Environment and Social Psychology (2024) Volume 9 Issue 11 ISSN: 2424-8975 (O)
doi: 10.59429/esp.v9i11.3199 2424-7979 (P)

RESEARCH ARTICLE

Analysis of portfolio for critical thinking and creativity development among education students

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ABSTRACT

Portfolio-based assessment is increasingly recognized as a valuable approach in educational contexts due to its multifaceted benefits. This method shifts the focus from traditional, standardized assessments to a more holistic evaluation of student learning. Unlike conventional assessments that often measure rote memorization and short-term recall, portfolio-based assessment provides a comprehensive view of a student's progress over time, capturing their evolving competencies, skills, and understandings. This paper explored the experiences of education students about portfolio-based assessment and how this developed their critical thinking and creativity. College students from Basilan, Philippines were purposively sampled through open-ended online survey. Narratives from one-on-one interview were the primary data of this study. The study revealed that the creation of portfolios had a profound impact on the critical thinking and creative development of education students. Participants noted that the process of constructing instructional materials and meeting academic requirements necessitated a thoughtful and analytical approach, requiring problem-solving and critical thinking skills. They emphasized the importance of observation and reflection, which allowed them to critically assess their teaching methods and make informed adjustments. The experience required creativity in structuring ideas, managing tasks, and developing innovative solutions, which not only enhanced their ability to teach effectively but also encourage thinking and a higher level of cognitive engagement. This process values portfolio creation as a tool for developing essential skills in education, particularly in enhancing both critical thinking and creativity among future educators.

Keywords: creativity; critical thinking; innovation; organization; portfolio-based assessment; problem-solving

1. Introduction

Alternative assessments have gained prominence as a complement to traditional methods, which primarily rely on standardized tests and teacher-made exams[1]. Globally, these emerging assessment techniques, encompassing methods such as portfolios and reflective observations, aim to provide a broader evaluation of students' skills, aptitudes, and interests, addressing the limitations of conventional assessments[2].

Portfolios, as a form of alternative assessment, serve as a vital tool for documenting and evaluating

ARTICLE INFO
Received: 29 October 2024 | Accepted: 10 December 2024 | Available online: 19 December 2024

CITATION
Abdurahim-Salain H. Analysis of portfolio for critical thinking and creativity development among education students. *Environment and Social Psychology* 2024; 9(11): 3199. doi:10.59429/esp.v9i11.3199

student progress. These collections of student work, curated by both learners and teachers, offer a platform for students to demonstrate their understanding and capabilities through their best efforts in classroom assignments and activities[3]. With continuous assessment, portfolios encourage deeper engagement, self-reflection, and improvement in learning. They function as diagnostic and remedial tools, fostering students' active participation in their learning processes and helping achieve desired educational outcomes[4]. The shift toward alternative assessments like portfolios is driven by the shortcomings of traditional methods. Conventional assessments often rely on summative measures that capture a snapshot of knowledge rather than a comprehensive view of students' progress over time. These methods tend to emphasize recall of content rather than the development of higher-order thinking skills, often failing to account for the dynamic changes in students' abilities and behaviors throughout a learning session[5].

Research on portfolio assessment in education highlights its diverse benefits, including positive impacts on student outcomes, instructional practices, and attitudes toward assessment. Farooq[6] identified portfolios as an innovative and impactful means of measuring student achievements. Research indicates that portfolios have a particularly positive influence on language learning, enhancing students' engagement and motivation[7,8]. Further, Aysu[2] found that portfolio-based assessments positively impact class attendance, with female students demonstrating higher attendance rates than their male counterparts. Portfolio assessments have been shown to improve critical thinking skills, self-regulation, and motivation while encouraging subject understanding, student engagement, and ownership of learning[9-11]. They provide opportunities for authentic assessment and self-reflection, enabling both students and educators to track and evaluate progress effectively over time[12,13].

Students appreciate the authenticity and relevance of portfolio assessments, as these allow them to showcase their learning through creative and personalized approaches[14,9,15]. This develops positive attitudes toward the assessment process by emphasizing self-expression and meaningful demonstrations of knowledge. Similarly, teachers benefit from the opportunity to employ student-centered assessment strategies that promote individualized feedback and facilitate ongoing dialogue with learners[16,14]. These practices align closely with modern pedagogical goals and enhance teachers' perceptions of assessments as tools for growth rather than solely evaluation[12].

This paper was interested on how portfolio-based assessment could develop critical thinking skills and creativity among students. For example, early studies noted that portfolios develop self-directed learning by encouraging students to take initiative in their educational process. This includes setting personal learning goals, actively engaging in the selection of evidence to demonstrate their progress and reflecting on their learning journey[17,18]. For institutions, portfolios serve as a valuable tool to evaluate the efficacy of their educational strategies, offering insights into how well they are achieving their academic goals and aligning with institutional objectives. For students, portfolios act as a reflective medium that enables them to assess their educational experiences and achievements in relation to their personal aspirations[19]. This paper would like to explore how portfolios developed students' competence in critical thinking and creativity through compiling their works and organizing their requirements.

2. Literature review

Critical thinking (CT) has been widely recognized as one of the most important skills and significant indicators of student learning quality. To develop successful critical thinkers, CT must be intentionally incorporated into curriculum content and teaching approaches and sequenced across all grade levels[20]. Similarly, creativity is an essential construct in education, often discussed alongside technology as a key component of future-focused educational practices[21]. However, while there is enthusiasm for integrating

creativity with technology in classrooms, a lack of consensus exists within and across disciplines regarding how creativity relates to technology in teaching and learning. This gap is particularly evident in the uncertain space of classroom implementation[22]. Research by Suharno[23] revealed that many students demonstrate low engagement and scored poorly in critical thinking, collaboration, communication, and creativity during the initial stages of online learning.

Critical thinking is the ability to approach problems systematically, engaging in a process of judgment and analysis to derive solutions[24]. Cahyono and Waluyo[25] emphasized the importance of critical thinking, decision-making, problem-solving, and reasoning for effective performance. The benefits of critical thinking are evident in several areas, such as problem-solving, informed decision-making, distinguishing facts from opinions, and maintaining composure when addressing complex issues[26]. Consequently, efforts to enhance 21st-century skills such as critical thinking, communication, collaboration, and creativity remain insufficient. Pre-service teachers must therefore be adequately trained to incorporate critical thinking into their instructional practices effectively[27].

Creativity and innovation are interconnected constructs, with creativity serving as the genesis of new ideas and innovation representing the process through which these ideas are implemented and transformed into practical applications[28]. Educational institutions, spanning from primary to higher education, provide a fertile environment for nurturing creativity and innovation, enabling learners to transfer these experiences to real-world contexts[29]. The relationship between creativity and innovation is further clarified by West and Rickards[30], who describe innovation as the deliberate introduction and application of new ideas, processes, or products within a specific context, designed to benefit individuals or organizations. Creativity initiates this process by generating original ideas, which then undergo a collaborative and iterative process of refinement and implementation within a group[31,32]. This collaborative dimension transforms innovation into a social process, where individual cognition merges with collective negotiation and teamwork to produce tangible outcomes.

Studies presented the potential of portfolio-based assessment in developing the critical thinking skills and creativity of students. A portfolio is a purposeful collection of materials providing evidence of learning and a reflective account of that evidence[33]. It teaches learners the skill of gathering evidence of their achievements and experiences, which can be applied later in their professional life[34,35]. It has also been reported that a portfolio is a compilation of samples that document progress, accomplishments and personal achievements[36]. Tekian and Yudkowsky[36] elucidated that a portfolio is a unique individual creation and documentation of evidence and is student-centred, unlike a logbook. Rees and Sheard[33] reported that a portfolio is a learning and personal development plan that documents learning outcomes and activities. Portfolios have become popular learning and assessment tools in higher education[37]. In addition, assessment of portfolios keeps students motivated to continue using them. In training, most portfolio tasks are focused on patient encounters, which is a major clinical learning activity[38].

Portfolio-based assessment is an evaluation approach that involves collecting evidence of student learning through various activities, enabling educators to assess progress and outcomes effectively[39]. Unlike traditional methods such as tests and observations, portfolio assessment offers students the opportunity to showcase their knowledge, skills, and achievements gained throughout the learning process[40,41]. In disciplines such as mathematics, where students are expected to think critically, logically, and creatively, portfolio-based assessment can play a significant role in enhancing problem-solving skills not only within the subject but also in real-world applications[42]. Critical thinking is cultivated when classroom environments encourage interaction and active communication, engaging students in constructing knowledge.

Regular practice in critical thinking during learning activities helps students build a solid foundation of knowledge and experience, enabling them to address challenges both inside and outside the classroom[39].

However, despite its potential, this method is not widely adopted in classrooms[43]. Given the limited studies conducted regarding portfolio-based assessment, this paper explored how students could gain essential skills through this approach. This paper explored how do students develop their critical thinking skills and creativity with portfolio-based assessment. This was remarkably interesting as early studies on portfolio-based assessment indicated that portfolios acknowledge the unique attributes of each learner, promoting intrinsic motivation and a sense of autonomy[44].

3. Objectives

This paper analyzed the experiences of education students in portfolio-based assessment and its role in the development of their critical thinking skills and creativity. Through this analysis, valuable insights were gained into how portfolio-based assessment serves as a dynamic educational tool that encourages students to engage deeply with their learning processes. Specifically, it highlights how such assessments prompt students to reflect on their experiences, analyze challenges critically, and devise innovative solutions to academic and real-world problems. Below are the specific objectives in this paper.

(a) Examine how portfolios influence the critical thinking abilities of education students.

(b) Explore the impact of portfolios on the creative skills of education students.

4. Methods

4.1. Research design

This paper explored the experiences of education students in portfolio-based assessment, and how this shaped their critical thinking and creativity. Exploratory studies are designed to investigate specific questions or gain preliminary insights into phenomena that are not yet fully understood[45-47]. According to Swedberg[48], the primary objective of exploratory research is to develop an understanding of a topic, serving as a springboard for subsequent, more focused inquiries. This process involves creating a broad framework or outline that can guide future investigations. Chavez et al.[49] emphasize that qualitative exploratory designs are particularly effective in addressing gaps in existing literature, as they allow researchers to discuss underexplored topics while actively engaging participants in the co-creation of new knowledge. These designs are essential in capturing the complexity and specificity of human experiences, especially in areas where established theories or data are scarce. Despite occasional criticism regarding their perceived lack of methodological rigor, exploratory studies are recognized for their ability to provide crucial preliminary insights. Swedberg[48] argues that their flexibility and adaptability make them valuable for efficiently framing research problems and collecting initial data. Akhtar et al.[50] further highlight that exploratory studies often function as precursors to more definitive research, laying the groundwork for subsequent studies to build upon. This paper answered one critical question: how do students develop critical thinking and creativity in portfolio-based assessment?

4.2. Participants and sampling

Exploratory research is characterized by its focus on understanding phenomena rather than quantifying them, which often leads to smaller, targeted sample sizes[51,52]. Unlike quantitative approaches, the emphasis in qualitative exploratory studies lies on how cases are selected and utilized to deepen insights[53]. In such studies, purposive sampling is commonly used to intentionally select participants who possess relevant experiences or expertise essential to the research focus[54,55]. This method's flexibility allows researchers to

design the sampling criteria as new insights emerge, making it particularly suited to uncovering patterns and generating innovative concepts[56,57]. In qualitative exploratory designs like phenomenology and narrative inquiry, small, focused samples—typically ranging from one to 20 participants—are deemed sufficient for generating detailed insights[58]. With depth over breadth, exploratory studies effectively identify emergent themes that might be diluted in larger samples[59,46]. In sampling, online purposive sampling[60] was carried out through preliminary online survey. College students from Basilan, Philippines were asked open-ended questions about their experiences in portfolio-based assessment. They were sampled based on three criteria: (1) enrolled in academic year 2024-2025, (2) had experienced making portfolio for any subject, and (3) use creative methods to meet their academic requirements. There were 16 education students participated in the one-on-one interviews. **Table 1** presents the summary of the information of participants.

Table 1. Summary information of interview participants.

Student No.	Sex	Age	GPA	Education Major	Year Level	Key Experiences in Portfolio-Based Assessment
Participant 1	Female	19	1.5	General Education	2nd Year	Reflecting on personal growth through portfolio entries.
Participant 2	Male	20	1.7	Secondary Education	3rd Year	Tracking teaching practice improvements.
Participant 3	Female	18	1.4	General Education	1st Year	Showcasing creative projects and learning artifacts.
Participant 4	Male	22	2	Secondary Education	4th Year	Documenting lesson plans and teaching strategies.
Participant 5	Female	21	1.8	General Education	3rd Year	Developing critical analysis through portfolio reviews.
Participant 6	Male	18	1.2	Secondary Education	1st Year	Presenting reflective essays on course learning.
Participant 7	Female	20	1.6	General Education	2nd Year	Exploring creative teaching aids via portfolios.
Participant 8	Male	19	1.3	Secondary Education	2nd Year	Recording demo teaching reflections and feedback.
Participant 9	Female	22	1.9	General Education	4th Year	Tracking academic growth and personal insights.
Participant 10	Male	21	1.5	Secondary Education	3rd Year	Illustrating problem-solving processes through portfolios.
Participant 11	Female	20	1.4	General Education	2nd Year	Documenting creative approaches in problem-solving.
Student No.	**Sex**	**Age**	**GPA**	**Education Major**	**Year Level**	**Key Experiences in Portfolio-Based Assessment**
Participant 12	Male	19	1.7	Secondary Education	2nd Year	Reflecting on peer feedback and classroom strategies.
Participant 13	Female	18	1.3	General Education	1st Year	Using portfolios for group projects and teamwork skills.
Participant 14	Male	22	2	Secondary Education	4th Year	Demonstrating mastery in curriculum design projects.
Participant 15	Female	19	1.8	General Education	2nd Year	Developing writing and critical thinking skills.
Participant 16	Male	21	1.6	Secondary Education	3rd Year	Highlighting innovative teaching techniques.

4.3. Instrumentation

Semi-structured interview guide was developed to gather the narratives from the participants. Conducting interviews in exploratory studies often favors flexibility and adaptability over rigid structures, making semi-structured interviews a widely preferred method. Unlike standardized questionnaires, semi-structured interviews allow researchers to delve deeply into participants' perspectives, providing opportunities to probe further into their beliefs, experiences, and ideas[61,62]. This flexibility ensures that essential themes are explored while also accommodating new perspectives that may emerge during the conversation[46]. Creating an effective interview guide begins with understanding the research context and objectives, which inform the preliminary design of questions[62]. Pilot testing these questions is crucial for refining clarity, accessibility, and their ability to elicit detailed responses. Feedback from expert reviews further enhances the guide's reliability and alignment with the study's goals[63]. Structured around key topics, the guide maintains a balance between facilitating free expression and ensuring all significant areas of inquiry are addressed[64,65]. Research by Kallio et al.[62], based on a review of 2,703 methodological studies, highlights five steps in designing a robust interview guide: identifying prerequisites, leveraging prior knowledge, drafting preliminary questions, pilot testing, and finalizing the guide. These steps ensure that the guide is both methodologically sound and contextually relevant. **Table 2** presents the final interview guide after pilot testing and expert validation.

Table 2. Interview guide questions.

Objectives	Questions
Examine how portfolios influence the critical thinking abilities of education students.	a. How has creating and maintaining a portfolio helped you analyze and evaluate information more effectively in your studies? b. Can you share an experience where using a portfolio encouraged you to think critically about a topic or problem in your coursework? c. In what ways do you believe the portfolio process has enhanced your ability to form reasoned conclusions or make informed decisions?
Explore the impact of portfolios on the creative skills of education students.	a. How has working on a portfolio allowed you to express your creativity or develop original ideas in your academic work? b. Can you describe a portfolio project or activity that inspired you to think innovatively or approach a task in a unique way? c. What aspects of the portfolio process have encouraged you to explore new methods or creative approaches in your learning?

4.4. Data gathering procedure

Conducting interviews is a cornerstone of qualitative research, offering a method to gather in-depth data about participants' personal experiences and the meanings they attribute to them[66,67]. This process involves active engagement with participants' narratives, emphasizing attentive listening and thoughtful interpretation to reveal insights into their lived experiences[68-70]. Particularly in phenomenological research, interviews are pivotal for understanding individual perspectives, focusing on personal insights rather than collective or cultural interpretations[71,72]. Researchers define the study's objectives, conduct background research, and develop thematic questions aligned with the study's aims[73,74]. Creating a comfortable environment, ensuring confidentiality, and using accessible language are crucial to encouraging openness and eliciting reflective responses from participants[75]. Semi-structured interviews are commonly employed, as they balance flexibility with focus, allowing discussions to flow naturally while ensuring key topics are addressed[76,77]. Narratives, as a means of meaning-making, are central to the interview process, as storytelling has provided a framework for individuals to articulate their perceptions and emotions[71]. Modern qualitative methods prioritize preserving the continuity of participants' narratives, minimizing interviewer bias, and fostering

positive interaction during the data collection process[78]. A typical interview sequence includes a preliminary phase where researchers outline the study's objectives, explain confidentiality measures, and describe how the data will be used. The core phase involves thematic questioning, supported by follow-up probes to deepen understanding. The process concludes with summarizing the discussion and addressing any final remarks from participants[73].

4.5. Data analysis

Thematic analysis was carried out to analyze the narratives from one-on-one interviews. Thematic analysis is a qualitative research method used to systematically identify, organize, and interpret patterns or themes within data, providing insights into shared meanings and experiences[79,80]. This technique is valued for its flexibility and adaptability, particularly in exploratory research, as it enables the emergence of themes directly from the data without being confined by pre-existing frameworks[49,81]. The process typically involves coding data at different levels, beginning with descriptive codes and moving toward interpretative themes that reveal underlying meanings[82,83]. Reflexive thematic analysis, a variant of this method, emphasizes the researcher's active role in interpreting the data while maintaining reflexivity to mitigate the influence of personal biases[84,85]. The approach involves an iterative six-phase process as outlined by Braun and Clarke[79]: (1) familiarizing oneself with the data, (2) generating initial codes, (3) searching for themes, (4) reviewing themes, (5) defining and naming themes, and (6) producing the report. These phases allow researchers to engage deeply with the data, ensuring a structured yet flexible analysis that captures participants' nuanced experiences[86,81]. An inductive, data-driven approach is often preferred, where codes and themes emerge organically from the data, ensuring alignment with participants' responses[86]. Reflexive thematic analysis further emphasizes the interpretative process, where researchers continuously reflect on their positionality and its influence on the analysis[87]. This reflexivity is viewed not as a limitation but as a strength that enriches the analytical depth. The iterative nature of this approach allows researchers to revisit earlier phases, refining their interpretations and ensuring coherence and rigor[85]. This method's adaptability and rigor make it a cornerstone of qualitative research, providing a systematic yet flexible framework for understanding complex qualitative data[88]. **Figure 1** presents the processes involved in analyzing the narrative data through reflexive thematic analysis.

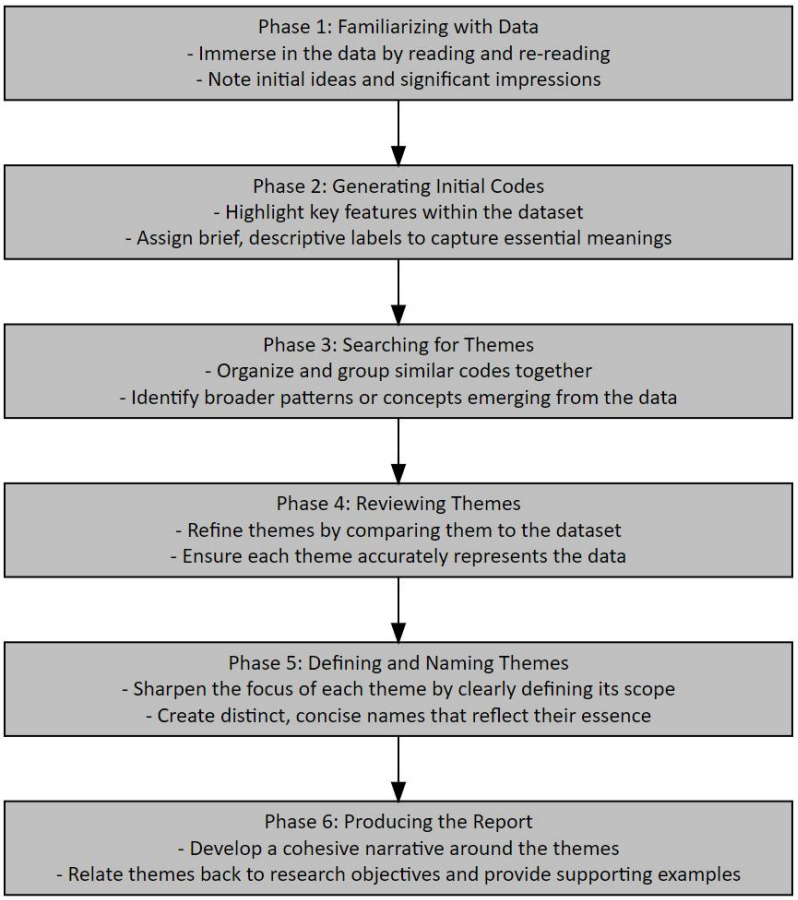

Figure 1. Six phases of reflexive thematic analysis by Braun and Clarke (2006).

5. Results

Objective 1: Examine how portfolios influence the critical thinking abilities of education students.

Findings provided an overview of how portfolio creation influences the critical thinking abilities of education students. The findings are categorized into three main themes—Creation, Problem Solving, and Observation—each highlighting distinct aspects of the critical thinking process.

Participants emphasized the role of portfolio-making in developing meaningful outputs, particularly through the creation of instructional materials (IMs). They discussed how conceptualizing and designing these materials requires careful thought to ensure they are engaging, relevant, and inclusive for diverse learners.

Students also described how creating portfolios involves navigating unexpected hurdles, from meeting academic requirements to producing innovative materials. These experiences enhanced their ability to analyze situations, develop strategies, and think creatively, which ultimately improved the quality and effectiveness of their outputs.

Participants stressed that observing teaching strategies and reflecting on their application in classroom scenarios enriched their understanding of effective teaching. They underscored the value of observation in ensuring the originality and authenticity of their work, as well as its role in enhancing their creative and critical thinking skills, such as designing instructional visuals and adapting methods to suit varied learning styles.

Theme 1: Creation

Portfolio creation was a central aspect of the participants' training as future educators, serving as a tangible representation of their teaching practice and academic efforts. The connection between portfolio creation and critical thinking emerged clearly, as students engaged in the mental process of generating meaningful outputs. This involved conceptualizing and crafting instructional materials that were integral to their portfolios and crucial for effective teaching. Developing IMs required critical thinking skills such as selecting appropriate materials, integrating them into lessons, and ensuring they were relevant and aligned with academic goals. This process not only made the learning experience more engaging but also demonstrated the teacher's critical thinking in instructional design.

> "As a future teacher, portfolio creation has been a significant aspect of teaching practice. A portfolio serves as a final output, compiling our efforts to be evaluated for grades." – Participant 10

> "The connection between portfolios and critical thinking lies in utilizing our minds to create meaningful outputs." – Participant 6

Participants explained how creating IMs demanded careful consideration of the content and its delivery method to suit diverse learning styles, including visual, auditory, and kinesthetic learners. This emphasized the importance of critical thinking in tailoring educational resources that meet varied learner needs. For instance, a BEEd student would first conceptualize a design that was visually appealing yet educational. This approach ensured that the IMs were engaging and facilitated learning effectively.

> "In our education major, we were tasked with creating instructional materials during our second year. These materials are integral to our portfolios and essential for teaching. Developing IMs demands critical thinking skills, such as selecting appropriate materials for the topic and integrating them effectively into lessons. This process enhances students' engagement and makes learning enjoyable, reflecting the teacher's critical thinking in their instructional design." – Participant 7

> "Critical thinking enables me to generate ideas that align with subject relevance and suitability. This ensures that my work resonates with the academic requirements and goals." – Participant 2

> "Creating effective and inclusive IMs that cater to diverse learners, including visual, auditory, and kinesthetic students, highlights the importance of critical thinking in education." – Participant 1

> "As a BEEd student, we are exposed to various instructional materials during demonstrations. Before I create my instructional materials, I first conceptualize a design that is not only visually appealing to students but also enhances their learning." – Participant 8

Challenges in the portfolio-making process also highlighted the need for creative thinking. For example, in the absence of readily available recyclable materials like a washing machine or trolley, participants had to think independently and creatively about designing and constructing these items using available resources. This required an expansion of thinking beyond conventional methods and relied on trial and error, reflecting an iterative process of testing ideas, refining approaches, and ultimately achieving success. The experience was both challenging and rewarding, demonstrating how critical thinking could transform theoretical knowledge into practical solutions.

> "In the process of creating a portfolio, which includes our instructional materials, we faced challenges in production. For instance, there was no existing washing machine or trolley made from recyclable materials to use as a reference. This required us to think independently about how to design and construct such materials using available resources." – Participant 15

> "Without any prior research or information to rely on, we had to expand our thinking and explore various possibilities. While the process involved trial and error, we were ultimately successful, and the outcome was both effective and rewarding." – Participant 8

Theme 2: Problem Solving

Creating a portfolio was not just about meeting academic requirements but also about developing critical thinking skills and problem-solving strategies. The primary objective was to ensure the portfolio met the standards required for assessment, which meant engaging in a rigorous process that involved analyzing situations and finding effective solutions.

> "The primary goal of creating a portfolio is to meet academic requirements. Students employ critical thinking skills or problem-solving strategies to accomplish this, ensuring the portfolio meets the standards required for assessment." – Participant 16

As a BEEd student, the development of problem-solving skills was a key outcome of portfolio creation. These skills extended beyond academic scenarios to real-life situations where participants had to think critically and apply solutions practically. Challenges encountered during portfolio-making required participants to engage in careful analysis, identify problems, and develop creative solutions that aligned with academic and practical constraints.

> "As a BEEd student, one critical thinking skill I developed through portfolio making is problem-solving. This skill extends beyond mathematical problems to real-life situations. Through portfolio creation, I encountered challenges that required me to apply these skills effectively." – Participant 5

The process of portfolio creation involved moving beyond conventional methods and thinking outside the box. Participants found that they needed to incorporate innovative ideas and approaches to address various issues. For example, as an artist, one participant explained how they creatively designed instructional materials to enhance their appeal and impact. This required a blend of technical skills and creative thinking to produce outputs that were not only visually engaging but also met educational objectives. The challenge was not merely about completing tasks but about doing so in a way that tested the limits of traditional methods, pushing participants to experiment with new ideas and refine their problem-solving abilities. The iterative nature of portfolio creation, involving trial and error, demonstrated how critical thinking was integral to developing effective solutions in both academic and real-world contexts.

> "Portfolio-making involves problem-solving, a critical thinking skill. Addressing challenges during the process requires analyzing situations and developing solutions, both in academic and real-life contexts." – Participant 12

> "Portfolio creation involves thinking beyond conventional methods. By thinking outside the box, I can enhance the quality of my outputs. For instance, as an artist, I incorporate creative designs to make my projects visually appealing and

> impactful. This process sharpens my critical thinking skills, pushing me to explore innovative ideas and approaches." – Participant 11

Theme 3: Observation

Observation and reflection were identified as key critical thinking skills that significantly influenced the participants' portfolio-making process. Participants emphasized the importance of reflecting on what they observed, particularly in relation to teaching strategies. This reflective practice involved thinking critically about whether the strategies they observed were suitable for the class context and could yield effective results. By applying these observations, participants developed a deeper understanding of how to adapt and refine their teaching methods to meet diverse learner needs.

> "Observation and reflection are key critical thinking skills that influence portfolio-making." – Participant 3

> "Keep on reflecting on what we observe; every time I see teaching strategies, I should apply them to see results and think about whether they suit the class." – Participant 13

Participants also highlighted the importance of drawing as a creative skill, especially for BEEd students teaching young children who learn best through pictures. The act of drawing became a powerful tool for creating visual aids, such as drawings of animals, which facilitated learning when traditional printing methods were unavailable. This creative skill not only engaged students but also served to effectively communicate concepts and information in a manner that was clear and easy to understand.

> "I think drawing is a key creative skill, especially as a BEEd student teaching kids who learn best through pictures. My love for drawing began in high school and has improved over time. In this course, I've further developed this skill, using it to create visual aids like drawings of animals, especially when printing isn't an option." – Participant 9

Observation also involved analyzing essential elements of teaching and learning, interpreting these observations was key to ensuring that portfolios were authentic. Reflection on these observations allowed them to critically assess their work, identify gaps, and make improvements to align with educational goals and standards. This iterative process of observation and reflection underscored the role of critical thinking in creating meaningful and effective portfolios.

> "Observation involves analyzing essential elements, while reflection encompasses interpreting these observations. These skills ensure that portfolios are authentic, avoiding plagiarism and scripted content." – Participant 4

Objective 2: Explore the impact of portfolios on the creative skills of education students.

This study also explored the impact of portfolios on the creative skills of education students. This involved examining how students engage with and develop creative thinking through the portfolio-making process. The analysis can be categorized into two themes—organization and unconventionality.

Students highlighted that creating a portfolio demands a foundational level of creativity, which translates into the ability to structure ideas and tasks effectively. Students recognized that an organized portfolio is essential as it serves as a reflection of their work and academic progress. They understood that creativity is not only about original ideas but also about how those ideas are presented and arranged.

In contrast, unconventionality focused on the role of creativity in generating new and innovative concepts. Participants described how they were encouraged to think outside the box when creating their instructional materials and how this approach helped them develop imaginative and practical solutions.

Theme 1: Organization

Organization emerged as a central aspect of the portfolio creation process, reflecting the importance of structuring ideas and presenting them effectively. Participants noted that creating a portfolio requires creativity, which is a fundamental skill underpinning the organization and presentation of ideas. This process demands a thoughtful arrangement of tasks and outputs to ensure they are original and impactful.

For instance, students highlighted the necessity of organizing their portfolios to reflect their academic compliance and to meet assessment standards. They emphasized that neatness and structure were not merely aesthetic choices but essential elements that contributed to the overall quality of their work.

> "Creativity drives the organization and presentation of ideas, ensuring that outputs are original and impactful." – Participant 1

> "This skill translates to a broader ability to structure tasks effectively, enabling the accomplishment of objectives in an organized manner." – Participant 14

> "I think the creativity depends on the work of individuals so for me if the students will report their portfolio. They need to think that it is important that their portfolio is organized and neat because the portfolio is the basis of their output, as it is the compliance of their requirements." – Participant 2

Participants noted that this organization translated to an ability to structure tasks more effectively, ensuring that objectives were met in a systematic manner. By arranging the requirements and materials coherently, they developed a deeper sense of creativity. This approach required them to think carefully about how to present their work, balancing content with visual appeal. The careful arrangement of materials helped students to see connections between different ideas, making their work more comprehensive and coherent.

> "…complying with those requirements, so by complying and arranging the requirements, it helps you in that way to become more creative and develop your creativity skills." – Participant 5

Participants described how adhering to organizational principles allowed them to express themselves more clearly and to showcase their understanding of the subject matter. This not only helped them comply with academic standards but also demonstrated their ability to manage tasks efficiently. The neatness of their portfolios became a form of self-expression, indicating their capability to manage information effectively and to present their work in a manner that was both structured and accessible.

> "So, in particular, organizing is one of the principles of creativity we all know. Through organizing and being neat with your portfolio, it gives you an impact, an expression that you are an organized person and a neat person." – Participant 8

Theme 2: Unconventionality

Unconventionality emerged strongly from the portfolio creation process, reflecting an emphasis on creativity and thinking beyond traditional boundaries. Participants described the importance of creating new ideas and solutions that were not already established. This required an approach that valued imagination and inventive thinking.

For instance, in their second year, students engaged in developing instructional materials for their major in Home Economics, which required them to think creatively about what was needed and how to meet those needs. This activity was seen as a way to nurture critical thinking skills, particularly the ability to think outside the box and to devise innovative solutions.

> "To create an idea or new ideas that we don't have before." – Participant 9

> "In our second year, we created IMs for our major in Home Economics. This activity developed critical thinking skills, particularly creativity, by encouraging us to think outside the box." – Participant 10

The process of creating these IMs highlighted the role of imagination as a crucial creative skill. Participants noted that this skill allowed them to manage tasks effectively and make the right decisions for their portfolios. It was through this imaginative thinking that they were able to devise solutions that were both functional and original. For instance, they described designing a washing machine with wheels and a storage compartment—a design that combined practicality with convenience. This unconventional approach addressed real-world problems effectively, demonstrating how creative thinking could translate theoretical knowledge into practical application.

> "Imagination is one of the best creative skills that you can acquire. It will really help you manage things and make the right decisions that you need in your portfolio." – Participant 13

> "When creating a portfolio, we develop creative skills by designing and inventing our own concepts, often surprising ourselves with the outcomes. For example, we designed a washing machine that includes both wheels and a storage compartment. The wheels make it easier to move the machine from one place to another, while the storage compartment provides a convenient solution for keeping soap and other items organized. This combination of functionality—serving as both a washing machine and a storage box—addresses practical problems effectively. I believe this is a great example of applying creative thinking skills." – Participant 3

Participants discussed how they extended their creative thinking by incorporating technology and other resources into their projects. By integrating diverse sources and tools, they were able to elevate their instructional materials to the next level. This process not only developed their creative skills but also enhanced the overall quality of their work. The willingness to experiment and innovate, even when faced with limited resources, showcased their ability to approach challenges in new ways.

> "Like, for example, the IMs we make, we improve them to the next level by applying the use of technology and other sources that we can use for this IMs. By doing that, my creative skills develop." – Participant 12

6. Discussion

Teachers' goals include preparing students to think critically, which is also a quality sought by employers of university graduates. As a result, critical thinking is seen as a significant factor in the educational process. Many academics and researchers have recently conducted studies on the advantages and impacts of critical thinking skills in various fields, the benefits of which have been widely addressed in educational curricula[89,90].

Frontline educators, who are responsible for designing, implementing, and reforming educational systems, have increasingly been encouraged or directed to focus on teaching CT across different subject areas. The goal is to develop a new generation of individuals who can act in a responsible, ethical, and autonomous manner within the complex, evolving, and disputed social landscape[91,92]. However, teaching CT, as highlighted in previous studies[93,94], proves to be a cognitively demanding and emotionally challenging task.

This study observed the potential application of portfolio-based assessment in developing the CT of education students. Portfolio-based assessment, as a form of alternative assessment strategy, has been widely used in writing courses, and studies on the impacts of portfolio-based assessment generally affirm its positive contributions to students' writing performance[95]. Notably, research on the attributes of changes in students' writing performance due to portfolio-based assessment focuses on two key aspects: changes in psychological attributes of learners and shifts in their writing habits. The portfolio was also found to influence motivation for reading among Iranian students[96] and metacognitive awareness[97], as well as positively impacted the autonomy of Iranian freshman undergraduate students[98]. A similar phenomenon was observed among education students when it comes to portfolio-based assessment. Education students are tasked to compile their instructional materials and teaching documentation in a portfolio as one of their academic requirements. Findings indicated that with portfolio-based assessment, the education students developed their critical thinking skills enabling them to generate ideas, solve problems, and reflect on their needs. One student said that "Addressing challenges during the process requires analyzing situations and developing solutions, both in academic and real-life contexts." Like Iranian students, education students benefit from the reflective nature of portfolio assessment, which helps them internalize learning processes, evaluate their progress, and adapt strategies accordingly.

Other studies further confirmed the positive effects of portfolio-based assessment on Iranian students' active involvement in the writing process, such as planning, revising, and editing[99,100]. It was established that portfolio-based assessment developed students' competence in planning, revising and editing, and this competence was also observed among education students. One education student revealed that "Keep on reflecting on what we observe; every time I see teaching strategies, I should apply them to see results and think about whether they suit the class." With portfolio-based assessment, education students were given the opportunity to reflect on their needs as young educators. Critical thinking is not merely a skill but a mindset that involves the ability to analyze, synthesize, and evaluate information critically[101,102]. In mathematics education, Nicolasora[103] observed the positive impact of this assessment on learners' attitudes toward mathematics and their engagement with the material. There was a notable enhancement in metacognitive skills, such as self-monitoring and debugging, as well as improved time management. The portfolio-based assessment serves as a catalyst for the development of such a mindset among education students. Allowing education students to reflect on their instructional strategies, justify their choices, and consider alternative perspectives, this method nurtures a habit of thoughtful inquiry that extends beyond academic tasks, as portfolio-based assessment allow education students to observe, reflect, and create solutions to their academic problems.

Studies on portfolio-based assessment have also linked positive effects to students' creativity, as they provide an opportunity for learners to engage actively with the material, experiment with ideas, and apply their problem-solving skills in practical contexts. For example, teaching with e-portfolios requires creativity and innovation, as they enable the development of transversal skills such as critical thinking, initiative-taking, digital tool usage, problem-solving, and collaboration[104]. One education student agreed to this explaining, "[Creating instructional materials] developed critical thinking skills, particularly creativity, by encouraging

us to think outside the box." This process not only enhances their problem-solving abilities but also encourages understanding of the content and the ability to adapt to new challenges. Similarly, e-portfolios were essential not only in developing transversal skills through innovative teaching and learning practices but also played a crucial role in the learning process itself by integrating new learning and assessment strategies[105,106]. Through portfolio-based assessment, students learned to use unconventional materials to present their works while developing effective instructional materials. One student said that "When creating a portfolio, we develop creative skills by designing and inventing our own concepts, often surprising ourselves with the outcomes."

Butakor[107] found out that nursing students believed e-portfolios could provide an opportunity for them to show their creativity and innovation. E-portfolios were also found to act as catalysts that stimulate creativity and the generation of new ideas among students[108]. Even in traditional ways, in instances where students use recyclable materials to make portfolios, it was still possible to develop their creative skills. For example, one student experienced making instructional materials designed as a "washing machine" with wheels and a storage compartment. She used this approach to present a report in front of her class. She believed that "this is a great example of applying creative thinking skills." In most cases, portfolios facilitate self-reflection by allowing students to review their work and identify areas for improvement[109,110]. One student reported, "we improve them to the next level by applying the use of technology and other sources that we can use for this IMs." Consequently, for students, they took their instructional materials to the next level by integrating the use of technology and other resources, like online research or multimedia tools, which could enhance both the content and the presentation. This self-assessment not only helps students refine their work but also cultivates a mindset of continuous improvement, essential for mastering skills and developing transferable skills that extend beyond the classroom. The result is a more profound and integrated learning experience that not only enhances their creativity but also prepares them for real-world challenges where adaptability and problem-solving are key.

7. Conclusion

This study examined the potential of portfolio-based assessment as a tool for developing critical thinking skills and creativity among education students. This assessment method encourage engagement with the learning process, allowing students to reflect on their thought processes, analyze information critically, and develop solutions to both academic and real-life problems. By compiling, revising, and reflecting on their portfolios, students were able to enhance their metacognitive awareness and autonomous learning. This process not only supported the internalization of academic content but also cultivates a mindset that values thoughtful inquiry, adaptability, and continuous improvement. It enabled students to navigate evolving educational landscapes and prepared them for real-world challenges where critical thinking and problem-solving are necessary. Portfolio-based assessments thus offer a valuable opportunity for education students to engage deeply with their learning, apply theories and concepts practically, and refine their instructional strategies in meaningful ways. This method can contribute significantly to the development of essential skills that are crucial for success in teaching and beyond.

Consequently, educators should clearly define assignment goals and provide structured guidance to help students understand how their portfolios align with these objectives. Professional development opportunities should be provided to teachers to equip them with the necessary skills to integrate digital tools effectively into portfolio creation and assessment. At the institutional level, there should be a commitment to supporting equitable access to technology and resources needed for portfolio-based assessments, ensuring that all students can benefit from this approach. From a policy perspective, educational frameworks should be

adapted to include portfolio-based assessments as an integral part of the curriculum, reflecting real-world challenges and promoting critical thinking skills. This would also involve the provision of appropriate training and resources to help educators implement these assessments effectively.

Several limitations were identified in this study. Firstly, the generalizability of the findings is constrained by the specific cohort of education students who participated in the study. Differences in institutional resources, access to technology, and individual student characteristics may impact the effectiveness of portfolio-based assessments across different contexts. Another limitation was the relatively short duration of the study, which limits the ability to assess the long-term impact of portfolio-based assessment on student outcomes. Further research is needed to track student progress over time to understand how the benefits of this approach sustain beyond initial implementation. Finally, the study was limited to assessing immediate changes in student behaviors and attitudes, such as reflection frequency and engagement with the assessment process. It did not measure the direct impact of portfolio-based assessment on student achievement in subject-specific competencies or career readiness skills. Future studies should include more comprehensive measures to assess the broader impacts of portfolio-based assessment and explore how it influences students' preparedness for professional roles and their overall development as critical thinkers and lifelong learners.

Conflict of interest

The authors declare no conflict of interest.

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