-DET provides an engaging learning experience that can capture students' attention and encourage them to interact more with the course material.

Keywords: Digital Electronics Technology, interactive web-based learning, pre-service technical-vocational teacher, industrial arts, e-learning

1   Introduction

The presence of technology in the classroom is vital as it provides instant access to information. Making technology a tool to improve learning in a subject area or cross-disciplinary setting is called "curriculum integration". Technology should be integrated into the classroom and be as available as all other teaching resources.

According to CHED Memo-randum No. 78, s.2017, The technological pedagogical content knowledge courses aim to provide students with a wide range of skills for facilitating and evaluating learning among diverse types of students in various learning settings. ICT integration in teaching is an essential component of methods and strategies courses that aim to provide teachers with technology-based teaching and training skills (Mateo, 2021).

The use of various types of technology in the classroom, including web-based learning, enables all the student participants to give their views on the particular topic and then discuss them further. It promotes active and student-centered learning (Angeles, 2023). In Web-Application, users can access the application through any web browser they prefer, removing the need for being physically present or having specific hardware needs. This get-to enables remote work, teamwork, and easy access to information and services while on the move (Aljraiwi, 2017).

Academics have recently seen a proliferation of web-based learning applications. Web-based learning is often referred to as e-learning. Web-based contexts have greatly facilitated learning by expanding spatial and temporal barriers. Chandra (2022) describes that a virtual learning environment (VLE) is usually for discussion boards, chat rooms, and online ratings. When the Internet is used to provide instructions, known as the "Internet of Things", it improves the accessibility of learning resources. A visual and interactive web-based environment provides new energy to enhance learning through instruction.

The researcher conducted a survey of 60 Bachelor of Science in Industrial Education students from the College of Education at Nueva Ecija University of Science and Technology. It was discovered that learning the fundamental knowledge and skills in digital electronics technology is one of the least understood subjects by students during the second semester of their third year, the 2021-2022 academic year. This is supported by the findings of Myers (2017), where students find electronic subjects difficult to understand when they are not being explained or presented very clearly and lack visual feedback. Therefore, a careful and innovative design of web-based application for digital electronics technology subject is needed.

To engage learners in learning digital electronics technology, the researcher seeks to design, develop, and assess a web-based application for teaching and learning digital electronics technology subject.

The development of a web-based program aims to allow an interactive web-based application for students to learn the basic knowledge and skills in digital electronics technology and further increase their learning interest in the subject. To meet these aims, this web-based application is developed with the following essential features: 1) Secured with a password, 2) Interactive Presentations, 3) Online Assessments, 4) Real-time Reports, 5) Printable Format, 6) User-friendly, and 7) Smart Phone Accessibility.

The researchers aim to design and develop an Interactive Web-Based Application that will engage Bachelor of Science in Industrial Education students to think critically at a higher level, enhance their attention span, and serve as a pedagogical tool in Digital Electronics Technology.

Objectives of the Study

The purpose of this study was to develop, validate, and assess an Interactive Web-Based Application in Digital Electronics Technology.

It aims to provide solutions to the following queries in particular:

1. How may the competencies presented in the IWA - DET be described according to:

1.1   CHED Memo No. 78 and No. s2020;

1.2   time allocation; and

1.3   skills presented?

2. How may the design of IWA - DET be described considering;

2.1 components; and

2.2 application standards?

3. How may the development of IWA - DET be described in terms of:

3.1   content development; and

3.2   procedure of development?

4. How may the implementation of IWA - DET be described as received by:

4.1   teacher; and

4.2   students?

5. How may the IWA - DET be assessed according to;

5.1   content and design;

5.2   functionality;

5.2.1 usability

5.2.2 reliability

5.2.3 security

5.2.4 maintainability

5.2.5 portability; and

5.3   instructional use?

2   Methodology

2.1   *Design.* The research employed a quantitative approach with a descriptive-developmental research design. Unlike straightforward instructional development, developmental research involves a systematic exploration of designing, crafting, and assessing instructional programs, processes, and products, ensuring they meet internal consistency and effectiveness standards. The aim of this research is to design, validate, and assess instructional materials for teaching and studying digital electronics technology via a web-based application. The IWA-DET was crafted utilizing Pappus' ADDIE model of instructional development, as referenced by Angeles (2023)..

2.2   *Research Instrument.* Researchers used validated instruments that were adopted and revised accordingly from existing research conducted by Angeles (2023). This study used i) Questionnaire for assessment of the content and design of IWA-DET for Digital Electronics Technology Professor and Pedagogical Expert; ii) Application Evaluation for IT expert; iii) Observation protocol for teachers; and iv) Interview Guide for BSIE students.

2.3   *Data Analysis.* The information collected at each stage underwent description and analysis employing the subsequent framework or statistical methodology:

1. The learning competencies outlined for the Digital Electronics Technology course provided by the College of Education, NEUST, will undergo thorough comparison with those mandated by the Commission on Higher Education, as per the guidelines stipulated in CHED Memorandum Order No. 78 and No. 4 series of 2017 and 2020. Additionally, the time allotted for utilizing interactive web-based applications will be scrutinized.

2. This IWA-DET was designed in accordance with the components and application standards. This IWA-DET's primary components are as follows: introduction, learning outcome, learning competencies, video discussion, learning module, assessment, scoring, and analytics. In elucidating the application standards, the alignment between established standards and the IWA-DET was deliberated upon. These standards encompassed: i) CHED Memoranda, ii) Philippine Professional Standards for Teachers (PPST), and iii) Product Quality Standards. The following framework will be used to describe the IWA-DET's coherence to these standards.

Table 1. Framework for the Application Standards

Policies and Standards	Section
CHED Memoranda	*Adhering to CHED Memorandum NO. 78, series of 2017:* a. *Section 5.3 (Program Goals); and* b. *Section 7 (Performance Indicators)* *In compliance to CHED Memorandum No. 4, series of 2020* a. *Section IV (General Guidelines in the Implementation of Flexible Learning);* b. *Section V (Various Modalities in the Implementation of Flexible Learning and Teaching)*

Philippine Professional Standards for Teachers (PPST)	In accordance with the Philippine Professional Standards for Teachers (PPST) outlined in:
	a. Domain 1: content Knowledge and Pedagogy;
	b. Domain 2: Learning Environment;
	c. Domain 4: Curriculum and Planning; and
	d. Domain 5: Assessment and Reporting
Product Quality Standards	In compliance with:
	a. Usability
	b. Reliability
	c. Security
	d. Maintainability
	e. Portability

3. To the development of the IWA-DET, two crucial aspects need to be considered: content development and procedural development. In terms of content development, extensive efforts were made to create and refine the application's essential components, ensuring accurate and relevant information was presented to users. On the procedural side, step-by-step procedures on how the newly programmed interactive web-based application is effectively used in different views of the system (teacher view and student view). By addressing both content and procedural aspects, the development of this application aimed to offer users a comprehensive and user-friendly tool for exploring the intricacies of digital electronics technology.

4. An interview guide was used to collect data for describing the IWA-DET's implementation. This guide was the primary tool for gathering useful insights and facts from participants. During this phase, the answers provided by participants on the IWA-DET were also used as a data source. By incorporating both the interview guide data and the user responses into the application, a thorough understanding of the implementation process was gained, allowing for informed decision-making and future enhancements.

5. During the evaluation stage, the content, design, functionality, and instructional use were evaluated. The IT expert used the Application Evaluation framework from ISO 25010 Product Quality Standards to comprehensively evaluate the technical aspects and ensure adherence to recognized quality standards. The teachers involved in the evaluation used an observation protocol to assess the practicality and effectiveness of the IWA-DET in an instructional environment. A scale was used to evaluate the content and design of the IWA-DET by a professor of digital electronics technology and a pedagogical expert.

3   Results and Discussions

The creation of the IWA-DET adheres to the ADDIE Model of Instructional Design, progressing through the following phases.

3.1. Analysis Phase

In this stage, the learning competencies within the Bachelor of Technology and Livelihood Education and Bachelor of Industrial Education curriculum underwent assessment following the guidelines established by the Commission on Higher Education

(CHED). Moreover, the allocation of time for each course topic underwent scrutiny to confirm compliance with the Commission's stipulations, as outlined in CHEd Memorandum No. 78, series of 2017. This adherence to CHED guidelines was evident in the Course Syllabi for the aforementioned courses as maintained by the College of Education.

Interviews among Industrial Arts and Digital Electronics teachers were conducted to understand if they experienced using a Web-based Application in delivering the content of the course, particularly Digital Electronics Technology. Despite this, Instructors admitted that they have not tried using this type of technology due to its demanding nature and complex system; it was considered too difficult to design or even utilize this mode in teaching lessons. They also stated that there is no available Web-based Application for the competencies of Digital Electronics Technology.

Based on the data stipulated, the researcher determined that it is necessary to create a web-based application to deliver the course's content.

The digital electronics technology lessons were combined into self-learning modules, and video discussions were merged through interactive web-based applications to gain fundamental knowledge of digital electronics technology. According to Babić (2016), e-based learning allows participants to interact with one another via the internet. Educators can design and create an instructive learning environment, a constructive learning environment, a socially constructive learning environment, or a combination of the three for their students.

3.2. Design Phase

3.2.1 Components. Certain aspects of this IWA-DET were borrowed from Angeles (2023). These adopted elements, combined with fresh additions in each learning unit, comprised: Introduction, Course Outcome, Learning Competencies, Video Discussion, Learning Modules, Assessment, and Generalization. These components were augmented to function as the concluding requisites for participants to fulfill upon completion of three units.

3.2.2 Application Standards. To guarantee that this Interactive IWA-DET fosters high-quality learning and adheres to the standards established by various quality assurance entities and policymakers, it was created in alignment with the policies and standards outlined by Alvarez & Galman (2021). These policies and standards encompass: a) CHEd Memoranda as reflected in CHEd Memo No. 78, series of 2017, and CHEd Memo No. 4, series of 2020, b) Philippine Professional Standards for Teachers (PPST), and c) Policies and Web Based-Application Development Standards.

3.3 Develop Phase

At this stage, the contents of the IWA-DET were written, adhering to the template established during the design phase.

3.3.1 Material and Procedural Aspects

During the development of the IWA-DET, the researcher consulted Industrial Arts teachers and his adviser. They reviewed the initial draft and commented that the presentation was too dull, consisting solely of text, and needed illustrative representations. The first draft was then revised to incorporate their suggestions. The second draft was

presented to the teachers and adviser for further feedback and recommendations. The readability and time allocation of the IWA-DET were tested among BSIE students from participating schools using the SPARTA Project of the Department of Science and Technology and a study by Galman and Del Rosario (2021).

3.4. Implementation Phase

At this stage, the third draft of the IWA-DET was tested on third-year Bachelor of Science in Industrial Education students at the College of Education, NEUST, who are currently enrolled in Digital Electronics Technology. The students involved in the implementation were informed about how the IWA-DET would be implemented, as well as how to use it. During the IWA-DET implementation, instructors/professors of digital electronics technology and industrial arts from the same college and university acted as observers.

Unit 1: Binary Systems and Logic Circuits was successfully completed by the researcher and the students. The researcher conveyed the unit's introduction, which the students understood clearly. The course outcome and learning competencies were stated simply and clearly. The students successfully completed the assessment. However, only a small number of students received a perfect score; thus, there is still room for improvement in terms of students' knowledge of the lessons "Number System, The Binary Number System: Its History, Applications and Advantages, and Logic Gates." In the video discussion, the lessons were thoroughly discussed, and examples were provided to clarify further the concepts covered in the lessons. In general, the guide questions were presented during the video discussion, and the teacher-observers made no suggestions for teaching the concepts of Binary Systems and Logic Circuits.

Unit 2: The researcher and students successfully completed the units on Boolean Algebra and the Mapping Method. The introduction provided by the researcher was well received, and the learning skills and course outcomes were presented clearly and concisely. Students fully understood the evaluation procedures during the assessment activities. However, while over 70% of students achieved nearly perfect scores, indicating a good grasp of the topic, there remains room for improvement in their understanding of Boolean Algebra and the Mapping Method. The topic was thoroughly discussed, with examples provided to clarify the concepts. Overall, the guidance questions were answered correctly, and the instructor-observers had no suggestions for improving the teaching of the fundamental concepts of Boolean Algebra and the Mapping Method.

Unit 3: The researcher and students successfully completed the unit on Logic Functions and Realization with MSI Circuits. The researcher provided an excellent introduction, which the students found extremely useful and informative. The learning skills and course outcomes were presented simply and straightforwardly. The students demonstrated a solid understanding of the evaluation technique during the assessment exercises. However, while the majority of students received near-perfect scores, indicating sufficient understanding of the topic, there is still room for improvement in their mastery of "Logic Functions, Realization with MSI Circuits." The topic was thoroughly examined during the discussion, with examples provided to help participants understand the issues. Overall, the guide questions were correctly answered.

The Interactive Web-Based Application (IWA-DET) was successfully completed when evaluated as a whole. Through the implementation of IWA-DET, the teacher-observers noted the presence of a novelty in teaching principles and applications in Digital Electronics Technology. This implementation phase resulted from the successful prior stages of analysis and design, as noted by Galman and Del Rosario (2021). According to the results collected from student scores, it is clear that these features are appropriate and viable, implying that any modifications or retentions should be done with extreme caution.

3.5. Evaluation Phase

Every stage underwent assessment to ensure compliance with pertinent standards and procedures. The Analysis phase strictly adhered to the Gantt Chart. In the Design phase, previously neglected elements were rectified. Actual content creation occurred during the Development phase, aligned with the design, while guidelines were meticulously reviewed in the Implementation phase. Qualitative analysis was employed for evaluating each phase, with insights drawn from the research of Galman and Del Rosario (2021). This approach emphasizes the importance of the assessment phase in design studies as it identifies areas for improvement and establishes domain-specific standards and advocates for using qualitative analysis to better understand the effectiveness of the design.

3.5.1 Evaluation of the Content of the IWA-DET

Table 2. Summary of evaluation on the content of IWA-DET by Digital Electronics Technology Professor and Pedagogical expert

Components	Unit 1	Unit 2	Unit 3	WM	Qualitative Rating
1. The introduction is parallel to the Discussion Proper	2.90	2.93	2.97	2.93	Very Good
2. Statement of the course outcome	2.83	2.90	2.93	2.89	Very Good
3. Appropriateness of Learning Competencies	2.90	2.93	3.00	2.94	Very Good
4. Video Discussion	2.83	2.97	2.93	2.91	Very Good
5. Learning Module	2.90	2.90	2.97	2.92	Very Good
6. Assessment and Scoring	2.93	2.93	2.93	2.93	Very Good
7. Generalization	2.93	2.97	2.93	2.94	Very Good
Grand Mean Rating	*2.89*	*2.93*	*2.95*	*2.93*	*Very Good*
Qualitative Rating	*Very Good*	*Very Good*	*Very Good*	*Very Good*	

Table 2 shows the results of the assessment of Digital Electronics Technology Professor and Pedagogical Expert based on the IWA-DET Content. Unit 1, which covered binary systems and logic circuits, received an average rating of 2.89 (Very Good) based on IWA-DET content. No additional recommendations were provided for modifying or revising any section of the aforementioned IWA-DET unit. The experts praised the video discussion of the learning content.

Meanwhile, the topic of Boolean algebra and mapping methods in Unit 2 received a mean rating of 2.93 (Very Good), with the design of the IWA-DET as the focus. There are no further suggestions for modifying or revising any part of the aforementioned IWA-DET unit. The experts identified the well-structured and learning module and engaging video discussion because it helps learners to perform the task without hesitation and confusion easily.

Unit 3 covers the topic of logic function realization using MSI circuits. had a mean rating of 2.95 (Very Good), with the IWA-DET content being the primary focus. There are no further suggestions for modifying or revising any part of the aforementioned IWA-DET unit. The experts acknowledged the video discussion's engaging tone and the modules' learning-centered nature.

In summary, according to the evaluations from the designated experts, the content of the IWA-DET received an average rating of 2.93, which was verbally described as "Very Good." The experts commended the mastery of the content, the pedagogical approaches employed, and the skills demonstrated. One evaluator even remarked that the application is well-endowed with the necessary knowledge, skills, and pedagogical methods for the subject.

3.5.2. Evaluation of the Design of the IWA-DET

Table 3. Summary of evaluation on the content of IWA-DET by Digital Electronics Technology Professor and Pedagogical expert

Components	Unit 1	Unit 2	Unit 3	WM	Qualitative Rating
1. The Introduction effectively communicates the lesson/unit's idea and content.	2.90	2.90	2.97	2.92	Very Good
2. There is coherence between the Learning Competencies and the course outcome.	2.90	2.93	2.93	2.92	Very Good
3. The learning competencies clearly convey the lesson/unit's idea and content, guiding towards achieving the course outcome.	2.80	2.93	2.97	2.90	Very Good
4. The Video Discussion effectively communicates the lesson/unit's idea and content, guiding towards achieving the learning competencies.	2.97	2.87	2.90	2.91	Very Good
5. The Learning Module contents are pertinent and correspond with the learning objectives, aims, and goals of the subject.	2.87	2.97	2.93	2.92	Very Good
6. The formulation of guide questions is precise and lucid, aiding students in reaching the Generalization.	2.90	2.93	2.90	2.91	Very Good
7. Provision of Scoring	2.93	2.93	3.00	2.96	Very Good
Grand Mean Rating	**2.90**	**2.92**	**2.94**	**2.92**	**Very Good**
Qualitative Rating	**Very Good**	**Very Good**	**Very Good**	**Very Good**	

Table 3 shows the result of the assessment of Digital Electronics Technology Professor and Pedagogical Expert considering the design of the IWA-DET.

Unit 1 received a mean content rating of 2.90 (Very Good) from the three evaluators in Binary Systems and Logic Circuits. They made no suggestions for modifying or revising the IWA-DET's specific unit.

Unit 2 received a mean content rating of 2.92 (Very Good) from the three evaluators in Boolean Algebra and Mapping Methods. There were no revisions or suggestions in this IWA-DET unit.

Unit 3 received a mean content rating of 2:94 (Very Good) from the three evaluators in Logic Function Realization with MSI Circuits. No modifications or recommendations were given.

To sum up, based on the evaluations of the identified experts, the design of the IWA-DET received a grand mean rating of 2.92 verbally interpreted as Very Good. The experts highly praised the proponent's content, as well as his pedagogies in delivering the content and skills. One of the evaluators even stated that the design used in the construction of this IWA-DET should serve as the foundation for the University's future learning management system/a tool for engaging students and improving educational materials. Finally, the experts praise the IWA-DET's design, particularly its video discussion and learning module. They commented that there should be no plagiarism of the application's image and graphics.

3.5.3. Evaluation of the Utilization of Instructional Methods

This section examines the Assessment of Instructional Utilization as evaluated by both Industrial Arts Instructors and Students.

3.5.3.1. Evaluation of Instructional Utilization by Industrial Arts Instructors

Ten instructors specializing in industrial arts assessed the instructional application of the IWA-DET, focusing on content and delivery across three units encompassing different topics within the Introduction to Digital Electronics Technology course. All ten instructors concurred that each unit's introduction was appropriately delineated. They emphasized that all the facts and information presented, including the introduction's content, captured the students' interest. The students found reading the introduction enjoyable. According to the teachers, integrating an application within the introduction aided students in correctly focusing on the assignment, representing progress in the IWA-DET.

Regarding the course objectives, all ten instructors concurred that these were clearly outlined in each unit in an observable and evaluable manner. They observed that the presentation of course objectives accurately reflected both the topic and the course itself.

Regarding the learning competencies, all ten instructors commended the delivery of the learning competencies for their specificity and achievability. The assessment procedures utilized to evaluate competency also reflected the learning competencies.

Concerning assessment, all ten instructors praised the use of the pre-installed assessment maker feature in the newly programmed platform as it is easily accessible to IWA-DET participants. Students found the instructions provided in each assessment within every lesson to be very clear. One teacher noted that the assessment feature is convenient and user-friendly.

In terms of the Video Discussion component of the IWA-DET, ten teachers lauded the researcher's adeptness in effectively conveying topics and delivering course content through video discussions. They expressed that the video discussion served as an excellent tool for achieving the learning competencies in each unit. They highlighted that it fostered student participation and enabled students to critically reflect on and generate ideas about what they had learned in the unit. This aligns with Petra's (2016) assertion that students engage in inquiry through collaboration with peers, while teachers oversee progress and provide guidance rather than leading the class.

Regarding the activities or laboratory exercises provided in each unit, all ten instructors agreed that incorporating game-based and simulation assessments facilitated a more effective assessment process for students. One teacher suggested including examination-like assessments accessible through another online platform.

Concerning generalization, all ten teachers praised the inclusion of questions assessing both lower- and higher- order thinking skills to evaluate and summarize students' developed competencies. Concerning the final output and test included in the IWA-DET, the teachers recommended utilizing output-based assessment for the final output. However, they noted the importance of providing students with a more realistic situation and task.

5.3.2. Evaluation of the Students' Utilization of the Instructional Material

The assessment of all three units of the IWA-DET by students relied on their firsthand experience in using and engaging with the platform, as well as their perceptions and opinions regarding its instructional efficacy.

In Unit 1: Binary Systems and Logic Circuits, nineteen randomly selected students expressed enjoyment in learning concepts and skills related to basic Digital Electronics Technology knowledge and skills through the IWA-DET. Despite the complexity of topics or units, all students stated that the extensively discussed and well-presented video content, along with additional teaching tools and exercises, facilitated their learning and comprehension. Although some students initially lacked prior knowledge of the topic, they found they could grasp the lesson's content effectively through the IWA-DET. One student mentioned needing to watch the video multiple times to understand the task. Ultimately, all participants preferred the IWA-DET over modular learning for learning basic digital electronics technology. This aligns with Bernard et al. (2018), who argue that the use of learning videos and supporting resources is crucial for better understanding teachings in each unit.

In Unit 2: Boolean Method and Mapping Methods, twenty randomly selected students expressed enjoyment in exploring concepts and skills related to basic Digital Electronics Technology through the IWA-DET. Similar to Unit 1, students found the well-discussed and well-presented video content, along with other learning aids and exercises, helpful in learning and understanding the lesson. When given the choice between face-to-face and IWA-DET instruction, students preferred the latter due to the variety of learning activities and interactive features that enhanced their understanding of the course material.

In Unit 3: Logic Function Realization with MSI Circuits, twenty out of thirty randomly interviewed students expressed liking and enjoying learning concepts and skills

through the IWA-DET. They found the complexity of the lesson, rather than the delivery method, to be the main source of learning difficulties. The IWA-DET was perceived as providing a more relevant and effective way to acquire, learn, and comprehend the concepts and skills embedded in the lesson. When given the choice between face-to-face and IWA-DET instruction, students again preferred the latter due to its variety of learning activities and interactive features that enhanced their understanding of the material.

Bugler (2017) conducted a study supporting the assessment results of content, design, and instructional use. The study suggests that instructional materials must undergo a comprehensive review by diverse stakeholders, including specialists, students, and teachers, to be considered legitimate and effective for promoting learning. The assessment from these stakeholders significantly improved the validity and instructional utility of the IWA-DET..

4 Conclusions & Recommendations

4.1 Conclusions

This study demonstrates the effectiveness of the developed Interactive Web-Based Application for Digital Electronics Technology (IWA-DET). The IWA-DET aligns with CHED Memorandum No.78, s.2017, in terms of competencies, platform, and time allocation. It complements existing standards and policies set by CHED, as reflected in its components. The development process considered both content and procedural aspects, and the IWA-DET was successfully implemented with BSIE students in an innovative and systematic manner. Furthermore, the study suggests that a standardized triangular assessment process involving experts, teachers, and students can be used to determine the validity of the IWA-DET. Finally, the ADDIE model proved to be a valuable framework for developing and validating educational materials like the IWA-DET.

4.2 Recommendations

In conclusion, this study presents a foundation for the Interactive Web-based Application for Developing English Teaching (IWA-DET). While this initial development is promising, further exploration holds immense potential. Future research can delve deeper into the various functionalities of IWA-DET, investigating the impact of features like gamified assessments, discussion forums, and AI assistance. Additionally, examining internal and external factors influencing its implementation would be valuable. To assess the true impact of IWA-DET, future studies should measure its effectiveness in student learning outcomes. Furthermore, exploring the influence of IWA-DET on students' affective factors, such as motivation and engagement, would provide valuable insights. Overall, this study offers a stepping stone for the university's goal of creating an interactive web application that can benefit various courses and learning experiences.

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