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Research Article

Self-Coded Digital Portfolios as an Authentic Project-Based Learning Assessment in Computing Education: Evidence from a Web Design and Development Course

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Abstract:

Digital portfolios have become an essential assessment tool in project-based and student-centered learning environments. Unfortunately, students exert minimal effort in creating digital portfolios because they find the writing component unchallenging. This issue is concerning since existing research predominantly focuses on the use of pre-existing platforms for building digital portfolios. With this concern, there is an opportunity to explore more challenging approaches to digital portfolio creation. Consequently, this study employs a project-based learning (PBL) approach within a website design and development course, where 176 undergraduate students completed weekly coding tasks culminating in a self-coded digital portfolio. Using a one-group posttest-only research design, data were collected through a structured questionnaire that included demographic items and validated scales measuring learning effectiveness and ownership of learning. The survey was administered electronically after students submitted their digital portfolio projects. The results reveal that device ownership shows only weak associations with students' perceptions, while internet connectivity and self-reported academic performance demonstrate stronger relationships with engagement and ownership of learning. Additionally, prior experience with digital portfolios positively influences students' engagement, motivation, and ownership of learning. Implications of these findings are discussed for supporting the integration of digital portfolios into technical disciplines. Overall, this study contributes to the literature on PBL methodology, expands our understanding of digital portfolio integration, and underscores the significance of student-centered pedagogies.

Keywords:

Digital Portfolios, Project-Based Learning, Educational Technology, Learning Effectiveness, Ownership of Learning, Student Portfolio

INTRODUCTION

A portfolio is a purposeful collection of evidence that demonstrates a person's abilities, achievements, and progress over time. Traditionally, it was used by the artistic community to showcase their work to potential clients or employers. Given its comprehensive nature, it has been recognized as an authentic form of assessment across a broader spectrum (e.g., Doeze Jager-van Vliet et al., 2019; Mohajer et al., 2023). In education, the growing interest in portfolios stemmed from a growing recognition of the limitations inherent in relying solely on tests to evaluate knowledge and skills acquisition (Chere-Masopha & Mothetsi-Mothiba, 2022; van der Gulden et al., 2022). Unlike other traditional assessments, portfolios serve as a pedagogical tool that encapsulates the learning journey of students. By showcasing their projects, achievements, and other artifacts, students can paint a complete picture of their academic growth. This assertion is supported by empirical studies, which found portfolios to be more effective in assessing both student performance (Gebrekidan & Zeru, 2023) and longitudinal learning outcomes (Isbej et al., 2022), with some studies even suggesting they are superior to examinations (Zaabalawi & Zaabalawi, 2024). Accordingly, the portfolio approach aligns more closely with a programmatic assessment model that emphasizes the measurement of ongoing formative processes rather than relying solely on evidence from a single examination instance. It is consequently unsurprising why student portfolios have become a popular assessment tool in various educational disciplines (Ashipala et al., 2022; Tang, 2022; Weldeana & Sbhatu, 2017).

The adaptation of portfolios in educational settings has since evolved, with digital portfolios (also known as e-portfolios) emerging as their modern counterpart. Unlike traditional paper-based portfolios, digital portfolios leverage technology to create an easily accessible, versatile, and multimedia-rich collection of a student's work. Numerous studies have indicated that students and teachers recognize the benefits and importance of digital portfolios as learning and assessment tools (e.g., Hsieh et al., 2015; Klampfer & Köhler, 2015; Nguyen & Ikeda, 2015; Sharifi et al., 2017; Song et al., 2024). However, the literature on building digital portfolios has mostly concentrated on utilizing open-source software and ready-made platforms (e.g., Google Sites, LinkedIn, and Behance). In these activities, students merely act as curators of learning artifacts rather than builders of digital portfolios (i.e., coding the websites themselves). For non-technical degrees, this strategy may be sufficient because it allows students to prioritize reflection on their learning (Bodle et al., 2017) as well as identification of their strengths and weaknesses (Farrell & Seery, 2019). However, this setup may be disadvantageous when implemented in technical degrees (e.g., where students are trained to build websites). According to Yang et al. (2016), students exert little effort in creating digital portfolios because they believe that writing learning plans is unchallenging and unhelpful for their learning. They posited that digital portfolios must be integrated more coherently into the course and relate the portfolio-building activity to other assessment tasks to make it more meaningful, cognitively challenging, and relevant to learning experiences. Unfortunately, it is unclear whether existing findings are transferable to technical courses because most studies are conducted in other disciplines (e.g.,

(Buzzetto-More, 2010; Harun et al., 2021; Janssens et al., 2022). One obvious reason for this research gap is that building digital portfolios requires technical knowledge and skills, which are beyond the scope of these disciplines.

These research gaps warrant further investigation in educational settings where students are expected to create digital portfolios from scratch using programming skills. Existing literature predominantly explores digital portfolios as reflective tools in non-technical disciplines such as education (Chye et al., 2019), business (Bodle et al., 2017), and nursing (Ashipala et al., 2022), where the emphasis is on curation and self-reflection rather than on the technical construction of digital artifacts. Consequently, these studies often treat digital portfolios as containers for learning evidence, rather than as evidence of learning itself. In technical disciplines like web development and computer science, this distinction becomes critically important. Students in such programs are not only required to reflect on their progress but also to demonstrate tangible technical competencies, including proficiency in front-end development, design thinking, and version control. Despite the rising demand for technically capable graduates with digital portfolios that showcase their coding abilities, there is a notable lack of empirical studies examining how coding-based portfolio creation impacts learning outcomes. There is limited understanding of how students engage with digital portfolios when they are responsible for every layer of development. Additionally, while studies often highlight the motivational and reflective benefits of using portfolios, they rarely consider whether building them from the ground up enhances critical thinking, autonomy, or real-world readiness in technical contexts. Addressing this oversight is vital, as such projects may contribute not only to skill development but also to the cultivation of a professional identity and increased ownership over learning. Therefore, this study adopts a project-based learning (PBL) approach, wherein students enrolled in a web design and development course completed weekly coding tasks that culminated in the creation of a fully functional, self-coded digital portfolio. These outputs serve both as assessment artifacts and as a demonstration of applied technical proficiency. By embedding portfolio creation into a PBL framework that emphasizes both technical skill application and reflective practice, this study aims to investigate not only how students perceive this hands-on approach, but also what contextual and experiential factors shape those perceptions. To evaluate the effectiveness of this study's approach, the following research questions have been formulated:

1. How do students perceive the creation of self-coded digital portfolios as a PBL activity in terms of learning effectiveness, skill development, and ownership of learning?
2. To what extent do technological constraints (e.g., device availability, internet connectivity) and academic background (e.g., self-reported academic performance) influence students' perceptions of digital portfolio creation?
3. Are there significant differences in student perceptions between those with and without prior experience in physical and digital portfolio creation, particularly regarding engagement, confidence, and perceived learning value?

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MATERIALS AND METHODS

Instructional Framework

Following a PBL educational approach, this study embedded the constructivist theories of Piaget and Vygotsky. While these developmental psychologists offered distinct views (Piaget emphasized individual cognitive development, whereas Vygotsky highlighted the importance of social interaction), they shared the foundational belief that learning is most effective when learners actively construct knowledge in meaningful contexts (see Huang, 2021 for a thorough comparison and contrast). In contrast to conventional, lecture-driven classrooms, constructivism supports learner-centered environments where students build upon their existing cognitive structures through exploration, problem-solving, and collaboration. In the context of this study, digital portfolio creation serves as a constructivist activity that fosters reflective practice and autonomy. According to Büyükduman and Şirin (2010), portfolio development enables students to take ownership of their learning by requiring them to make decisions about what knowledge to showcase and how best to present it. This process encourages metacognitive awareness and deeper learning. Furthermore, PBL complements constructivist ideals by requiring students to apply theoretical knowledge to real-world challenges—in this case, designing and coding their own portfolio websites. As Guo et al. (2020) and Lavado-Anguera et al. (2024) explain, PBL not only improves technical skills but also promotes collaboration, critical thinking, and sustained engagement through inquiry-driven tasks. Within a technical education setting such as web development, integrating PBL with constructivist principles provides students with authentic learning experiences that mirror professional practices. Students are not passive recipients of information, as they take on the role of creators, problem-solvers, and designers who construct both knowledge and digital artifacts through iterative learning cycles. This pedagogical synergy supports the overarching goal of fostering student agency, technical competence, and reflective thinking.

Setting and Sample

The research was carried out in the College of Computer Studies and Multimedia Arts (CCSMA) at FEU Institute of Technology in the City of Manila, Philippines. At the time of the study, the university offered a four-year information technology program with four specializations: Digital Arts (BSIT-DA), Business Analytics and/or Service Management (BSIT-SMBA), Animation and Game Development (BSIT-AGD), and Web and Mobile Application Development (BSIT-WMA). All specializations include a website design and development course with both lecture (IT0043) and laboratory (IT0043L) components. The course is designed to equip students with foundational design principles (e.g., visual hierarchy and responsive website design) and development languages (HTML, CSS, and JavaScript). During the third trimester of academic year 2021–2022, a total of 280 students across eight sections were enrolled in the course. All sections followed the same syllabus, but only five sections (n = 176 students) were assigned the creation of a digital portfolio as their final course requirement. The remaining three sections

completed a different culminating activity. The total sample size exceeds the minimum required sample of 165, as determined using Slovin's formula. Although the presence of non-portfolio sections offered some contextual contrast, they were not used as a control group because the project types differed, and the section assignments were non-random (based on instructor discretion and scheduling constraints). Accordingly, this study employed a one-group posttest-only design with a sole emphasis on the five portfolio sections. While this research design is often regarded as weaker in terms of internal validity, it was the most appropriate and feasible given the institutional constraints and instructional setup. Random assignment across sections was not possible and using non-portfolio sections as a comparison group would have introduced confounds due to differences in culminating tasks. Moreover, the purpose of the study was not to measure change but to evaluate students' web design and development skills through e-portfolio creation. Unlike existing studies that use drag-and-drop software tools or preconfigured platforms for digital portfolio development (e.g., Ciesielkiewicz, 2019; López-Crespo et al., 2022), this study emphasizes students' ability to demonstrate actual web development skills by coding their portfolios from scratch.

Research Instrument

The research instrument used in this study was a structured survey questionnaire consisting of two main parts: demographic information and self-report scales. Including both demographic and perceptual measures allowed for a comprehensive understanding of how contextual factors interact with students' experiences of digital portfolio development. The demographic section included standard variables such as age, gender, year level, specialization, and self-reported academic performance, along with portfolio-related items (e.g., preference for and experience with traditional or digital portfolios, and perceived benefits of e-portfolios) and access-related factors such as device availability and internet connectivity. The access variables were included based on prior findings that they can serve as barriers to the successful implementation of digital portfolios (Poole et al., 2018). On the other hand, the self-report scales measured the effectiveness of digital portfolios as a PBL activity and student ownership of learning when digital portfolios are part of the course requirements. The scale for learning effectiveness was adapted from the instrument developed by Chang et al. (2018) and included items across four sub-dimensions: flow experience, product evaluation, self-efficacy, and learning motivation. The ownership of learning scale was based on Shroff et al. (2013) and measured personal value, control, responsibility, and learning attitude. Each item was rated on a five-point Likert scale ranging from "strongly disagree" (1) to "strongly agree" (5). The complete list of all items used in the study is provided in Appendix A.

Table 1. Summary of Questionnaire Scales, Sample Items, and Reliability Coefficients

Construct	Subscale	Sample Item	α
Effectiveness of Digital	Flow Experience Perception	I often feel time passes very quickly when I am designing and developing a digital portfolio	0.89

Portfolios as a PBL Activity	Product Evaluation	When designing and developing a digital portfolio, I adhere to industry standards and good practices	0.74
	Self-Efficacy	I think I have the necessary skills to design and develop a digital portfolio	0.85
	Learning Motivation	Designing and developing a digital portfolio will help me find a good job in the future	0.79
Ownership of Learning Using Digital Portfolios	Finding Personal Value	I acquired useful skills and techniques in designing and developing a digital portfolio	0.88
	Feeling in Control	I could choose what content and design to display in my digital portfolio	0.72
	Taking Responsibility	The process of designing and developing my digital portfolio makes me responsible for my own learning	0.76
	Attitude Towards Learning	I enjoyed designing and developing my digital portfolio as part of the course requirements	0.81

The questionnaire underwent a two-stage validation process to ensure both content quality and measurement reliability. First, content validity was established through an expert review involving faculty members with backgrounds in educational technology and instructional design. Their feedback led to revisions that enhanced the clarity of item wording, improved formatting, and ensured alignment with the research objectives and target constructs. Second, the revised questionnaire was pilot tested with 40 students from the same institution who were not part of the main study sample. This step was conducted to assess the instrument's reliability and internal consistency. Cronbach's alpha coefficients (α) for each of the subscales ranged from 0.72 to 0.89 (see Table 1), which is considered acceptable to excellent according to conventional psychometric standards. The overall reliability for the entire scale was $\alpha = 0.87$, indicating a high degree of internal consistency across all items. The final version of the survey was administered electronically using Google Forms, and participants typically completed it within 5 to 10 minutes. Participation was voluntary, and informed consent was obtained prior to survey administration. Although the institution does not maintain a formal ethics review board, the study adhered to widely accepted ethical research standards, including voluntary participation, anonymity, informed consent, and the right to withdraw from the study at any time.

Procedures and Data Analysis

In IT0043L, there were seven formative and four summative assessments. As the laboratory component of the course, these assessments required students to either develop complete websites or create functional components (e.g., widgets, interface sections, or interactive elements) based on topics covered in lecture sessions. Examples include creating a resume webpage (HTML), coding a web-based calculator (JavaScript), and building responsive websites using the Bootstrap framework (CSS). At the beginning of the semester, students were informed that compiling these outputs into a digital portfolio would be a key course requirement. All digital portfolios were required to be deployed on a free web server and made publicly

accessible online. At the time of the study, generative artificial intelligence (GenAI) tools (e.g., ChatGPT, GitHub Copilot, Gemini, or similar coding assistants) were not available to students. Consequently, all portfolio content (including code, structure, and design) was developed independently, ensuring that the findings reflect students' unaided technical abilities. After submitting their project URLs, students completed a validated questionnaire survey. The data collected were analyzed using IBM SPSS Statistics 22.0. Descriptive statistics were used to summarize demographic characteristics and student perceptions regarding portfolio development. Because the data were derived from ordinal Likert-scale responses and preliminary checks indicated non-normal distributions, non-parametric statistical tests were deemed most appropriate. Accordingly, Spearman Rank correlation was applied to examine relationships between perception variables (learning effectiveness and ownership of learning) and student background characteristics (e.g., internet connectivity, device availability, academic performance). The Mann–Whitney U test was conducted to compare perception scores between students with and without prior experience in physical and digital portfolios.
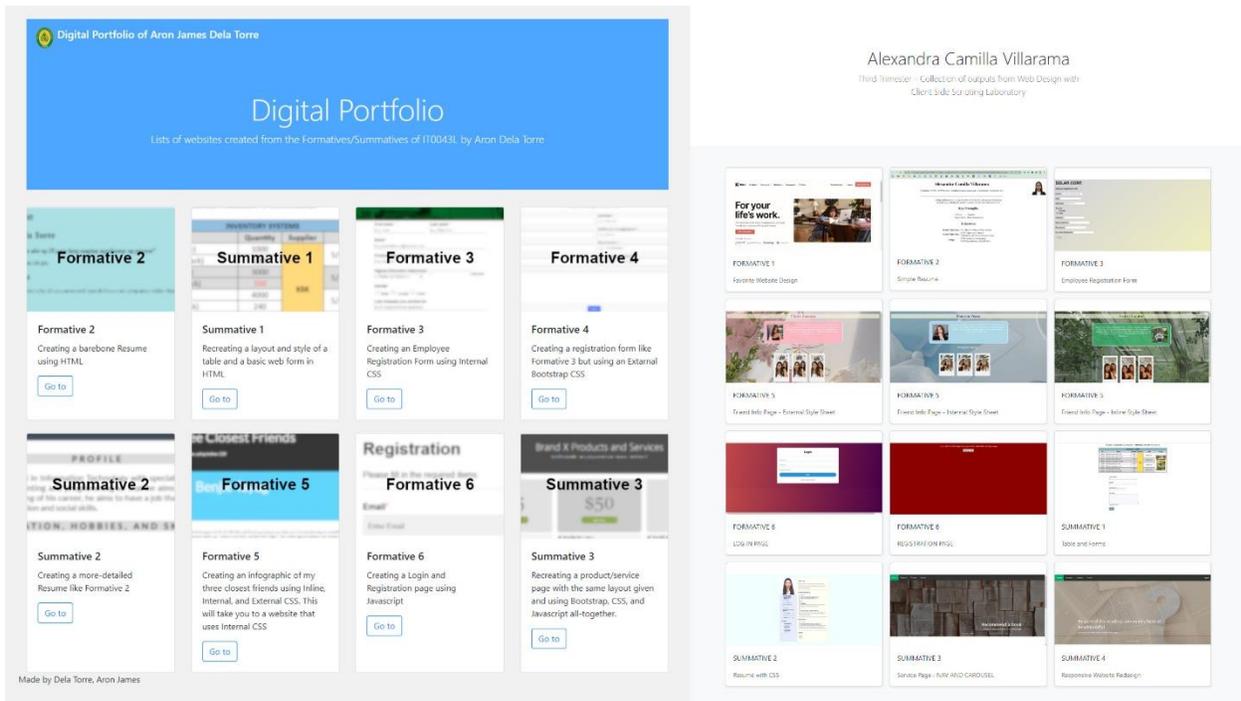
Figure 1. Illustrative Examples of Digital Portfolios Submitted by Students

RESULTS

All students (n = 176) submitted their final digital portfolio projects, with Figure 1 showing examples, and responded to the survey. As presented in Table 2, most students were male (n = 144, 81.82%), aged 19 years old (n = 92, 52.27%), in their second year (n = 171, 97.16%), and enrolled in a BSIT-AGD (n = 105, 59.66%) program. This gender distribution is

consistent with broader enrollment trends in computing and information technology programs, where male students have historically been overrepresented. This imbalance reflects a persistent global trend in computing, where structural factors such as cultural stereotypes, limited early exposure for women, and the perception of computing as a male-dominated field contribute to lower female participation. While the gender imbalance reflects the demographic reality of the field, it presents a limitation in the current study's ability to explore potential gender-based differences in perceptions, particularly in areas such as self-efficacy and ownership of learning. Almost half of the participants self-reported their academic performance in the course as acceptable ($n = 84$, 47.73%). Although a large percentage of students owned one or two devices ($n = 169$, 96.02%), intermittent internet connection was still a common problem ($n = 126$, 71.59%). In terms of creating portfolios, more students had experience with digital ($n = 124$, 70.46%) than with physical portfolios ($n = 69$, 39.21%). When asked which version of student portfolios they preferred, students favored the digital version ($n = 150$, 85.23%). More than half of the students believed that having a portfolio increases their employability, highlights their achievements, and enhances their technical skills. Surprisingly, fewer students perceived that monitoring their academic progress was a benefit of digital portfolios ($n = 55$, 31.25%).

Table 2: Demographic Characteristics

Variables	Attributes	Frequency	Percentage
Gender	Male	144	81.8
	Female	28	15.9
	Prefer not to say	4	2.3
Age	18	8	4.5
	19	92	52.3
	20	48	27.3
	21	20	11.4
	22	8	4.5
Year Level	Second Year	171	97.2
	Third Year	5	2.8
Specialization	BSIT-AGD	105	59.7
	BSIT-DA	44	25.0
	BSIT-SMBA	2	1.1
	BSIT-WMA	25	14.2
Device Availability	One	82	46.6
	Two	87	49.4
	Three or more	7	4.0
Internet Connection	Very Slow	4	2.3
	Slow	12	6.8
	Sometimes fast, sometimes slow	126	71.6
	Fast	30	17.0

	Very Fast	4	2.3
Self-Reported Academic Performance	Very Low	4	2.3
	Low	30	17.0
	Acceptable	84	47.7
	Good	44	25.0
	Very Good	14	8.0
Physical Portfolio Experience	Yes	69	39.2
	No	107	60.8
Digital Portfolio Experience	Yes	124	70.5
	No	52	29.5
Portfolio Preference	Physical Portfolio	26	14.8
	Digital Portfolio	150	85.2
Perceived Benefits of Digital Portfolios	Increase employability	113	64.2
	Highlight achievements	125	71.0
	Enhance technical skills	109	61.9
	Monitor learning progress	55	31.3

Perceptions of Learning Effectiveness and Ownership

Students generally perceive digital portfolios as an effective PBL activity in enhancing their learning (3.59 ± 0.81) and fostering a sense of ownership over their learning process (3.84 ± 0.79). The mean scores across various dimensions of learning effectiveness and ownership of learning suggest positive student perceptions. For learning effectiveness, the dimensions of flow experience perception (3.65 ± 0.85) and product evaluation (3.65 ± 0.77) indicate that students find the digital portfolio creation process engaging and are satisfied with their completed projects. However, the mean score for self-efficacy was slightly lower (3.22 ± 0.77), indicating a need for greater support to strengthen students' confidence in creating digital portfolios. Learning motivation scored the highest among the effectiveness measures (3.83 ± 0.83), indicating a strong motivational impact of digital portfolios on student learning. In terms of ownership of learning, the data reflects a strong sense of personal value (3.78 ± 0.77), control (3.90 ± 0.80), and responsibility (3.91 ± 0.84) in the learning process through digital portfolio creation. These scores highlight the effectiveness of digital portfolios in encouraging students to take an active and autonomous role in their learning. The attitude towards learning, while slightly lower (3.76 ± 0.76), still indicates a positive perception, suggesting that while students appreciate the learning opportunities digital portfolios provide, there may be room for enhancing this aspect to further improve learning attitudes. Overall, these findings suggest that digital portfolios are valued by students as a means to enhance learning effectiveness and ownership.

Table 3: Students' Perceptions of Digital Portfolios and Their Relationships with Device Ownership, Internet Connectivity, and Academic Performance

Digital Portfolio Perception	M	SD	Device Ownership	Internet Connectivity	Academic Performance
Flow Experience Perception	3.65	.849	$r = .118$ $p = .119$	$r = .154^*$ $p = .041$	$r = .281^{**}$ $p = .000$
Product Evaluation	3.65	.770	$r = .140$ $p = .065$	$r = .102$ $p = .177$	$r = .282^{**}$ $p = .000$
Self-Efficacy	3.22	.770	$r = .121$ $p = .109$	$r = .004$ $p = .953$	$r = .361^{**}$ $p = .000$
Learning Motivation	3.83	.831	$r = .085$ $p = .261$	$r = .098$ $p = .196$	$r = .137$ $p = .070$
Finding Personal Value	3.78	.770	$r = .027$ $p = .727$	$r = .247^{**}$ $p = .001$	$r = .362^{**}$ $p = .000$
Feeling in Control	3.90	.801	$r = -.023$ $p = .767$	$r = .188^*$ $p = .012$	$r = .175^*$ $p = .020$
Taking Responsibility	3.91	.837	$r = -.064$ $p = .397$	$r = .210^{**}$ $p = .005$	$r = .253^{**}$ $p = .001$
Attitude Towards Learning	3.76	.758	$r = .122$ $p = .108$	$r = .202^{**}$ $p = .007$	$r = .560^{**}$ $p = .000$

Note: $^*p < 0.05$; $^{**}p < 0.01$.

Influence of Students' Profiles on Digital Portfolio Perception

As shown in Table 3, the correlations between technological and academic variables and students' experiences with digital portfolios demonstrate varying degrees of association. The correlation coefficients (r) between device ownership and aspects of learning effectiveness and ownership of learning are relatively low, with the strongest positive correlation found with the feeling of control ($r = .188$, $p = .012$) and taking responsibility ($r = .210$, $p = .005$). While statistically significant, the small effect size suggests that device ownership plays only a limited role in shaping students' perceptions. By contrast, internet connectivity showed stronger and more consistent associations with students' perceptions, particularly in finding personal value ($r = .247$, $p = .001$), feeling in control ($r = .188$, $p = .012$), and taking responsibility ($r = .210$, $p = .005$) in their learning. These correlations suggest that reliable internet access enhances students' engagement and perceived value of digital portfolios, potentially by facilitating smoother access to resources and uninterrupted workflow. The positive correlation with the flow experience perception ($r = .154$, $p = .041$) further supports the importance of internet connectivity in fostering engaging learning experience with digital portfolios. Lastly, the strongest correlations are observed between students' self-reported academic performance and their perceptions of digital portfolios. Notably, strong positive correlations are evident in self-efficacy ($r = .361$, $p =$

.000), finding personal value (r = .362, p = .000), and particularly attitude towards learning (r = .560, p = .000). These significant correlations indicate that students with higher academic performance are more likely to perceive digital portfolios positively across various dimensions, including their confidence in using them (self-efficacy), the personal value they find in the activity, and their overall attitude towards learning. This could be due to higher-performing students being more adept at integrating digital tools into their learning process or finding such activities more reinforcing of their learning habits.

Comparative Analysis of Student Portfolio Experience

As illustrated in Table 4, the comparison between students with and without prior experience in physical and digital portfolios reveals varying degrees of impact on their perceptions across different dimensions of learning effectiveness and ownership of learning. Regarding physical portfolio experience, the data show no significant differences in most dimensions of learning effectiveness and ownership of learning between students with and without prior physical portfolio experience. The p-values for flow experience perception (p = .903), learning motivation (p = .809), finding personal value (p = .860), and taking responsibility (p = .462) suggest that prior physical portfolio experience does not significantly impact students' perceptions in these areas. However, there is a notable exception in self-efficacy (p = .031, r = .163) and feeling in control (p = .032, r = .170), both reflecting small effect sizes. These findings suggest that experience with physical portfolios may positively influence students' confidence and their perceived control over their learning when engaging with digital portfolios. Nevertheless, the limited effect sizes indicate that the practical influence of physical portfolio experience is modest, which may be because the organizational and presentational skills developed through physical portfolios transfer only in a limited way to digital portfolio development.

Table 4. Impact of Prior Physical and Digital Portfolio Experience on Students' Perceptions of Learning Effectiveness and Ownership of Learning

Digital Portfolio Perception	Physical Portfolio Experience				Digital Portfolio Experience			
	Yes	No	U	p	Yes	No	U	p
Learning Effectiveness								
Flow Experience Perception	87.95	88.86	3653.50	.903	96.22	70.10	2267.00	**.001**
Product Evaluation	86.73	83.19	3123.50	.063	86.60	93.02	2989.00	.411
Self-Efficacy	95.01	85.16	2520.00	**.031**	92.72	78.44	2571.00	**.036**
Learning Motivation	87.41	89.20	3616.50	.809	94.76	78.12	2344.00	**.021**
Ownership of Learning								
Finding Personal Value	89.28	88.00	3638.00	.860	94.82	82.73	2484.00	**.043**
Feeling in Control	92.93	81.64	2385.50	**.032**	94.35	82.23	2182.00	**.019**
Taking Responsibility	85.18	90.64	3462.50	.462	92.50	78.73	2476.00	**.013**

| Attitude Towards Learning | 90.72 | 86.15 | 3267.50 | **.049** | 93.19 | 77.31 | 2642.00 | **.041** |

Note: The values under the "Yes" and "No" columns represent the mean ranks from the Mann–Whitney U test. The effect size (r) was calculated using the formula r = $Z / \sqrt{N}$, where Z is the standard score and N is the total number of observations. According to Cohen's (2013) guidelines, effect sizes are interpreted as follows: small ($r \approx 0.10$), moderate ($r \approx 0.30$), and large ($r \geq 0.50$). Including effect sizes helps contextualize the practical significance of statistically significant results.

Conversely, students with prior digital portfolio experience show significantly more positive perceptions across several dimensions. For instance, students with digital portfolio experience report higher levels of engagement and immersion in their learning activities ($p = .001$, $r = .248$). With a moderate effect size, this finding suggests that working with digital portfolios may enhance the quality of the learning experience by promoting a state of flow. Additionally, these students exhibit increased confidence in their abilities ($p = .036$, $r = .158$) and a higher motivation to learn ($p = .021$, $r = .174$), both with small-to-moderate effects. This evidence points to the effectiveness of prior engagement with digital portfolios in enhancing self-assurance and stimulating educational aspirations among students. The impact of prior digital portfolio experience extends to a greater sense of autonomy in the learning process, as evidenced by significant differences in feeling in control ($p = .019$, $r = .167$), taking responsibility ($p = .013$, $r = .181$), and attitude towards learning ($p = .041$, $r = .166$). These findings highlight that the creation of digital portfolios not only empowers students by fostering a stronger sense of ownership but also encourages a proactive stance toward their education. Collective findings also underscore the substantial benefits of integrating digital portfolios into educational practices, which emphasize their potential to enhance students' learning experiences, increase their confidence and motivation, and promote a deeper sense of ownership over their educational journey.

DISCUSSION

Digital portfolios are increasingly recognized as essential tools in enhancing learning and assessment within educational settings. Their integration into curricula across various disciplines underscores the shift towards more dynamic, reflective, and student-centered approaches to education. Given their capacity to encapsulate learning achievements, digital portfolios offer a multifaceted view of student progress and foster a sense of ownership over the learning process. Unfortunately, the prevailing research on digital portfolios largely focuses on their implementation through open-source software and ready-made platforms, which might not be entirely suitable for technical courses such as website design and development (Garcia & Yousef, 2023). In these disciplines, the hands-on process of building digital portfolios from scratch is integral to the learning experience. To support this argument, Yang et al. (2016) underscored the necessity for digital portfolios to be more intricately woven into the curriculum, which suggests a deeper integration that could render the portfolio-building activity more intellectually stimulating. For a website design and development course, this approach necessitates a departure from the reliance on pre-existing platforms, pushing students to apply their coding skills, design principles,

and creative thinking in a real-world context. However, despite the clear benefits and the call for a more integrated approach, there remains a significant gap in the research concerning the application of digital portfolio creation in technical disciplines. This study aims to fill this gap by examining the effectiveness of digital portfolios as a PBL assessment tool.

Enhancing Engagement and Skill Development Through Self-Coded Portfolios

Based on the results, there is an overall positive reception of digital portfolios as a PBL tool in a website design and development course. This favorable perception could be partly attributed to the students' existing technical skills, such as their proficiency in building websites. Such skills could inherently enhance their experiences with digital portfolios by making the process more engaging and less daunting. The potential relationship between students' technical skills and their positive perceptions of digital portfolios suggests the importance of aligning educational tools with students' skill sets. This orientation is in line with the principles of Cognitive Load Theory (Duran et al., 2022; Yousef et al., 2023), which emphasizes the need to balance instructional design with the learner's existing knowledge and capabilities to optimize learning outcomes (Surbakti et al., 2024). By leveraging students' competencies, the integration of digital portfolios in the curriculum serves to strengthen these skills through practical and real-world application opportunities (Bolton & Emery, 2021). Such strategic alignment has the potential to significantly boost self-efficacy, as it enables students to apply their knowledge effectively and observe tangible outcomes from their work. This process of active engagement and applied learning not only validates students' existing technical skills but also encourages a deeper connection with the course content (Balalle, 2024). It also validates the constructivist premise that learning is most effective when active engagement with content leads to the creation of knowledge artifacts that embody the learners' understanding and skills. In this way, digital portfolios contribute to the development of professional identity, employability, and digital literacy by showcasing students' applied technical competencies.

Particularly noteworthy in the results is the high regard for flow experience and product evaluation, which indicates that the process of creating digital portfolios is not only engaging but also satisfying for students. As posited by the Self-Determination Theory (Ryan & Deci, 2020), this engagement and satisfaction are crucial for maintaining intrinsic motivation. When students find an activity enjoyable and rewarding, they are more likely to invest effort and persist in it (Garcia, 2022). However, the relatively lower scores in self-efficacy signal an area for targeted interventions. The slight decrease in confidence levels among students in creating digital portfolios suggests a gap between the perceived and actual ability to engage with this pedagogical activity effectively. According to Bandura's (1997) theory of self-efficacy, students' beliefs in their capabilities to execute the actions required to produce specific performance attainments significantly affect their motivation and performance. Thus, this gap presents an opportunity for educators to implement scaffolding strategies that gradually increase complexity and provide incremental challenges aligned with students' skill levels. Such pedagogical strategies could include step-by-step guides, exemplars of successful student portfolios, and opportunities for

iterative feedback, which are known to enhance self-efficacy and skill acquisition in learners (Hempel et al., 2020; Masters, 2013). In practice, teachers could start with basic tasks such as customizing templates before advancing to more complex activities like coding from scratch or integrating multimedia elements. Additionally, incorporating peer review sessions where students critique and learn from each other's portfolios can enhance learning through collaboration and provide diverse perspectives on problem-solving within web development. Such scaffolding not only bridges the gap in self-efficacy but also enriches the student's learning experience by closely mirroring the iterative and collaborative nature of real-world web development projects (Garcia, 2023).

Digital Portfolios as Tools for Ownership and Reflective Learning

Another interesting finding is that the dimensions of learning motivation, combined with the reported strong sense of personal value, control, and responsibility, underscore the impact of digital portfolios on ownership in learning. This heightened sense of ownership is crucial in establishing a learner-centered environment, where students are motivated to take the reins of their educational journey (Hendrickx et al., 2023). This observation mirrors the findings of Pagone et al. (2024), who explored the use of portfolios as an assessment practice in another discipline. The implication of this finding in educational practice is profound as it underscores the necessity of providing students with the tools and opportunities to shape their learning pathways (Ingkavara et al., 2022). From a methodological perspective, this finding is supported by Weimer's (2013) learner-centered teaching approach, which highlights the significance of empowering students with more responsibility in the learning process. Similar to a prior work (Gutiérrez-Santiuste et al., 2022), this study also revealed that attitudes towards learning reflect a generally favorable perspective on digital portfolios as a valuable educational tool. A prevailing explanation for this positive attitude is the inherent reflective nature of building digital portfolios (Chye et al., 2021). As students apply their technical skills in website design and development, they engage in a process that goes beyond simple task completion. This process involves critical reflection on their user interface design choices, problem-solving strategies, website-building techniques, and the overall learning journey. Through this reflective practice, students not only consolidate their understanding of the subject matter but also develop a deeper connection with their work. Thus, digital portfolios foster a reflective mindset that bridges technical skill development with deeper learning engagement.

Technology Access and Academic Achievement: Uneven Foundations for Digital Work

As noted by Poole et al. (2018), device availability has been identified as a significant barrier to the integration of digital portfolios into educational settings, primarily because these portfolios necessitate frequent updates and personalization. Contrary to their research, this study reveals that device availability does not significantly correlate with students' perceptions of digital portfolios both in terms of learning effectiveness and ownership in learning. One potential explanation for this discrepancy could be the evolving landscape of digital access and the ubiquity of technology in educational environments (Zou et al., 2025). Today's students, especially after

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the pandemic, may have access to multiple devices or shared resources that mitigate the necessity of personal ownership for engaging with digital portfolios effectively. Furthermore, educational institutions may have implemented more robust digital infrastructures that can provide students with the necessary resources and support. However, aligning with the findings of Poole et al. (2018), this study underscores that internet connectivity remains a critical barrier to the effective integration of digital portfolios. Despite advancements in digital access, reliable internet connectivity is paramount for engaging with digital portfolios. This is a critical requirement as it facilitates the seamless uploading of content to a web server as well as access to online resources (e.g., interface kits, code snippets, and frameworks). The significant correlation between internet connectivity and positive perceptions, particularly regarding learning effectiveness and ownership, highlights the indispensable role of continuous online access in maximizing the benefits of digital portfolio use (Domene-Martos et al., 2021). In a world increasingly reliant on digital educational tools, the disparity in internet access can exacerbate educational inequalities, which suggests an urgent need for educational policies and infrastructure developments aimed at ensuring universal, high-quality internet access to support equitable learning opportunities.

The Influence of Prior Portfolio Experience on Perception and Performance

The notable correlation between students' self-reported academic performance and their perceptions of digital portfolios holds significant implications for educational practice and policy. This relationship suggests that students who are academically higher performing tend to view digital portfolios more favorably, particularly in terms of learning effectiveness and ownership. Such students may find digital portfolios to be more aligned with their learning strategies, possibly due to their already-established skills in managing and integrating various digital tools into their learning processes. This affinity could also stem from higher-performing students' propensity to engage more deeply with tasks that require self-regulation and reflection (Rodríguez et al., 2022). The implications of this finding are multifaceted. For educators and curriculum designers, understanding the positive reception of digital portfolios among higher-performing students could inform more targeted approaches to using digital portfolios across different levels of academic performance. It suggests a need for scaffolded support and resources tailored to students' varying levels of academic achievement to ensure that all students can benefit from digital portfolios. For policymakers, this correlation underscores the importance of incorporating self-regulated learning and digital literacy skills into the curriculum from early stages to ensure that students develop the competencies necessary to engage productively with digital portfolios. Encouraging students to perceive digital portfolios positively, irrespective of their academic standing, may involve integrating these tools in contextually relevant ways, supported by adequate training and resources, and aligned with students' learning pathways (Dolic et al., 2024; McCarthy et al., 2025; Roberts et al., 2024).

Lastly, the differential impact of prior experience with physical and digital portfolios on students' perceptions offers intriguing insights into how past interactions with portfolio-based

learning shape current educational experiences. The negligible differences in perceptions between students with and without prior physical portfolio experience, except in areas of self-efficacy and control, indicate that physical portfolios may not substantially influence most aspects of learning effectiveness and ownership in the context of digital portfolios. This finding suggests a potential disconnect between the skills and attitudes developed through physical portfolio creation and those required for engaging effectively with digital portfolios. However, the positive impact on self-efficacy and perceived control points to the value of any portfolio experience in building foundational skills such as confidence and a sense of agency in one's learning process (Mogas et al., 2023). In stark contrast, prior digital portfolio experience has a markedly positive influence across multiple dimensions of learning effectiveness and ownership. This finding demonstrates the direct relevance of digital portfolio skills and mindsets to students' current educational engagements, which emphasize the continuity and applicability of digital literacies and self-regulatory practices. Students with digital portfolio experience not only engage more deeply with their learning but also exhibit heightened confidence and motivation. Thus, this study advocates for the early integration of digital portfolio activities in educational curricula to cultivate digital literacies and self-regulated learning skills from the outset (Chye, 2021). It also supports the need for pedagogical strategies that bridge the gap between physical and digital portfolio experiences. For educators, this study underscores the importance of designing portfolio activities that are reflective, integrative, and aligned with the digital competencies required in modern learning environments (Marinho et al., 2021; Parker et al., 2012; Salem & Elrasoul, 2020).

Limitations and Future Directions

While this study offers valuable insights into the integration of self-coded digital portfolios in a project-based learning environment, several limitations should be acknowledged. First, the sample exhibited a significant gender imbalance, with over 80% of participants identifying as male. While this reflects typical enrollment trends in computing and information technology programs, it restricts the generalizability of findings across genders. This imbalance also limits the ability to explore how gender may influence perceptions of digital portfolios, particularly in areas such as confidence, motivation, and sense of ownership. Prior research suggests that female students in male-dominated computing contexts may experience distinct motivational and self-efficacy challenges (Kwon et al., 2025), potentially affecting their engagement with technical tasks such as coding-based portfolio development. Future research should aim to recruit more balanced samples or explicitly investigate gender-specific experiences within technical project-based learning environments. Another limitation relates to the timing and technological context of the study. Data collection occurred before the widespread availability of GenAI tools such as ChatGPT and GitHub Copilot (Garcia, 2025). As a result, all student work reflected unaided technical ability and coding knowledge. However, the educational landscape is rapidly evolving. With the increasing accessibility of AI-powered code assistants and content generators, future students may approach digital portfolio development very differently. These tools could enhance productivity, but they may also reduce opportunities for deliberate practice and conceptual

understanding if not integrated thoughtfully. Thus, future studies should investigate how GenAI use affects student engagement, learning outcomes, skill development, and academic integrity in portfolio-based assessments. Lastly, the study relied on self-reported data to assess student perceptions of learning effectiveness and ownership, without triangulation through objective performance metrics or instructor evaluations. Incorporating multimodal evidence (e.g., rubric-based portfolio scoring, reflective journal entries, or interviews) could strengthen future analyses. Longitudinal studies could also help determine whether these perceptions translate into sustained skill gains, deeper learning, or improved employability over time.

CONCLUSION

Digital portfolios offer a global platform for students to showcase their competencies and achievements. To fully leverage its potential in enhancing their learning journey and employability, students must engage deeply in the process. Regrettably, students often invested insufficient effort into their digital portfolios due to the lack of challenge presented by the writing aspect. Building on prior recommendations for a more coherent integration of digital portfolios into the curriculum and for linking portfolio-building activities with other assessment tasks, this study adopted a PBL approach within a website design and development course, where students applied their technical skills to create digital portfolios. It explored their perceptions, the factors influencing their opinions, and the impact of their prior experiences. The findings illuminated that while device ownership had minimal influence, internet connectivity, and self-reported academic performance significantly affected students' views on digital portfolios. Moreover, prior digital portfolio experience notably influenced students' engagement, motivation, and sense of ownership over their learning. These revelations underscore the necessity for educational strategies that not only foster digital literacy but also ensure equitable access to technology. Implications drawn from these insights advocate for a refined integration of digital portfolios across technical disciplines. Thus, this study not only contributes to the PBL methodology and digital portfolio integration but also champions student-centered pedagogies. In a world ever more reliant on digital proficiency, it casts a visionary light on the potential of digital portfolios to sculpt the future of education where every student's achievement is not just documented but celebrated across the global stage.

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Appendix A. Survey Questionnaire

Please answer the following questions based on your experience in designing and developing a digital portfolio for your website design and development course. There are no right or wrong answers. Your responses will be kept anonymous and used solely for research purposes.

For each statement, indicate your level of agreement using the following scale: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree.

Part I: Effectiveness of Digital Portfolios as a Project-Based Learning Activity

A. Flow Experience Perception

- I often feel time passes very quickly when I am designing and developing a digital portfolio.
- I become fully absorbed in the process of creating my digital portfolio.
- I lose track of time while working on my digital portfolio.
- I find the process of building my digital portfolio enjoyable and immersive.
- I feel highly focused and engaged when working on my portfolio tasks.

B. Product Evaluation

- When building a digital portfolio, I adhere to industry standards and good practices.
- I am satisfied with the quality of the digital portfolio I created.
- My digital portfolio reflects my technical knowledge and creativity.
- My portfolio showcases my best work from the course.
- I feel proud of the digital portfolio I submitted.

C. Self-Efficacy

- I think I have the necessary skills to design and develop a digital portfolio.
- I feel confident using HTML, CSS, and JavaScript to create a functional website.
- I can solve technical problems that arise during web development.
- I am comfortable integrating multiple web development tools into my portfolio.
- I believe I could create another digital portfolio independently if needed.

D. Learning Motivation

- Designing and developing a digital portfolio will help me find a good job in the future.
- The digital portfolio project encouraged me to take my coursework more seriously.
- I felt motivated to complete each part of the portfolio with care and effort.
- Working on the portfolio made me more interested in web design and development.
- I see clear career benefits in having a digital portfolio.

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Part II: Ownership of Learning Using Digital Portfolios

A. Finding Personal Value

- I acquired useful skills and techniques in designing and developing a digital portfolio.
- I found the portfolio project meaningful to my personal and academic growth.
- The portfolio allowed me to reflect on what I learned during the course.
- I improved my problem-solving skills while working on my portfolio.
- I believe the portfolio project helped deepen my understanding of the subject.

B. Feeling in Control

- I could choose what content and design to display in my digital portfolio.
- I made independent decisions on the layout and structure of my portfolio.
- I felt free to experiment with creative design choices.
- I had control over the pace and process of my portfolio development.
- I personalized my portfolio to reflect my identity as a student or future professional.

C. Taking Responsibility

- The process of building my digital portfolio made me responsible for my own learning.
- I managed my time effectively to meet portfolio deadlines.
- I took the initiative to revise and improve my portfolio beyond the minimum requirements.
- I sought feedback to enhance the quality of my portfolio.
- I was accountable for each decision I made during the development process.

D. Attitude Towards Learning

- I enjoyed designing and developing my digital portfolio as part of the course requirements.
- The portfolio activity made learning more engaging and interactive.
- I would recommend portfolio development in other courses.
- The project helped me appreciate my learning journey.
- The portfolio encouraged me to take a more active role in my education.

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LET'S COLLABORATE!

If you are looking for research collaborators, please do not hesitate to contact me at mbgarcia@feutech.edu.ph.

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