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Digital science poster: Implementation of project-based learning for pre-services early childhood teachers

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ABSTRACT

This research delves into assessing students' competency in designing and presenting digital science posters within a project-based learning framework. Participants included all students enrolled in the early childhood science introduction course at State Islamic Institute of Kerinci. Over an 8-week period, students had the opportunity to develop their projects, subsequently evaluated through four type assessments: self-assessment, peer-assessment, lecture-assessment, and external expert-assessment. Varied assessment strategies were employed to ensure fairness and prevent bias. Correlational analysis aimed to unveil relationships between data associated with digital science poster presentations. Results demonstrated that project-based learning, specifically through poster design and presentation, yielded significant benefits for pre-service early childhood teachers. Correlation analysis (Spearman's rho) showed a high and significant correlation ($r_s = 0.717, \rho = 0.003$) between students' abilities in designing and presenting digital science posters. Despite the existence of assessment rubrics, self and peer-assessment struggled to provide accurate and reliable data. The study recommends implementing project-based learning activities, such as poster development and presentation, across diverse content, approaches, and educational levels.

Keywords: digital, poster, science, pre-services teacher, project-based learning

INTRODUCTION

Education is confronted with challenges arising from globalization and technological advancements (OECD, 2018). Moreover, technology proves beneficial when integrated into education, particularly in learning. To maximize the advantages of technological progress, the ability to adapt early on is crucial. The influence of technology has permeated the world of children from an early age (Macdonald & Rafferty, 2015). So, there is an awareness that science should be introduced to individuals from an early stage. Consequently, science learning should also be integrated with technology.

The integration of learning with technology actually emerged in the 1980s with the advent of personal computers (Redish, 1993). The presence and role of technology have continued to strengthen in the educational environment until now. In learning and from the teacher's perspective in the current era, the integration of learning or the pedagogical, content, and technological aspects, is well recognized as TPCK (Mishra & Koehler, 2006) or TPACK (Hsu, 2015). As prospective educators, understanding the integration of technology in learning is not enough. They are expected to be able to practice this integration in teaching as preparation to become educators and as a foundation to face students in the future (Macdonald & Rafferty, 2015).

One form of learning that supports the application of technology in education while still requiring the direct involvement of students is active learning. Science education views active learning as an essential form of learning. One way to realize active learning and also integrate technology is by implementing project-based learning, such as using posters (Dorner, 2015). Previous studies have revealed that activities involving the depiction or design of a visual concept in the form of a poster are interesting and crucial in the learning process (Cahyani & Pranata, 2023). Learning activities can also be diversified in relation to projects and posters. Previous studies have confirmed that varied learning activities are necessary to achieve learning objectives (Cahyani & Pranata, 2023; Hodson, 2014).

Posters have been widely applied across various contexts. The use of posters as a communication medium has rapidly evolved due to the support of more engaging visualization. Posters have even contributed to changing communication trends in national and international scientific forums such as conferences and scientific meetings (Gosling, 1999), becoming a common and popular communication medium in the academic world (MacIntosh-Murray, 2007; Rowe, 2017). Posters have proven effective not only as a means of information transfer in scientific conferences but also in disseminating information in the fields of science, education,

and health to the general public (Ilic & Rowe, 2013). They have also been found to be effective when applied inside and outside the classroom, particularly when instructors seek to enhance interaction with students (Ramsey & Fowler, 2004).

Posters have been proven successful in supporting classroom learning at various levels (Newbrey & Baltezore, 2006). They continue to play a significant role in middle and high school science classrooms (Hubenthal et al., 2011), as well as in early childhood science education (Ortiz, 2023; Ramsey & Fowler, 2004). Recently, the use of posters has been on the rise. Students consistently create scientific posters as part of their coursework (Brown, 2020; Deonandan et al., 2013; Hay & Thomas, 1999; Ilic & Rowe, 2013; Rauschenbach et al., 2018; Siddiqui et al., 2021). The same activity has also been applied in project-based learning at the higher education level (Gruss, 2018; Schmitt-Harsh & Harsh, 2013) and in lab-based learning as a means to showcase experimental results (Rauschenbach et al., 2018).

The primary purpose of scientific or academic posters is to convey scientific information and ideas in a visually engaging format (Gosling, 1999). Poster presentations are recognized as a valid form of knowledge transfer within the academic sphere (Rowe & Ilic, 2009). Posters prove to be an effective tool for communicating the significance of scientific resources to non-scientists and can be applied across various disciplines and classroom settings (Mayfield et al., 2018). In an educational context, posters offer numerous benefits. They serve as colorful and attractive learning aids, built on the premise that visual stimuli can capture interest, attention, and aid in memory retention (Çetin & Flamand, 2013).

Thus, learning activities involving the development of posters and related skills offer numerous benefits for students. Poster preparation and presentations serve as a logical extension and visualization of learning-dependent tasks or projects (Brown, 2020). Posters provide students with opportunities to reflect on their learning, receive feedback from peers and faculty, share their acquired knowledge, and strengthen the connection between information retrieval skills and effective communication (Kinikin & Hench, 2012). Additionally, posters facilitate rapid communication of scientific ideas, visually represent concepts, stimulate an exchange of ideas between the presenter and the audience, serve as a summary of work, can be viewed in the author's absence, and offer valuable networking opportunities (Cook & Fenn, 2013).

Previous research also shown that a poster presentation was a better examination tool than traditional tests (Fernandes et al., 2005). Poster considered that it provided multiple opportunities to display their knowledge, both in poster development and presentation. Posters are common assessment tools in science programs, and they are a common means for professional communication in the sciences (Jarvis & Cain, 2003). The poster exam provides a valuable and viable alternative assessment measure (Mills et al., 2000). Poster assessment was an efficient and fair method that provided opportunities for meaningful feedback (Ross et al., 2019). Poster assignment can be a useful tool for all instructors in both secondary and postsecondary education (Dorner, 2015). From a learning and teaching perspective, they have the potential for creativity and originality, reliable and fast marking, active learning, peer assessment, can promote positive attitudes in students, and also help students to explore and confront misconceptions about a topic (Cook & Fenn, 2013).

Posters have been implemented as projects in subjects such as science (Ortiz, 2023), physics (Pranata et al., 2023b), chemistry (Fernandes et al., 2005), and biology (Dorner, 2015) in various levels. Posters are a common feature in many classrooms, often incorporating visually appealing components and text to explain specific topics. Typically displayed on classroom walls, posters cover subject matters like science, history, and languages (Çetin & Flamand, 2013). Posters are recognized as a valid and reliable form of media for knowledge transfer. They provide an opportunity to convey in-depth information adaptable to a wide range of academic, professional, and commercial disciplines (Rowe & Ilic, 2009).

However, in general, the development and design of posters are still in non-digital print form and can only be observed in the classroom. Non-digital and traditional posters, however, have their own unique downsides (Ahmad, 2019). Traditional posters are more challenging to produce and modify, and there is minimal tolerance for errors in their design. When there is a slight mistake in creating a poster, the designer must think of alternatives to anticipate the error. Issues and challenges like these can be addressed when poster design is done digitally. The development of posters involving technology integration becomes necessary. Posters tend to evolve rapidly with technology, supported by advancements in software and the internet. Thus, flexibility in design and dissemination needs to be enhanced, and technology provides that opportunity. Poster designers only need access to applications or software that supports them in designing posters, such as Photoshop, Canva, and others. In the digital realm, errors in poster design can be easily rectified by students.

In addition to designing posters, the ability to present posters also offers numerous benefits. Presenting scientific ideas through posters serves as practice for students to articulate their thoughts and concepts about science. Furthermore, presenting using posters can facilitate communication with the audience. This is because posters are supported by a combination of visual and verbal information, utilizing illustrations, written text, and oral explanations during the presentation. The organization and delivery of posters play a crucial role in facilitating active communication (Gosling, 1999).

Poster presentations are undergoing transformation with digital media, impacting competence development in this multimodal form of research communication. Future research should explore how the technological evolution of posters affects interaction, communicative purposes, and the texts themselves (MacIntosh-Murray, 2007). The integration of computer and information technology with poster presentations is still in its early stages, with limited innovations available to promote a learner-centered and active method of education (Ilic & Rowe, 2013; Rowe & Ilic, 2009). Digital posters offer an attractive way to present information, providing flexibility for students to create and present while giving them the freedom to be creative. Creating digital posters requires students to develop information literacy skills (Cook & Fenn, 2013).

As a starting point, students (as prospective educators) can be directed to create simple projects such as digital science posters, produce video demonstrations of simple scientific concepts, implement extended reality in learning, and so on. Activities like these have evolved by integrating technology. Integrating technology in learning help students more familiar with science and

Table 1. Competencies and assessment indicators

No	Name	Poster design scores			Poster presentation scores			Comments
		Format & originality	Content relevance	Aesthetics & clarity	Fluency	Accuracy	Confidence	
1	Student 1	…	…	…	…	…	…	…
2	Student 2	…	…	…	…	…	…	…
3	Student 3	…	…	…	…	…	…	…
…	…	…	…	…	…	…	…	…

technology (Putri et al., 2024). Various forms of digital learning products, such as digital posters, have emerged with the advent of various cutting-edge tools and applications (Hubenthal et al., 2011). The primary focus of projects, like science posters, goes beyond designing visually appealing posters for students. It also emphasizes how prospective educators can effectively present these posters. A good presentation ensures that the content on the poster can be conveyed and understood by the audience or students.

Based on studies on posters, both in design and presentation, numerous benefits for the learning process are evident. The implementation of posters is seen as necessary and important for further exploration. Posters will be applied as a technology-based project, and the results (design and presentation) will be analyzed from various perspectives to provide a comprehensive overview of the application of posters in learning.

METHODS

The research included all students from the early childhood education program at State Islamic Institute of Kerinci who were enrolled in the introduction to early childhood science course. To clarify, the study utilized total sampling, involving a total of 15 students. Each student had the opportunity to create their posters over an 8-week period, starting from the beginning of the course. Guidance for poster development from the instructor (lecturer) was provided to each student during this timeframe, both during and outside regular class hours. Previous research has emphasized the importance of specific guidance time for poster development (Ortiz, 2023). In the 8th week, students submitted and presented their posters.

The assessment is divided into two main competencies related to the poster, namely poster design and presentation. The assessment uses a numerical scale ranging from 0-100. Poster design is evaluated based on three indicators, as follows:

1. Format & originality: The poster is an original work designed according to agreed-upon specifications (digital poster with A4 paper size, portrait orientation, containing the designer's name, poster title, and State Islamic Institute of Kerinci logo).
2. Content relevance: The content included in the poster aligns with the course content (including ideas related to science and/or early childhood learning). Written explanations in posters should be accurate, easily understood, and free of typing errors.
3. Aesthetics & clarity: The poster's appearance is clear and attractive. The arrangement of words and images is well-organized and systematic.

Subsequently, poster presentations are evaluated based on three indicators, as follows:

1. Fluency: The presenter appears enthusiastic and can communicate the scientific concepts from their poster fluently.
2. Accuracy: The presenter understands the content of their poster, demonstrated by the ability to accurately explain scientific concepts.
3. Confidence: The presenter can manage the explanation, showing command of the stage and maintaining a suitable pace during the presentation.

The assessment sheet is structured based on these competencies and assessment indicators, as shown in **Table 1**.

The research was conducted through the application of descriptive and correlational quantitative methods. Descriptively, the aim was to explore students' abilities in designing and presenting digital science posters in project-based learning. Additionally, to enhance objectivity in assessment, four different assessment were applied: self-assessment, peer-assessment, lecture-assessment, and external expert-assessment. Previous studies also revealed that diverse assessment strategies are necessary to fairly evaluate students and avoid discrimination (Billington, 1997). However, those studies only involved assessments from instructors, peers, and school/university staff. In this study, students were given the opportunity to assess themselves. Thus, in project-based learning with such a design, students could gain a comprehensive experience from planning, delivering, and evaluating the poster as a learning project.

Correlationally, the aim was to reveal relationships among data related to digital science posters. First, the relationship between the frequency of guidance given to students in designing posters with instructors (lecturers) and the design poster scores. Second, the relationship between students' abilities in designing and presenting digital science posters. Third, the correlation of the four different evaluators was also explored as an additional analysis. The data of scores for the design and presentation of digital science posters were analyzed using descriptive and correlational statistical methods with the assistance of the SPSS application. Correlation tests were conducted using the Pearson correlation test or Spearman's rho, depending on the data's normality conditions.

Table 2. Descriptive statistics

Data	Minimum	Maximum	Mean		Standard deviation	Skewness	
			Statistics	Standard error		Statistics	Standard error
Poster design	62.96	86.14	81.25	1.47	5.70	-2.60*	0.58
Poster presentation	73.21	86.74	78.61	1.06	4.12	0.52	0.58
Final score	68.41	85.84	79.93	1.13	4.38	-1.23*	0.58

Note. The data is not normally distributed

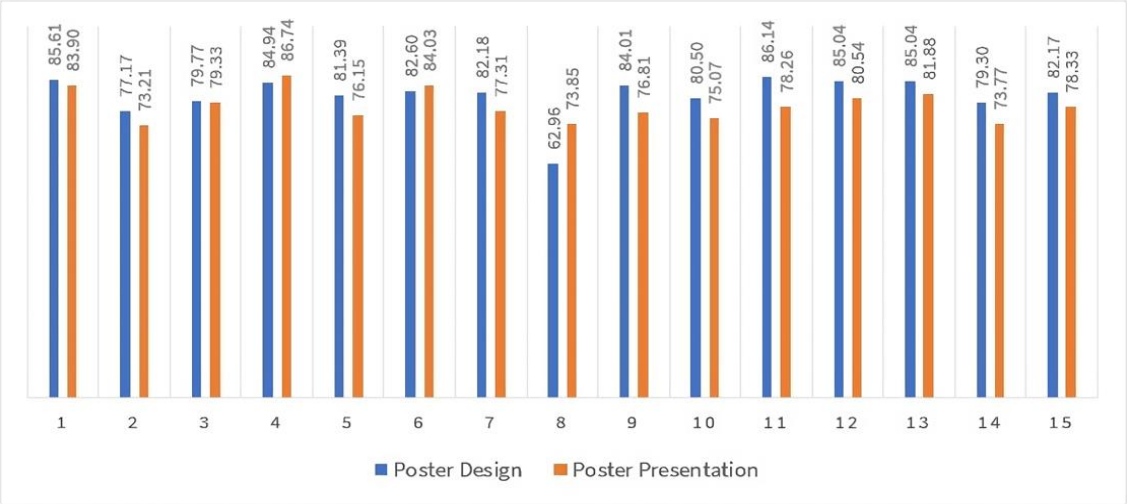

Figure 1. Data for each student (Source: Authors' own elaboration)

RESULTS AND DISCUSSION

Descriptive Statistics

Scores for the design and presentation of digital science posters were collected from four different assessment and analyzed descriptively. The results of the descriptive statistical analysis for overall design and presentation scores are presented in **Table 2**. It can be observed that the average design poster score (81.25) is higher compared to the presentation poster score (78.61). Furthermore, the data for the design and presentation scores for each student can also be illustrated, as shown in **Figure 1**.

The highest design score was achieved by student number 11 (86.14), and the highest presentation score was obtained by student number 4 (86.74). The highest scores for each design and presentation earned them the awards for 'best design' and 'best presentation.' The goal is to enhance motivation through positive and constructive feedback for the effort and work put in by the students. Such feedback has proven effective in triggering active student engagement in subsequent learning activities or lectures. Motivation plays a pivotal role in learning, especially within the realm of science education (Hermiati et al., 2024). Students who exhibit high levels of motivation are more inclined to engage actively in all phases of the learning process to attain their desired educational objectives (Satrianti et al., 2024). These awards can be viewed as a competitive platform and a novel strategy in education, aligning with recommendations from previous studies (Siddiqui et al., 2021).

Design scores are determined by three indicators, as explained in the methodology: format and originality, relevance to science, and aesthetics. Format and originality are crucial indicators for a poster designed by students. However, one out of 15 students, namely student number 8, was found to have a non-original poster. Instructors can use tools like Google Lens to check the originality of an image. This student, as a result, obtained the lowest design score (62.96), as shown in **Figure 1**. Moreover, information contained in the poster should be presented in a concise, clear, and well-organized format to ensure both coverage and clarity. Previous related studies have highlighted the importance of reducing text in posters (Carter, 2021).

To support poster development from a descriptive perspective, instructors must be proficient in using appropriate language to demonstrate and explain scientific concepts during teaching (Macdonald & Rafferty, 2015). This relates to the next design indicator, namely content relevance. Each student develops a poster focusing on a specific scientific concept or content. Students determine the content freely, considering the scope and relevance to science. Students are guided to develop a poster to showcase their understanding of one scientific concept. The development of poster design requires students to assimilate information they have found to explain what they have learned about their chosen topic (Kinikin & Hench, 2012). For digital science posters, students need to consider scientific topics they are familiar with and understand, connecting them to the topics learned in lectures. Based on the collected poster designs, it can be concluded that the distribution of selected content is, as shown in **Figure 2**.

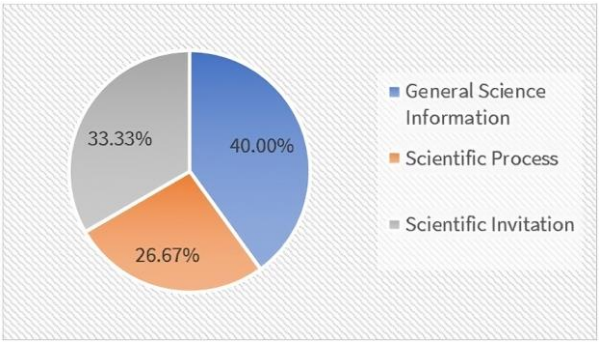

Figure 2. Science content in poster design (Source: Authors' own elaboration)

40% of students chose to include general scientific information on their posters, covering topics such as plant parts, animal species, aquatic life, weather, and global warming. Additionally, 26.27% of students opted to feature processes or cycles occurring in nature, such as rainfall, rice cultivation, life cycles, and butterfly metamorphosis. Finally, 33.33% of students chose to develop posters with invitations, encouraging actions like environmental conservation, health preservation, exploring nature, and raising awareness about global warming. The digital science posters designed by students represent a comprehensive understanding of scientific concepts. Posters can serve as a representation reflecting students' comprehension of the scientific concepts presented (Wade-Jaimes et al., 2018). As artifacts, posters or other multimedia products have proven to effectively represent students' understanding of scientific concepts (Krajcik & Czerniak, 2018).

The final design indicator is aesthetics & clarity. Posters are designed to provide a visual representation of an issue that first captures attention and then conveys the desired message. Previous studies have revealed that the visual appeal of a poster has a greater impact than the subject content, and the images in a poster are the most likely feature to attract the audience's attention and interest (Rowe & Ilic, 2009). For science posters, the issue or content is limited to science, as explained in the previous design indicators. Regarding the beauty of the poster design, various aspects need to be considered, especially design composition and argument structure (Hay & Thomas, 1999; Rowe & Ilic, 2009). Design layout, including color scheme, framing of information, and readability, all influence how effectively essential information is conveyed to the reader, but sometimes, it can also have a negative impact on the scientific message presented (Rowe & Ilic, 2009). Posters provide an opportunity to emphasize the structure of narrative schemes and arguments (Jarvis & Cain, 2003). The background work required to produce a scientific poster demonstrates the knowledge gained about the topic and showcases the student's ability to find, select, and concisely summarize and present relevant information (Newbrey & Baltezore, 2006).

So, on one hand, visualization becomes the main attraction of the poster. In addition to organizing the layout of explanations, posters can also utilize various diagrams, images, icons, and so on. In fact, posters have also proven to be effective in science education by incorporating cartoons into their designs. On the other hand, negative impacts can arise due to errors in visualization in design and insufficient information, which may trigger misconceptions or misinformation.

Another challenge faced by students in developing poster designs is the limited space available for design. Generally, engaging in the process of designing a poster helps students visualize their thought processes (Wade-Jaimes et al., 2018). The limited space on the poster forces students to prioritize and focus their efforts on the main arguments and evidence, the main theme, or the main conclusions. The aesthetics of the poster design play a crucial role in attracting the audience's attention and showcasing the creator's creativity (Newbrey & Baltezore, 2006). Additionally, the presence of cartoons can also encourage active student discussions, help identify, and address misconceptions held by students, and serve as a foundation for scientific inquiry (Kabapinar, 2005).

In general, designing posters can be a beneficial learning activity for students. Developing an educational poster also has practical implications for teachers (Hubenthal et al., 2011) and pre-services teacher. Creating digital posters has the potential to enhance student engagement. The success of a poster as an educational tool largely depends on its design (Rowe & Ilic, 2009). Poster creation provides an opportunity to showcase skills, capabilities, information, and nuances (Siddiqui et al., 2021). The use of poster construction as an effective pedagogical strategy in science teacher education is acknowledged (Navarro et al., 2022). Students can enhance their second language (L2) vocabulary knowledge through posters as a result of self-directed learning (Çetin & Flamand, 2013). In science, many terms originate from a second language. Familiarity with scientific terms should also be a primary focus for science educators (Aprilia et al., 2023). Exploring the role of posters in improving students' familiarity with scientific terms is worthy of further investigation

Posters have been believed to serve as a foundation for communicating their ideas, scientific concepts, and findings to others (Krajcik & Czerniak, 2018). Therefore, project-based learning through the development of posters can assist students in building a solid and integrated understanding of scientific concepts and ideas, which they can apply in different contexts. Even though creating a poster results in a passive medium containing a wealth of information on a specific topic, particularly in science, the presentation of the poster is essential. Posters, as a single intervention, did not elicit changes in knowledge, attitudes, or behavior. Posters should be accompanied by an active intervention, such as an oral presentation. Poster presentations can support the promotion of an interactive learning environment for users and counteract the passive nature of current poster designs (Ilic & Rowe, 2013). Thus, posters not only provide an opportunity for learners to practice critical thinking and organizational skills but also support the development of oral and visual presentation skills (Dorner, 2015).

Related to poster presentations, their evaluation is also determined by a combination of three indicators: fluency, accuracy, and confidence. Essentially, poster presentations create an atmosphere of greater engagement and discussion within the class. Presenting posters facilitates and showcases students' written and oral abilities, allowing assessors to gain insights into the depth and understanding of students' knowledge (through questions) (Newbrey & Baltezore, 2006). Poster presentations enable students to demonstrate their engagement in a meaningful and accurate way, receiving prompt and effective feedback (Ross et al., 2019). The smoothness of the presentation, discussion, and feedback becomes a crucial part of the assessment for the fluency indicator.

The next indicator is related to accuracy. Poster design involves various representations divided into visual and textual elements. Even though the design has included accurate scientific concepts, the ability to communicate these concepts through various representations (multi-representation) is crucial for students aspiring to become early childhood science educators in the future. Poster presentations and discussions about the poster content might serve as a beneficial platform for students to experience conceptual changes in learning. The accuracy of delivering poster content becomes the determinant. In this process, instructors play a crucial role in facilitating conceptual changes. Although conceptual changes through poster presentations and discussions do not always occur, they are more likely to happen with guidance from instructors (Wade-Jaimes et al., 2018). In addition to fluency and accuracy in poster presentations, the presenter's confidence is also one of the skills honed through poster presentation. Students' self-confidence reflects the extent to which they feel assured and capable in dealing with tasks or projects. Previous studies have proven that engaging in poster presentations makes students feel accomplished and enhances their confidence (Siddiqui et al., 2021).

Formal poster presentations are an innovative format for science education and may more accurately reflect the realities of careers in science compared to traditional educational formats (Deonandan et al., 2013). Furthermore, poster presentations as a learning activity enable students to practice lifelong learning skills that can be utilized throughout their professional careers and provide other benefits, such as building a dialogue or engaging in informal conversations about subjects with their peers in school and future workplaces (Vollaro, 2005). So, project-based learning by developing and presenting posters is not only beneficial for students during their academic phase but also advantageous when they enter the workforce, both in academic and non-academic settings (Newbrey & Baltezore, 2006).

Introducing poster tasks as projects into learning/teaching provides many benefits to students. Such projects can facilitate the learning process and student engagement (Ahmad, 2019; Brown, 2020; Schmitt-Harsh & Harsh, 2013), enhance effective written and verbal communication skills (Jarvis & Cain, 2003; Newbrey & Baltezore, 2006; Rauschenbach et al., 2018), develop students' scientific identity and self-efficacy in science communication (Leone & French, 2022), synthesize and organize information, analyze ideas, and integrate ideas from various sources (Gruss, 2018). Overall, posters as projects involve personal and social competencies of students, which are integral to students' emotional intelligence (Pranata et al., 2023a). These abilities, skills, and competencies can be transferred and are crucial for learners and professionals to communicate advanced information and master a subject.

The activity of designing poster layouts and presenting them is one of the engaging learning activities for students. Creating posters is a fun experience for them. This happens because they are more exposed to technology, and in other oral assessments, they already use a smart TV as a poster projector for presentations. Additional activities are also interesting for them, such as observing, listening to peer explanations, and assessing both peer and self-posters. All these activities are considered complex, involving various types of activities such as motor skills, visual, oral, and auditory. Previous studies have revealed that these four types of activities are learning activities that can support active engagement in the learning process (Cahyani & Pranata, 2023).

So, the implementation of posters in science courses for future educators brings many benefits. The development and presentation of posters are valuable learning experiences, where students have to present what they have learned to their instructors (Kinikin & Hench, 2012). Furthermore, the goal is not only to provide a platform for the construction and presentation of science posters but also to offer experience in planning, presenting, disseminating, and assessing. Their posters as their projects promote students' ownership of their work while subtly putting additional pressure on them to work to higher standards. Their peers are watching. In this context, the tutor's praise for the competence and learning achievements of students in their presentations can have significant long-term consequences for motivation and student engagement (Jarvis & Cain, 2003).

Previous studies have also shown relevant elaboration related to science that can be explained through posters to young children in schools in the future (Ortiz, 2023). Posters also pave the way for increasingly beautiful, engaging, and captivating science learning (Siddiqui et al., 2021). Posters also function to foster cognition, invite student questions by developing thought-provoking questions, expand learning opportunities by including relevant URLs, and reduce cognitive load on posters (Hubenthal et al., 2011). Cognitive load was found to contribute the most to students' boredom in science learning (Putri & Pranata, 2023; Utami et al., 2024). Teachers should create an environment that encourages children to play freely, facilitating relevant and contextually active learning and allowing observation of children's spontaneous use of emphasized mathematical and scientific skills and concepts in posters. Furthermore, teachers can guide posters as projects that can confirm students' understanding of concepts (confirmatory tools). The presence of confirmatory tools is crucial to support the students' learning process, especially through integration with technology (Pranata, 2023, 2024). Furthermore, descriptive analysis was also conducted from the perspective of different assessment. The results are shown in **Table 3**.

Based on the results of the descriptive statistical analysis for data from different type of assessment, several interesting patterns can be concluded. First, the average score for poster design tends to be higher compared to the average score for poster presentation from all assessors. The largest difference was found in the scores given by instructors (lecturer). Second, there is a tendency for students to assess their peers with higher scores. This finding can be inferred from the comparison of scores from peer-assessment with scores from lecture-assessment and expert-assessment. Third, a significantly higher tendency, compared

Table 3. Descriptive statistics from different type of assessment

Type of assessment	Data	Minimum	Maximum	Mean		Standard deviation	Skewness	
				Statistics	Standard error		Statistics	Standard error
Lecture-assessment	Poster design	50.00	90.00	81.22	2.44	9.46	-2.79*	0.58
	Poster presentation	68.33	85.00	76.89	1.51	5.84	-0.09	0.58
	Final score	61.67	86.67	79.06	1.66	6.42	-1.38*	0.58
Expert-assessment	Poster design	66.67	83.33	79.09	1.06	4.09	-2.11*	0.58
	Poster presentation	72.67	86.00	77.04	1.14	4.40	1.50*	0.58
	Final score	70.33	84.17	77.94	0.91	3.53	0.15	0.58
Peer-assessment	Poster design	73.93	95.12	82.90	1.51	5.85	0.41	0.58
	Poster presentation	70.00	93.75	82.07	1.78	6.89	0.06	0.58
	Final score	73.04	94.43	82.49	1.60	6.19	0.35	0.58
Self-assessment	Poster design	78.33	100.00	88.40	1.91	7.39	-0.09	0.58
	Poster presentation	76.67	99.33	88.31	2.03	7.84	0.07	0.58
	Final score	77.50	99.67	88.36	1.94	7.51	0.03	0.58

Note. The data is not normally distributed

Table 4. Correlation between guidance frequency and poster design score

Correlation	Spearman's rho	
	Correlation coefficient	Significance (2-tailed)
Guidance frequency and poster design score	0.107	0.705

to the second pattern, was found when students were asked to assess themselves (self-assessment). A similar trend was also identified in a previous study. Students tend to evaluate their digital physics poster work with higher scores (Pranata, Sundari, et al., 2023).

The poster project can be combined with oral presentations or other assessment tools. Posters can be assessed as the final product of a course project (Jarvis & Cain, 2003) The use of scientific posters as a teaching and assessment tool in undergraduate education allows for the demonstration and evaluation of various skills (Brown, 2020; Ilic & Rowe, 2013). Previous studies have revealed that poster examinations are well-received by students and may be a more effective learning tool than standard written exams (Mills et al., 2000). To enhance the novelty related to poster assessment, various assessment groups can be involved (self-, peer-, lecture-, and expert-assessment). Different assessment groups can also improve the objectivity and validity of poster assessment results.

The activity of creating posters, specifically, is actually one of the alternative assessment tools for students. Various stages of the poster project can support self- and peer-assessment (Jarvis & Cain, 2003). Students can visualize and understand their own progress in terms of language use and creativity (self-assessment). Assessment should also enable students to actively generate meaning that connects with their prior understanding. The development and presentation of scientific digital posters become a suitable project for students to demonstrate what they have learned related to science (Krajcik & Czerniak, 2018). Self-assessment serves to enhance self-assessment skills and provides opportunities for future revisions (Navarro et al., 2022).

Furthermore, poster presentations provide an ideal opportunity for utilizing peer assessment as students can view and evaluate each other's work more quickly and efficiently compared to other course assignment formats (Billington, 1997). Posters are one of the most common and effective means of scientific communication among peers (Navarro et al., 2022). Engaging in peer assessment provides them with a purpose to listen and participate in poster activities (Vollaro, 2005) and aids in understanding scientific processes and methods (Rauschenbach et al., 2018). When planed appropriately, assessment can serve as a crucial tool for providing feedback to both teachers and students (Krajcik & Czerniak, 2018). Students produce and present scientific posters as a novel form of assessment (Brown, 2020).

Furthermore, the results of the descriptive statistical analysis can provide information about the distribution of data. Data distribution serves as the basis for determining the correlation test to be used (Pearson correlation or Spearman's rho). The data distribution can be assessed based on the skewness statistic. When the value falls within the range of -1 to 1, the data is considered to have a normal distribution. Conversely, if the skewness statistic is smaller than -1 or greater than 1, the data distribution is concluded to be non-normal (Morgan et al., 2004). **Table 2** and **Table 3** indicate that some data groups are not normally distributed, as denoted by asterisks (*). Therefore, the correlation test will be conducted using Spearman's rho.

Correlation Test: *Spearman's Rho*

In addition to descriptive statistical analysis, the analysis also involves correlation tests among data sets related to digital science posters. Three correlation tests were conducted, all processed using Spearman's rho with the assistance of the SPSS application. Firstly, the results of the correlation test or the relationship between the frequency of guidance sessions for students in designing posters with lecturers and the scores for the design of digital science posters are shown in **Table 4**.

The correlation between the frequency of poster guidance and the score of digital science poster design was found to be low (0.107) and not significant (significance or $\rho > 0.05$). This result indicates that there is no significant relationship or correlation between the frequency of student guidance with the teacher in designing or creating a poster and the poster score. In other words, students with low guidance frequency may have both low and high design scores. Similarly, more frequent guidance does not guarantee high design scores. But previous studies have shown that feedback from teachers can support a better understanding of poster content (Krajcik & Czerniak, 2018). This finding is worth exploring further with a more systematic approach.

Table 5. Correlation between students' abilities in designing and presenting posters

Correlation	Spearman's rho	
	Correlation coefficient	Significance (2-tailed)
Design score and presentation score	0.717**	0.003

Note. **Correlation is significant at the 0.01 level (2-tailed)

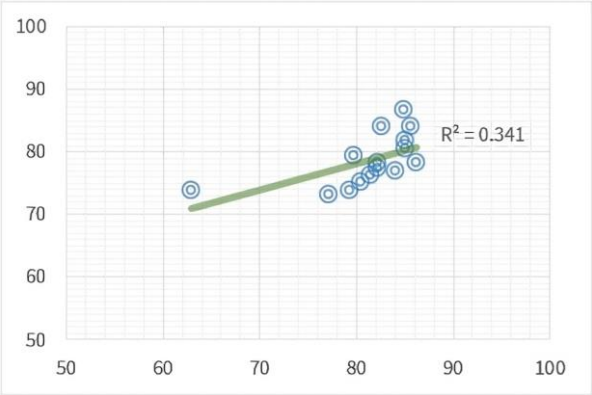

Figure 3. Scatterplot for design and presentation score (Source: Authors' own elaboration)

Table 6. Correlation between different type of assessments (poster design score)

Spearman's rho (poster design score)		Lecture-assessment	Expert-assessment	Peer-assessment	Self-assessment	Final score
Lecture-assessment	Correlation coefficient	1.000	0.673**	0.085	0.292	0.849**
	Sig. (2-tailed)		0.006	0.763	0.291	0.000
Expert-assessment	Correlation coefficient	0.673**	1.000	0.223	0.435	0.834**
	Sig. (2-tailed)	0.006		0.425	0.105	0.000
Peer-assessment	Correlation coefficient	0.085	0.223	1.000	0.284	0.409
	Sig. (2-tailed)	0.763	0.425		0.305	0.130
Self-assessment	Correlation coefficient	0.292	0.435	0.284	1.000	0.579*
	Sig. (2-tailed)	0.291	0.105	0.305		0.024
Final score	Correlation coefficient	0.849**	0.834**	0.409	0.579*	1.000
	Sig. (2-tailed)	0.000	0.000	0.130	0.024	

Note. **Correlation is significant at the 0.01 level (2-tailed) & *Correlation is significant at the 0.05 level (2-tailed)

The second correlation analysis examines the relationship between students' abilities in designing and presenting digital science posters, as shown in **Table 5**.

The correlation analysis results (Spearman's rho) show a high correlation (0.717) that is statistically significant ($\rho = 0.003$) between students' abilities in designing and presenting digital science posters. This indicates that students with high poster design scores tend to have high presentation skills, and vice versa. This finding is believed to be influenced by students' confidence in communicating their posters. Students need confidence and motivation to perform at their best (Pranata & Marshal, 2023). Essentially, when students produce a project (digital science poster) themselves, they feel that their communication skills will improve, leading to a deeper mastery of the material or content (Gruss, 2018). In more detail, it has been revealed that the better the design, the more confident students are in showcasing and presenting their posters to others (Siddiqui et al., 2021). Furthermore, this result can be represented by a scatterplot in **Figure 3**.

Third, the correlation from four different type of assessment is also explored as additional analysis. In class, previous studies have often applied student work or project assessment in two ways, by the instructor and peers (Dorner, 2015). Now, assessment is conducted in four ways or by four groups of assessors. This is to create a more collegial, academic, professional environment. The third correlation test is further divided into two parts according to the assessed poster competencies, namely the correlation of scores from different assessors for poster design and presentation, as shown in **Table 6** and **Table 7**.

The correlation results from four different assessors, as indicated by the correlation coefficient and significance value, lead us to interesting findings regarding the assessment of digital science poster projects. The values from the instructor and expert show a relatively high and significant correlation, both for the design and presentation of digital science posters. The correlation for design scores is found to be 0.673 with a significance of 0.006, as shown in **Table 6**. Then, the correlation for presentation scores is 0.597 with a significance of 0.019, as indicated in **Table 7**. These correlation values underlie some important fundamental assumptions in project assessment. These findings confirm that assessment rubrics can indicate values that are accurately and reliably measured, even when used by different assessors. Although there is still an aspect of subjectivity from the assessors (instructors and experts), they can still provide assessments with minimal bias.

The next interesting findings are presented from the perspective of different assessors, namely peers and self-assessment. No significant correlation was found between scores from peers and other assessor groups, both for design and presentation. Similarly, for self-assessment scores, all correlations with other assessors were not significant. These findings indicate that despite

Table 7. Correlation between different type of assessments (poster presentation score)

Spearman's rho (poster design score)		Lecture-assessment	Expert-assessment	Peer-assessment	Self-assessment	Final score
Lecture-assessment	Correlation coefficient	1.000	0.597*	-0.043	0.316	0.874**
	Sig. (2-tailed)		0.019	0.879	0.250	0.000
Expert-assessment	Correlation coefficient	0.597*	1.000	-0.063	0.518	0.704**
	Sig. (2-tailed)	0.019		0.824	0.048	0.003
Peer-assessment	Correlation coefficient	-0.043	-0.063	1.000	0.163	0.271
	Sig. (2-tailed)	0.879	0.824		0.561	0.328
Self-assessment	Correlation coefficient	0.316	0.518	0.163	1.000	0.580*
	Sig. (2-tailed)	0.250	0.058	0.561		0.023
Final score	Correlation coefficient	0.874**	0.704**	0.271	0.580*	1.000
	Sig. (2-tailed)	0.000	0.003	0.328	0.023	

Note. **Correlation is significant at the 0.01 level (2-tailed) & *Correlation is significant at the 0.05 level (2-tailed)

the existence of assessment rubrics, assessments by peers and self-assessment are still unable to demonstrate accurate and reliable grade data. Various approaches are needed to enhance the reliability of assessments by peers and self-assessment. Because assessing peers and self is a crucial activity in the learning process, especially for reflection.

Overall, academic posters are considered effective mediums for knowledge transfer and are also recognized as valid forms of academic publication (Rowe & Ilic, 2009). Educational posters engage students' attention, catalyze cognitive processes, provide a framework to guide students' knowledge construction, and connect with extended learning through direct exploration or web-based activities (Hubenthal et al., 2011). The design and presentation of posters were then assessed by four different groups of evaluators. In addition to evaluations by different assessors for design and presentation, quizzes can also be included as part of the assessment. Quizzes can be employed to gather information about students' understanding of the content (Krajcik & Czerniak, 2018). Virtual poster presentation activities can also be directed to attract and involve a larger audience while maintaining high accessibility (Hernández et al., 2022).

CONCLUSIONS

The development of poster design and presentation as a project in science learning for pre-service early childhood teachers offers numerous benefits, especially in the face of changing learning environments due to globalization and technological advancements. Designing posters as a medium for conveying information or learning content is evolving with the utilization of various applications or software. Subsequently, presenting them in class serves as a process of disseminating information and practicing to become educators. Additionally, the peer and self-assessment processes provide an engaging experience for students. Despite the existence of assessment rubrics, self and peer-assessment struggled to provide accurate and reliable data. Developing novel approaches for peer and self-assessment could be considered for further study. The presence of additional external expert assessors, apart from instructors, adds a different perspective to project-based learning. The assessment data from experts confirm the objectivity of evaluating poster. Instructors and experts provide fair and objective assessments, supported by the high correlation analysis results for both poster design and presentation.

Project-based learning (poster development and presentation) are recommended for implementation across different content, approaches, and school levels. Group approaches are also worth exploring, focusing on students' collaborative abilities. Different audiences can be considered, such as scientific forums and the general public. The activities can be gradually directed to showcase the learning process following scientific methods or inquiry to demonstrate scientific exploration. Most importantly, poster development should be accompanied by presentation and assessment (self- and peer-assessment) to provide students with a comprehensive experience in implementing project-based learning.

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