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ENHANCING COGNITIVE SKILLS THROUGH INTERACTIVE DIGITAL INNOVATION IN COMPUTER PROGRAM DESIGN FOR VOCATIONAL STUDENTS

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ABSTRACT
The objectives of this study were: 1) engaging developing digital innovative interactive on computer programming design for cognitive skills enhancement among vocational certificate students of the Office of Vocational Education Commission 2) effectiveness evaluation 3) compare the cognitive skills of the control group and the experimental group; 4) assess satisfaction among experimental group students; and 5) evaluate acceptance of the developed innovation. The sample comprised second-year Business Computer students from Suphanburi Vocational College, Thailand who were placed in control and experimental groups via purposive sampling techniques. Research instruments included: 1) interactive digital innovation; 2) innovation evaluation form; 3) cognitive skill measurement; 4) satisfaction survey questionnaire; and 5) innovation acceptance form. Analyzed using means, standard deviation, and t-tests for both dependent and independent samples. The findings showed that the interactive digital innovation, based on Bloom's Digital Taxonomy and integrated with tools like ClassPoint and WordWall, achieved the highest ratings for effectiveness ($\bar{x}$ = 4.52), student satisfaction ($\bar{x}$ = 4.53), and expert acceptance ($\bar{x}$ = 4.51). The experimental group significantly improved their cognitive skills ($p < 0.01$). This innovation is effective for enhancing vocational students' skills and serves as a model for 21st-century learning.
Keywords : *Interactive Digital, Innovation, Cognitive Skills, Vocational certificate students*

1. Introduction

It means an education that adopts both hard and soft skills to meet the needs of the job market in the 21st century for it encourages self-directed, experiential, and critical thinking-based learning. Self-directed learning encourages critical thinking and problem-solving whereby the students can direct their learning (UNESCO, 2019). and problem-based approaches promote higher order thinking especially in vocational settings. By the introduction of such culture in learning, vocational education should develop learning, literacy, and life skills for modern workplaces (UNESCO, 2022). Project-based learning provides students on-site job-related competencies and experience (UNESCO, 2022). The use of multimedia technologies in education provides students with the opportunities to develop their intellectual and cognitive skills through the transformation of learning into an interactive and engaging process. This method is not only effective in promoting student participation and interest but also in the development of digital skills and technology know-how (Zakirova & Abdurakhmanova, 2020). Besides, the availability of interactive tests and various multimedia sources allows students to learn faster, thus improving the effectiveness of using and retaining language skills for a long time.

It probably puts the students' cognitive structures active by stimulating them further by thinking critically and creatively. The primary focus of the recent digital innovations in vocational education has been on the efficient delivery of content through learning-management systems, multimedia resources, and virtual classrooms. Nevertheless, these technologies often do not effectively involve the students in higher-order cognitive processes such as through analytical reasoning, critical thinking, and complex problem-solving. Despite the digital tools being capable of customising the learning process and building cooperation among the learners, the pedagogical strategies that explicitly support cognitive engagement are still not rooted in the current implementations for the vocational curricula most of the time. This shortcoming points out the need for those teaching methods that would incorporate interactive digital tools along with the structured cognitive-skills development scaffolding (Sukatiman et al., 2020; Cahyono et al., 2024). Cognitive approaches depict thinking in modeling as students encouraged to using self-regulatory and peer-mediated strategies introducing them to a world beyond where they would dwindle digitally (Dockery, D. J., 2012; Moore, A., 2017; Tondeur, Scherer, & Siddiq, 2020;). However, most technology dependence is a limitation to the activity of deep cognitive processing, thus calling for a mixture between digital and traditional channels for the all-rounded growth of the student.

Bloom's Digital Taxonomy (BDT) is a foundation that lays out the skills along the route of their development, to furnish higher-order thinking skills and thus make knowledge transfers easy. Besides, it fosters the learning of the critical and solving-the-problems competences through the establishment of collaborative learning environments. Continuous professional development is very crucial for the teaching staff to apply BDT successfully and be compatible with the rapidly changing technology (Raimondi & Raimondi, 2022). Also, the focused training enables the teachers to move from classical to contemporary teaching styles, thus creating more interaction leading to better learning results (Coleman et al., 2017). On the other hand, relying too much on the online environment for learning might discourage the students from interacting with one another physically which will, in turn, affect their social learning negatively. So, it’s a must for the educators to come up with the assessment and interaction strategies that are appropriate for the online context (Santos et al., 2024). In summary, BDT has a great impact on educational practice, however, the drawbacks of E-learning that are inherent to its form still call for the amalgamation of both approaches (technique and face-to-face) for the best possible outcomes.

The use of ICT in classrooms has changed the whole conduct of teaching and learning, the main changes being increased student participation, personalized instruction, and taking into account the various learners' needs. Among the methods used are interactive platforms, gamification, and adaptive learning technologies, which all work hand in hand to increase motivation and students' independence, while also providing a thorough understanding and inclusiveness in learning (Kumar, 2023; Anastasopoulou et al., 2024; Aveiga et al., 2025). Through these technological innovations, educators can customize learning resources according to each student's pace and even let students choose how they want to approach their learning (Qudsi et al., 2024). Nevertheless, the issue of digital divide still exists; socio-economically disadvantaged groups are still lacking in the availability of hardware and internet, plus at the same time many teachers are still in need of continuous support to acquire the skills needed for proper digital tools integration (Idowu, 2025; Qudsi et al., 2024). These disparities should be dealt with as a prerequisite for the realization of ICT's promise in producing just and highly productive learning experiences for every student. Research findings support the notion that the provision of interactive digital tools (for example, simulation software, gamified platforms, and collaborative applications) can significantly increase the cognitive engagement of students in vocational settings ✓(Chen & Looi, 2020; Teng & Wang, 2021; Roll & Ifenthaler, 2021; Journal of Vocational Education Studies, 2024; Zhang & Lee, 2025). Nevertheless, there is still a lack of solid empirical evidence regarding the impact of these tools on the measurable development of higher-order thinking skills in vocational curricula; thus, such a situation has created an obvious research gap. Develop students to prepare themselves in analytical thinking and problem solving, as this will teach students cognitive skills in the 21st century. Teachers need to redefine the teaching and learning process by employing the use of technology media as another tool for the organization of learning in the most effective way possible for the students. Thus, the present research aims to develop and assess a digital learning innovation specifically designed for vocational students and based on Bloom's Digital Taxonomy. The innovation includes a variety of technological tools to promote cognitive engagement, strengthen the problem-solving skills, and eventually enhance the learning outcomes. Moreover, it is planned to be a prototype that can be easily scaled and modified for other subjects and vocational institutions with the support of the Office of the Vocational Education Commission.

2. Literature Review

Management of Vocational Education

The pace at which an economy and industry grow can be integrally depended on technological developments. These developments must require workforce readiness for both professional knowledge and for technological skills. What vocational education needs is that it has to keep pace with the economic growth rate. Thus, there is a need for collaboration with industries to develop the curriculum, educational management, and assessment systems that meet professional and global standards. Critical and probative thinking, problem-solving, communication, technology proficiency, and teamwork are vital skills of the 21st century which help improve competitiveness, employment market demand, and readiness for students' successful jobs and further education (Neema, M., 2020).

Notwithstanding these ongoing efforts, the gap between the successful adoption of digital innovations aimed at cognitive engagement and vocational education is still enormous. Recent researches, on the other hand, point out that there is a dire need to introduce digital tools and instructional methods that foster cognitive skills like higher-order thinking, problem-solving, and collaboration across vocational students in a systematic manner (Santos & Pedro, 2019; Chen & Looi, 2020; Zhang & Lee, 2025).

Bloom's Digital Taxonomy

It alters Bloom's original taxonomy for the modern age, thus allowing educators to direct their pupils to the higher-order thinking levels through the application of technology (Coşgun Ögeyik, 2022). The author commends the Digital Taxonomy of Bloom for the effective management of cognitive skills development (Aguiar et al., 2015) and its incorporation of digital tools in various types of learning environments (Halland et al., 2015; Lai et al., 2022) while also providing assessment frameworks (Prieto et al., 2017). The claims to be the yielding of a very high academic performance in an online setting as per the provided research (Prieto et al., 2017) and thus it is being talked about as the main area of interest in education research (Ameri et al., 2016). Besides, the necessity of the professional development that is on-going cannot be overemphasized since the resistance to the adoption of new technologies and the absence of proper training are among the factors that will contribute to the ineffectiveness of digital pedagogy, thus, the need for the educator's structured training programs will be more than ever before (Tondeur, Scherer, & Siddiq, 2020; Roll & Ifenthaler, 2021; Zhang & Lee, 2025).

Concept of Cognitive Skills

And, attention, reasoning, and critical thinking are just a few examples of cognitive skills that have importance for learning and solving problems (Singh & Alhulail, 2022). Metacognitive strategies, which generally increase self-awareness and self-regulation, can help children develop cognitive skills and thus lead to academic success, especially in early school years. Applications range from therapy contexts such as CBT to newly conceived learning models that emphasize problem-solving (David & Balakrishnan, 2013). Development is likely to be limited, however, in non-metacognitive learning settings where the use and practice of cognitive strategies are restricted (Jiang et al., 2021; Zhao & Ko, 2020).

Concepts of Technology for Learning

Digital innovations such as ClassPoint, WordWall, Kahoot, Canva, Google Forms, Flowgorithm, and Google Classroom significantly enhance student engagement and learning outcomes by fostering interaction, collaboration, and accessibility. ClassPoint enables real-time engagement through interactive quizzes (Ahmad et al., 2021), while WordWall creates interactive classroom environments with customizable games (Rodríguez-Hernández, Musso, Kyndt, & Cascallar, 2021). Kahoot gamifies quizzes to boost student participation (Kalegele, 2020). Canva supports creative educational material design (Li, Zhang, Cheng, et al., 2022) and efficient assessment creation and feedback (UNESCO, 2022). Flowgorithm simplifies programming concepts (Ebhota, Isabona, & Srivastava, 2019), and Google Classroom facilitates communication and task management for diverse learning environments (UNESCO, 2022). New research has indicated that the use of technology to support learning in the digital environment not only helps in the cognitive aspect but also through the active participation of students, collaboration, and individualized feedback (Noguera et al., 2024; Ahmad et al., 2021).

Concepts on innovation development and innovation adoption

Innovation is an essential engine for economic growth and development and is based on the conception and incorporation of new ideas influenced by the culture of the organization and other contextual factors. (Ebhota, Isabona, & Srivastava, 2019). In the case of vocational and healthcare sectors, factors related to the organization and society such as limited resources, and different regulations are the main reasons for the adoption of innovations. To get a good grasp on how to deal with these non-linear innovation processes, one will have to come up with and apply adaptive strategies (Isabona, 2021; Isabona, 2022).

3. Research Methods

Conceptual framework of the study: Another creation being developed through interactive digital innovation was the one which made up the researcher designing an innovation on the subject Creating Computer Programs- course code 20204-2004 (2-2-3). The focus of the learning content was understanding problem analysis (Analysis the Problem)- and flowchart creation (Flowchart). In developing the new innovation, there were six levels of learning as defined by Bloom's digital taxonomy: Remembering, Understanding, Applying, Analyzing, Evaluating and Creating. The stages of the learning activity were as follows: Preparation, Lesson Introduction, Knowledge Construction and Application, Work Presentation, and Review, Conclusion and Evaluation. Integrated technologies were used in the instruction at each level: ClassPoint, WordWall, Kahoot, Canva, Google Forms, Flowgorithm, and Google Classroom. They create instructional activities, de-conceptualize difficult content, and scaffold learning for higher-order thinking such as analysis and problem-solving in the studied topics. The innovation development followed the conceptual framework of the study shown in Fig.1.

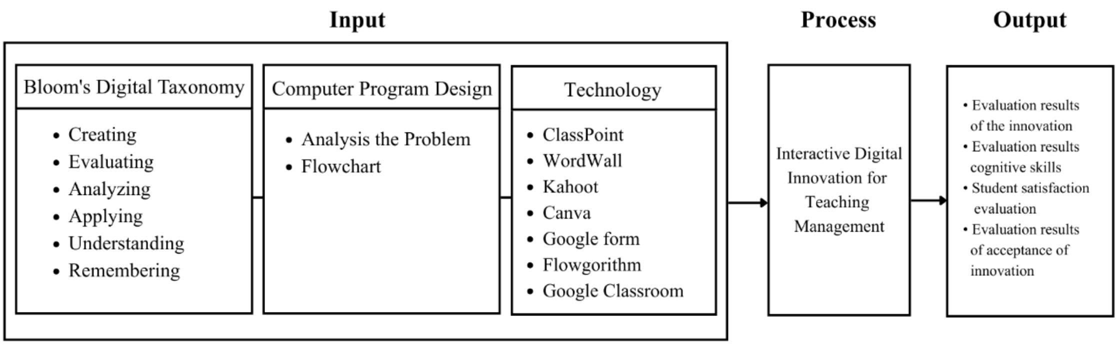

Fig. 1. Conceptual framework of the study

The architecture design for an interactive digital innovation in developing computer programs. The architecture model illustrates the operational structure of the system in terms of interfaces used between the users involved-administrators, teachers, and students-and the nature of technologies applied shown in Fig.2.

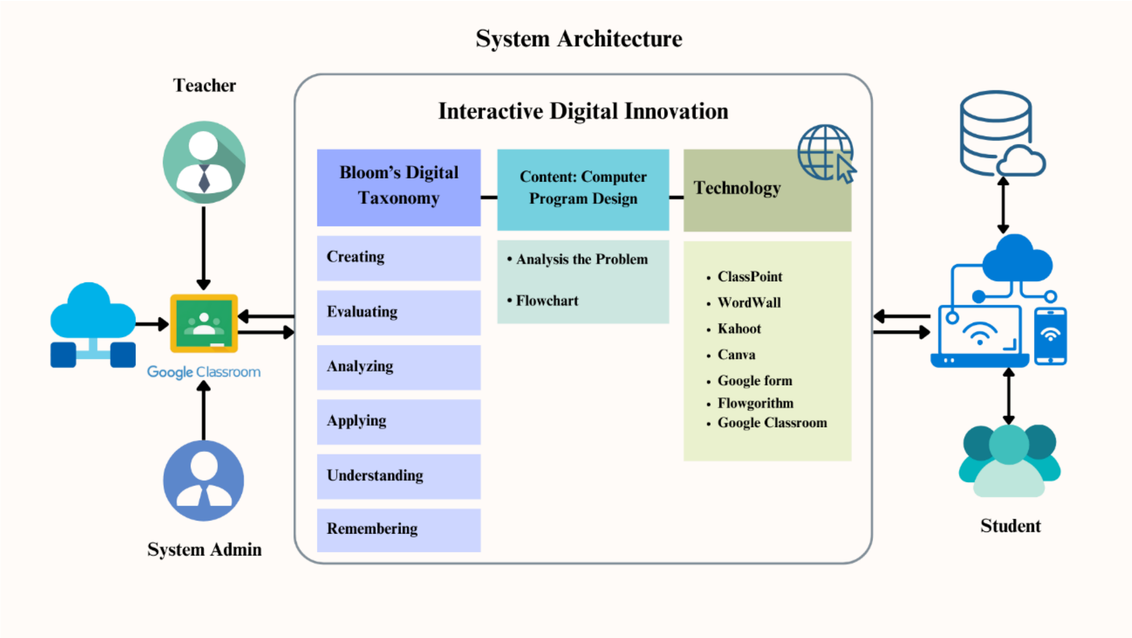

Fig. 2. The architecture of the Interactive Digital Innovation

For the purpose of developing an innovation for teaching-learning activities, the researchers learned different technologies that could be put into every step of the teaching-learning process-as they adopt the aspect of applying Bloom's digital taxonomy to help students improve their cognitive skills. The tools they have to support this innovation include: 1) Development of web-based platform through Google Classroom, which facilitates interactive digital innovation. 2) Learning materials, media and games were produced with the use of Canva and ClassPoint for content delivery and online games. 3) Exercises were created with WordWall and Kahoot to interactively engage students in their learning. 4) The pre-and post-test cognitive skill assessment were developed using Google Forms and Google Docs. 5) Task assignments were created in Canva and Flowgorithm to learn flowchart writing skills. There is an instance of practicing drawing flowcharts for the Flowgorithm program shown in Fig. 3.

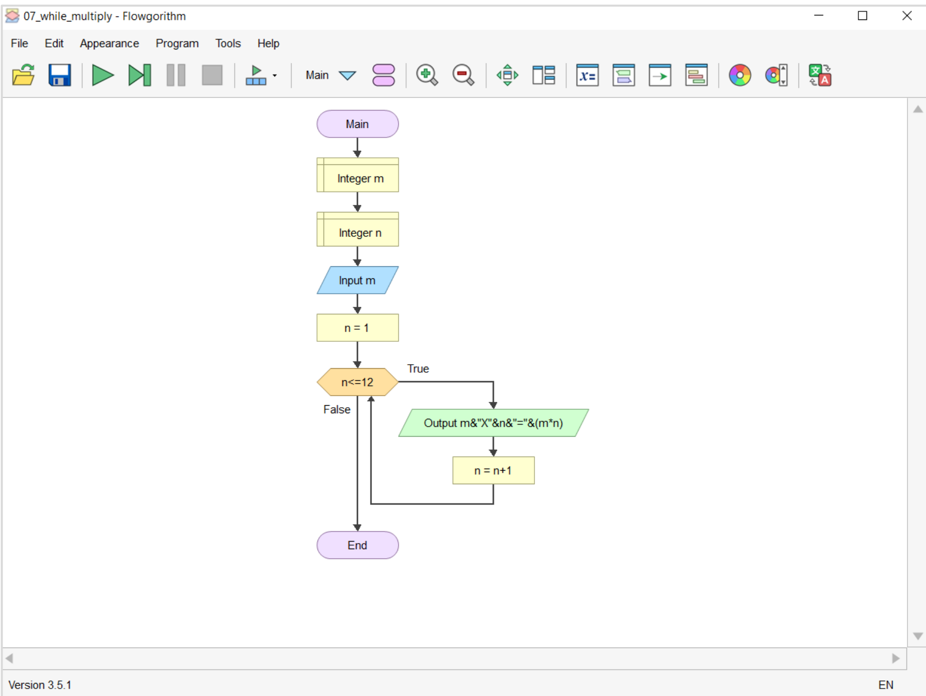

Fig. 3. Practice flowchart writing using Flowgorithm program

This research employed an experimental research design. The methodology was conducted as follows. Respondents included in the population were second year students enrolled in a Vocational Certificate Program under Business Computer approved under the Office of Vocational Education Commission with experts who were of specific expertise. The said experts should hold at least a master's degree and pose an academic qualification as Assistant Professor or at least three years' experience in a similar field (Neema, 2020; Aguiar, Dame, Miller, Yuhas, & Addison, 2015)

Using purposive sampling techniques, the subjects of the experiment consisted of the second-year Business Computer students from Suphanburi Vocational College, Thailand distinguished into control and experimental groups. The complete population of 66 second-year vocational students took part in the sampling process, from which 33 students were subsequently chosen for the experimental group and 33 for the control group. To verify that the groups were truly equal, the students were paired according to their GPAs, gender, and previous experience with game-based learning. In addition, 12 other experts were used to evaluate the research instruments and another 15 were used to validate the results. Both Purposive sampling have been used to select participants and experts (Aguiar, Dame, Miller, Yuhas, & Addison, 2015; Halland, Igel, & Alstrup, 2015).

Instrument for Investigation

This research uses the following investigative tools. 1) By Interactive Digital Innovation 2) The Evaluation Form of Innovation Effectiveness 3) Cognitive Skills Assessment Form 4) Participants' Satisfaction Survey 5) Innovation Acceptability Evaluation Form (Aguiar, Dame, Miller, Yuhas, & Addison, 2015; Prieto, Rodríguez-Triana, Kusmin, & Laanpere, 2017). The research was conducted over a period of 12 weeks with 3 sessions each week of 3 hours each. The interactive digital innovation provided the following content/modules: Problem Analysis, Flowchart Design, Algorithm Implementation, Interactive Game-based Learning, and Knowledge Application Exercises. The innovation was evaluated by experts on the basis of content clarity, appropriateness of learning activities, cognitive skills development, and technology usability.

Innovation design and development process

The five phases of design and development in whole interactive digital innovation include. Phase 1 Analysis : 1) Define problems and need for innovation (Problem and Need Analysis), 1) Classroom study to try and examine teaching-learning problems that interfere in the expected educational activities like learning activities, technological tools, classroom atmosphere, and interaction during lessons. 2)-analyze_existing-data_1: Develop and design a data collection survey for students from first-year to third-year students in the vocational certificate level in Business Computer major, where data collected is with respect to gender, academic year, and GPA, as well as behaviors such as failed a course (0 or failed), enjoys games, interested in game-based learning, and had previous experiences in it. 3) Prepare and analyze the data using a classification algorithm with a Decision Tree technique. Analysis showed that those students who enjoyed games, had had prior experiences with game-based learning, and had failed a course were interested in game-based learning. While those who enjoyed games, had prior experiences with game-based learning, but had passed all courses showed decreased interest in game-based learning. The basis of creating the innovation development used these findings. 2) Identify how technology will apply within the innovation in learning activities designed to enhance the cognitive skills with respect to the subject computer program design. 3) Research, and looking through literatures, for the suitable application of such knowledge in dealing with problems. Thus, the course description probationally determines the learning objectives and competencies for the course Principles of Programming (code: 20204-2004, 2-2-3 credits). The contents of the course mainly revolve around problem analysis and flowchart development. Bloom's Digital Taxonomy is also reviewed for cognitive learning as conceptualized through six levels relative to theories of cognitive skills that include analytical thinking and problem solving (Ameri et al., 2016). These two theories are employed in the analysis and design of learning activities congruent to the content and learning objectives of specific units. The different technologies ClassPoint, WordWall, Kahoot, Canva, Google Forms, Flowgorithm, and Google Classroom are also explored in their potentials and characterization. Phase 2 Design : 1) Based on the findings from literature and related research studies, plan the architecture of the interactive digital innovation. For example, this architecture outlines the system structure in relation to the interactions that will occur between the administrators, end users, and the technologies that will be employed. 2) Design and develop the interactive digital innovation. The researcher synthesized knowledge for the design of learning activities based on five stages (Wisesanan, 2022). 1) Preparation Stage. 2) Introduction Stage. 3) Knowledge Construction and Application Stage. 4) Presentation and Review Stage. 5) Conclusion and Evaluation Stage. Alike the steps of learning activities, these phases are designed according to Bloom's Digital Taxonomy targeting cognitive skills (Cognitive Domain) such as analytical thinking and problem solving. The design outlines the learning behavior and activity of students in utilizing diverse technologies (Ameri, Fard, Chinnam, & Reddy, 2016; Singh & Alhulail, 2022). Phase 3 Development : 1) A discussion with the advisor regarding the developed interactive digital innovation has been done to check the defects or issues existing in them, which have been then rectified and improved. 2) The interactive digital innovation was evaluated by five experts in terms of content and technical methodology to gauge its effectiveness and suitability. 3) The interactive digital innovation was modified and modified through the recommendations of the experts to be ready for actual usage (Jiang, Justice, Purtell, Lin, & Logan, 2021). Phase 4 Implementation : The interactive digital innovation was piloted on a sample of 30 students who are not part of the study sample. Adjustments and improvements will be made according to the findings before full implementation. Phase 5 Evaluation : Tested with five experts, the interactive digital innovation involved simulating the teaching and learning process through this innovation to allow these experts to observe the activity process, with all technologies used, from both the students' and the teachers' perspectives. Then, an evaluation of the innovation's acceptance was done right after the trial (David & Balakrishnan, 2013; Ahmad et al., 2021; Rodríguez-Hernández, Musso, Kyndt, & Cascallar, 2021)

Creating a data collection tools

It includes all the study of pertinent documents, textbooks, and research papers concerning the instruments which have four things: 1) the new innovation efficacy assessment form, 2) cognitive abilities assessment form (Kalegele, 2020), 3) satisfaction survey form (Li, Zhang, Cheng, et al., 2022), and 4) innovation acceptance evaluation form (UNESCO, 2022; (Ebhota, Isabona, & Srivastava, 2019) 2. The four newly drafted instruments should also be created. 3. Review the instruments developed together with the advisor then revise them again based on the feedback. 4. Content validity for each of the four instruments was determined by calculating the Index of Item-Objective Congruence (IOC), through the rating by three experts on each of the instruments, followed by necessary revisions (Ebhota, Isabona, & Srivastava, 2019; Isabona, 2021). 5. Determine the difficulty, discriminating power (Isabona & Divine, 2021; Isabona, 2020), and reliability (KR-20) of the cognitive skills assessment test piloted to a sample group of almost similar characteristics of the target sample (Ituabhor, Isabona, Zhimwang, & Risi, 2022; Obahiagbon & Isabona, 2018), and further revise prior to final implementation. 6. Assess the reliability of the three instruments by administering them to a sample group representative of the target group using Cronbach's alpha coefficient and further refine them for real use (Ojuh & Isabona, 2021).

Data Collection

The researcher has completed the data collection for the first semester of the academic year, 2024. The data from a single classroom was used as part of the experimental group formed by 33 second-year vocational students from the Business Computer program of Suphanburi Vocational College, Thailand. Detrimental data collected following this experimental practice would later be analyzed statistically to make inferences and discussions of the findings (Isabona, 2019). The analysis of data was carried out with the help of SPSS that included performing descriptive and inferential statistics, besides determining reliability coefficients (KR-20, Cronbach's alpha) and Index of Item-Objective Congruence (IOC) as outlined below.

Data Analysis

Instruments, all four of them, were evaluated for their quality in research. Innovation Effectiveness Evaluation: Index of Item-Objective Congruence (IOC) was from 0.67 to 1.00 (Ebhota, Isabona, & Srivastava, 2019; Isabona, 2021) for the overall instrument and Cronbach's alpha coefficient of the same was 0.86. Cognitive Skills Test: IOC was 0.67 - 1.00, difficulty values (p) from 0.27 to 0.93, and discrimination power (r) from 0.27 to 0.63. Reliability was computed using Kuder and Richardson's KR-20 formula, leading to 0.89 coefficients (Ituabhor, Isabona, Zhimwang, & Risi, 2022). For assessing cognitive skills, there are 15 multiple-choice questions and 3 open-ended questions that comprise the test. Satisfaction Questionnaire: The IOC ranged from 0.67 to 1.00, and the Cronbach's alpha coefficient for the entire instrument was 0.89 (Ojuh & Isabona, 2021). Innovation Acceptance Evaluation: The IOC ranged from 0.67 to 1.00, and the general Cronbach's alpha for the instrument was 0.89 (Ebhota, Isabona, & Srivastava, 2019; Isabona, 2021).

4. Results and Discussions

Results of the Development of Interactive Digital Innovation

Findings of Research according to Research Objective on the Outcomes from the Development of an Interactive Digital Innovation Computer Program Design for Cognitive Skill Enhancement for Vocational certificate students, Office of the Vocational Education Commission. The present researcher innovated the interactive digital medium termed "Computer Program Design" as a means of partnering students participate with teachers. The teachers were to maintain their traditional role of managing the environment, as per the predefined sequence of the steps involved, adhering to Bloom's Taxonomy learning theory, that is learning progression from simple to complex levels. The innovative design employs a mixture of technologies for example ClassPoint, WordWall, Kahoot, Canva, Google Forms, Flowgorithm, and Google Classroom. It also utilized Web games as well as other resources for the learner accessing highly complex content that lays the foundation for a higher-order thinking skill analysis and problem-solving when it becomes much easier. Thus, development of this innovation was informed by the research framework for purposes of evaluation of efficacy and realization of other research objectives.

Innovation Efficacy Assessment Results

The rating of how effective the interactive digital innovation called "Computer Program Design" is overall was rated the highest ($\bar{x}$ = 4.52, S.D. = 0.54). As far as effectiveness by content is concerned, it was rated the highest ($\bar{x}$ = 4.53, S.D. = 0.54), and in relation to technical methodology, it was rated quite high as well ($\bar{x}$ = 4.51, S.D. = 0.54) shown in Table 1.

Table 1- Evaluation results of the innovation on computer program design

Item	$\bar{x}$	*S.D.*	Level
Content Aspect	4.53	0.54	Highest
1. Content Aspect	4.55	0.53	Highest
2. Evaluation Aspect	4.52	0.57	Highest
Technical Aspect	4.51	0.54	Highest
1. Interactive Digital Innovation Design	4.32	0.63	High
2. Use of Interactive Digital Innovation in Learning Activities	4.66	0.48	Highest
3. Evaluation	4.57	0.56	Highest
4. Communication	4.48	0.51	High
Arithmetic Mean	4.52	0.54	Highest

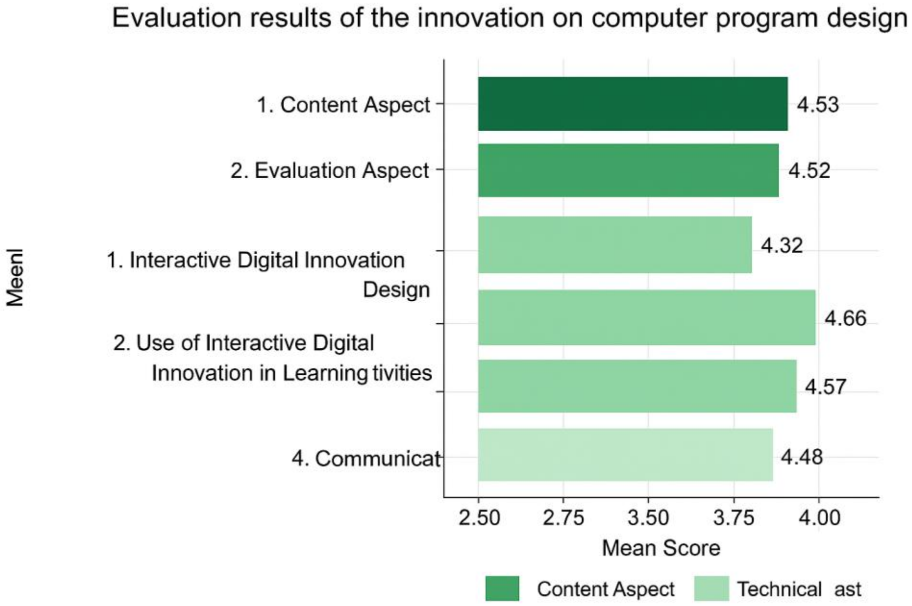

Fig. 4. Evaluation results of the innovation on computer program design

Fig.4 the Interactive Digital Innovation for Computer Program Design was evaluated very positively by the participants not only on the technical but on the content side ($\bar{x}$ = 4.52), which was a great help to the students' engagement and intellectual skills. Interactive tools like ClassPoint, WordWall, Kahoot, and Google Classroom made possible the real-time interaction and self-regulated learning that were in line with Active Learning and Bloom's Taxonomy (Lamon et al., 2020; Canavesi & Ravarini, 2023). Formative assessment has shown such remarkable results that it has clearly marked the role of digital evaluation in adaptive instruction (King, 2023; Hopfenbeck et al., 2023). The innovation that brought about interactivity, cognitive alignment, and instantaneous feedback has made the classroom a student-centered place where not only comprehension and higher-order thinking were permitted but also encouraged.

Cognitive Skills Comparison Results

There was a significant difference in post-learn cognitive skills between the experimental group and the control group at the 0.01 level. Moreover, the performance of the experimental group on cognitive skills showed a highly significant improvement after learning at the same level of 0.01. The results are given in Table 2. and Table 3.

Table 2 - Comparison of cognitive skills posttest between experimental and control groups

Student Group	Number of Students	Full Score	$\bar{x}$	*S.D.*	***t***	Sig (2-tailled)
Experimental Group	33	30	25.39	2.34	5.81	.00**
Control Group	33	30	21.85	2.60		

**P<0.01

Table 3-Comparison of cognitive skills pretest and posttest for experimental group

Cognitive Skill Test	Number of Students	Full Score	$\bar{x}$	*S.D.*	***t***	Sig (2-tailled)
Pretest	33	30	18.94	2.87	10.43	.00**
Posttest	33	30	25.39	2.34		

**P<0.01

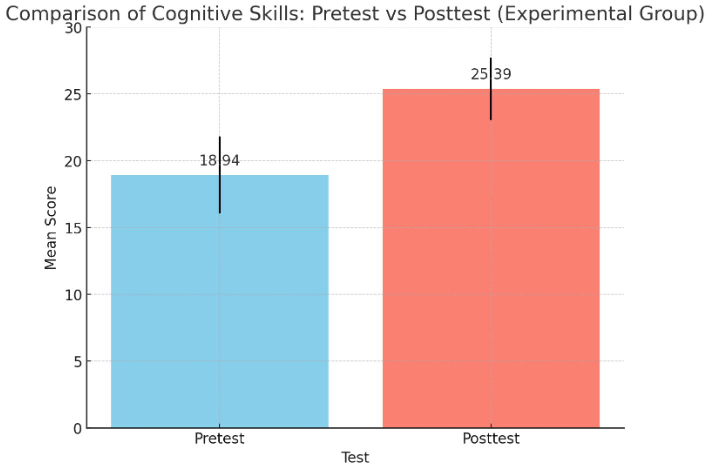

Fig. 5. Comparison of cognitive skills pretest and posttest for experimental group

Fig. 5 a bar chart displays the mean scores of the pretest and posttest of the experimental group, thereby making clear the significant increase in posttest results as a sign of cognitive gains after the intervention.

A significant improvement was noticed and it pointed out that the different interactive platforms mix especially the ones giving real-time feedback such as Kahoot and WordWall facilitated the active participation and comprehension of students to a great extent. This corresponds to Bloom’s Digital Taxonomy guidelines, particularly in the “Applying” and “Analyzing” stages where students exhibited superior problem-solving and analytical thinking skills.

The cognitive advancements detected in this study when compared to previous works (e.g., Prieto et al., 2017; Ahmad et al., 2021; Jiang et al., 2021) correspond with the ever-increasing body of evidence that claims, by the way, that interactive and gamified learning environments are the ones that promote deeper cognitive engagement and knowledge retention among vocational learners. This consistency reinforces the belief in the ability of technology-enhanced pedagogical designs to be effective in promoting higher-order thinking and long-term learning outcomes in the context of vocational

Cognitive Skills Comparison Results

The satisfaction of the experimental group students regarding the interactive digital innovation entitled "Computer Program Design" is at the highest rating ($\bar{x}$ = 4.53, S.D. = 0.61) on the scale shown in Table 4.

Table 4-Student satisfaction evaluation of interactive digital innovation

Item	$\bar{x}$	*S.D.*	Level
Content Aspect	4.50	0.64	High
Learning Activities Aspect	4.52	0.62	Highest
Graphics and Design Aspect	4.50	0.59	High
Innovation Aspect	4.60	0.54	Highest
Benefit Aspect	4.51	0.64	Highest
Arithmetic Mean	4.53	0.61	Highest

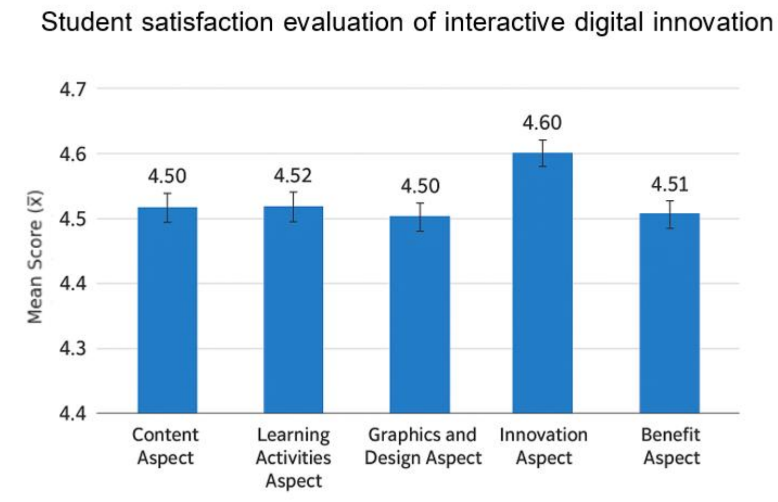

Fig. 6. Student satisfaction evaluation of interactive digital innovation

Fig.6 according to the qualitative feedback that was derived from the open-ended responses, the students valued the visual clarity and the interactivity of the innovation (Anggraeni, 2022). A lot of students' comments suggested that the use of such tools like Canva and Flowgorithm helped them a lot in getting the hang of programming concepts which are usually considered difficult to learn (El-Sherbiny et al., 2023). The teachers as well had a positive experience with the innovation saying that it helped in the implementation of differentiated instruction and also in the increasing of participation in the classroom.

Results of the Innovation Attitude Evaluation

The highest level of acceptance regarding the interactive digital innovation termed "Computer Program Design" is rated as follows ($\bar{x}$ = 4.51, S.D. = 0.54) shown in Table 5.

Table 5- Evaluation of acceptance of developed interactive digital innovation

Item	$\bar{x}$	*S.D.*	Level
Perceived Ease of Use	4.52	0.51	Highest
Perceived Usefulness	4.57	0.59	Highest
Attitude Towards Innovation	4.43	0.54	High
Behavioral Intention to Use	4.50	0.53	Highest
Arithmetic Mean	4.51	0.54	Highest

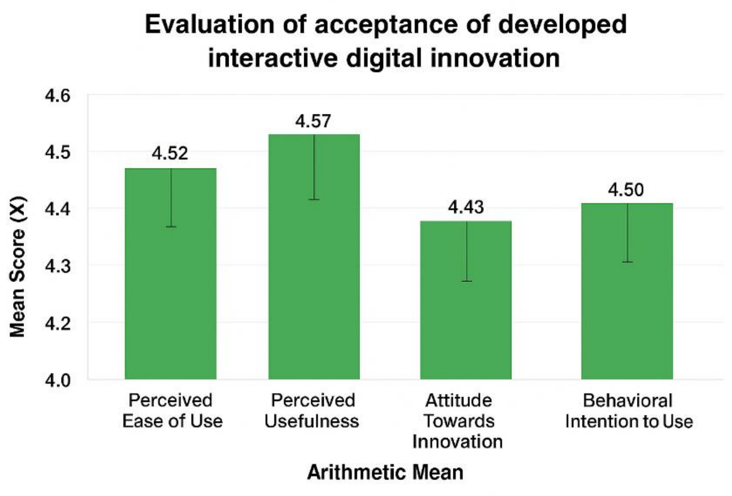

Fig. 7. Evaluation of acceptance of developed interactive digital innovation

Fig.7 the extensive evidence from both the quantitative and qualitative findings points to the digital innovation being very effective, mostly due to its interactive framework, multimodal learning design, and coherence with the already established cognitive learning hierarchies. There is a continuous echo in the literature regarding the importance of interactivity, learner feedback, and adaptive instructional design as the factors that improve cognitive engagement and learning performance (Ahmad, et al., 2021; Rodríguez-Hernández, et al., 2021).

5. Conclusion

This innovative digital learning research has brought about the need to implement computer program design curriculum with the goal of enhancing vocational learners' efficiency in learning. It is all anchored to Bloom's Digital Taxonomy because it married all blended technologies: ClassPoint, Wordwall, Kahoot, Google Classroom, and Flowgorithm. These tools are elevating much engagement to learning interactivity. As for teachers, such innovation has greatly improved instruction efficiency by giving shape to pedagogy with digital tools for content delivery, student engagement, and standard assessment. The approach further looks into being the remedy to weaknesses in a traditional lecture-based way of teaching and to create a space for interactivity, whereby the teacher uses technology to facilitate the learning process. This innovation taps the students into active learning environments with its boost of academic performance and satisfaction. For the experimental group with interactive technology, it resulted in a statistically significant improvement in learning outcomes. Such digital tools helped students better understand complex topics, review themselves, and build analytical and problem-solving skills.

In conclusion, interaction and rotation in innovative digital form of teaching increase not only teachers' effectiveness but also learning achievement among learners. Teachers thus make apt and effective lessons fulfill the needs of their students, who have a modern learning experience that realizes efficiency in the outcome. The practical implications of this research for the designers of vocational education curricula are the need to incorporate interactive digital tools in order to improve engagement and enhance cognitive skill development. To policymakers, the results advocate the creation of digital innovation scaling frameworks, while educational institutions are to be advised to adopt the technology implementation of their choice comprehensively. However, some limitations still exist which include a small sample size, a single vocational college as the research site, and possible instructor bias that could have influenced the results. It is suggested that future studies utilize longitudinal designs to assess the sustainability of learning outcomes, replicate the research in various vocational settings to widen the generalizability, and incorporate the analysis of the affective and psychomotor domains in addition to cognitive outcomes. To summarize, the outcomes not only highlight the significant changes that digital technologies can bring to vocational education but also indicate the directions of further research and application that might be fruitful.

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