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Scientific digital poster assignments: strengthen concepts, train creativity, and communication skills

Wisanti, Novita Kartika Indah, Eva Kristinawati Putri
Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Negeri Surabaya, Surabaya, Indonesia

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ABSTRACT

Student-centered learning promotes the development of students' knowledge and skills with poster assignments used to ensure their active participation in academics. Therefore, this research aims to explore student competencies in concept strengthening, creativity, and communication skills from working on digital poster project assignments. Research using observation method with a quantitative approach. Data were collected from 86 participants learning plant systematics in their first semester based on the criteria for strengthening the concept, creativity, communication, and student responses. The instruments used for data collection were a poster scoring rubric and a closed questionnaire. Data were analyzed descriptively with simple statistics in the form of average, standard deviation, and percentage. The hypothesis about the correlation of concept strengthening, creativity, and communication was tested with Spearman's coefficient. The result showed that students made 29 posters with concept strengthening, creativity and communication skills in the very good (3.42±0.49), very good (3.57±0.26), and very good (3.41±0.25) categories, respectively. Student competency shows a positive correlation between communication skills and concept reinforcement and between communication skills and creativity. Students give a positive response to the application of posters in learning in terms of learning experiences, concept strengthening, creativity and communication. Hence, using posters as project assignments in learning helps develop students' knowledge and skills by acquiring varied experiences.

Corresponding Author:

Wisanti
Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Negeri Surabaya
Ketintang Surabaya Street, Surabaya 60231, East Java, Indonesia
Email: wisanti@unesa.ac.id

1. INTRODUCTION

Higher education must play a varied and complex role in accordance with the rapid social and natural environment development. Similarly, the development of science and technology has profound implications for higher education. Therefore, as agents of change, students must be equipped with appropriate and useful competencies to overcome the challenges. According to Hénard and Roseveare [1], the learning method needs to prepare undergraduates to enter a changing environment and equip them with the appropriate skills, knowledge, values, and attributes. Graduate attributes include discipline-specific knowledge, communication skills, leadership, commitment to learning and research, creativity, and self-confidence [2].

The student-centered approach promotes the development of knowledge and skills, which enables them to take responsibility [3]. Teachers must create a learning environment that supports appropriate academic activities to achieve the desired outcomes [4]. However, in practice, many higher education disciplines continue to follow the traditional teacher-centered model, thereby fostering these attitudes and skills explicitly but not

optimal [3]. One of the student-centered learning is project-based with poster products, an artifact involving building their knowledge in school to present scientific information [5]. Poster-making effectively develops students' creativity [6], [7] and facilitates motivation-based social interaction [8].

Besides project artifacts, the poster can also be presented in class, where students are allowed to act like presenters at scientific meetings. This product is a way for them to convey information about research to others despite being novices. Therefore, poster presentations have expanded further into teaching and learning sessions in class [9]. This method promotes effective communication skills as essential components for 21st-century learners [10]–[12]. Poster presentations are also useful for practicing knowledge mastery [7] and concept strengthening [13].

A scientific poster is a form of written/visual communication widely used at academic community meetings, such as symposiums, seminars, and conferences. According to Bavdekar *et al*. [5], the poster is a popular method for concisely presenting research findings. Along with the development of technology, this medium has shifted from traditional to digital with the difference in the display. The digital poster is usually displayed on a large screen such as an LCD projector, hence the presenter can enlarge parts of the content such as images, tables, or text while providing a summary. Several studies have been conducted on the digital poster in learning, which is associated with student competencies, such as communication skills [14], understanding of reading information and ideas, and collaborative participation [15]. Studies have also focused on gaining learning experiences, such as creating, using, and presenting e-poster [9], [16].

Therefore, considering the importance of student activity-oriented learning for achieving learning outcomes, the plant systematics course introduced the use of project assignments, specifically a scientific digital poster. This research is different from previous studies because the digital scientific poster is made by students based on research on plant systematics. Furthermore, it is not only focused on investigating communication skills but also on strengthening students' concepts and creative abilities. According to this, the research was conducted to build student's competency in making digital-based scientific poster based on scientific concepts they have, developing communication and creativity skills as well. Thus, the results of the research can reveal the potential of posters as project assignments for achieving student learning outcomes namely: strengthening concepts, communication and creativity skills.

2. LITERATURE REVIEW

The poster presentation is increasingly popular for scientific knowledge dissemination at professional conferences [17]. It is used as an alternative to paper presentations at many academic conferences [18]. This allows for question and answers sessions [11], exchanges of ideas [19], and research information [20]. According to Boggu and Singh [11], it is a key instrument in disseminating research findings to the academic community. In other words, the scientific poster can be a powerful tool to communicate research findings because it is considered a genre in academic communication activities [21].

The basic principle of an effective poster is clarity and simplicity in communication [22], as well as the ability to transfer knowledge to stimulate further discussion between viewers and presenters [13]. Therefore, an effective poster is focused on delivering a single message in simple language with textual elements, images, and charts arranged in an aesthetical sequence [5]. The required text includes abstracts, introductions, methods, results, discussions, and conclusions [16]. The detailed format consists of the title and author information, an overview of the reasons, methods, and results, as well as references, acknowledgments, and summaries [23].

In recent years, the scientific community has shifted to producing posters in more technologically advanced formats, thereby eliminating the need for paper [24]. This technology-based poster is usually called a digital poster and is displayed on the screen. Berg and Hicks [17] called it a digital image digitally projected on a large, high-resolution monitor screen. In contrast, another study [25] stated that it is an electronic poster with limitations and a traditional poster format created via a personal computer and presented on an LCD screen or whiteboard. Therefore, despite the different formats, the digital poster presentation design remains the same as the traditional paper [26]. The difference is that a QR code accompanies the digital poster, hence readers can easily access a copy of its content [27] through email and phone number. Moreover, the digital poster is considered cheaper than the traditional one because it is not printed [9]. Other advantages are ease of preparation and transportation, dissemination to a larger audience, and significant archiving capabilities [28].

The poster has been identified as a useful undergraduate learning tool for many disciplines [29]. Newsom *et al*. [28] showed positive student perceptions of its use in classrooms and assessed understanding of library research skills [30]. It is also a strategy used by International Economic Cooperation to improve the quality of learning outcomes [31]. Other studies found that posters can be applied as project assignments, including in public health learning [32], managerial accounting [29], Microbiology [33], and English as a foreign language [15], [34].

Coşkun and Eker [7] stated that students acquire in-depth knowledge of subjects through teaching with poster-based activities. Similarly, Rowe and Illic [13] argued that poster session reviews can reinforce important lecture concepts. According to Bavdekar *et al*. [5], feedback and discussion during presentation sessions can help presenters better understand the methodology, analysis, and interpretation.

Other research also reported the benefits of the poster in learning related to the development of communication skills. Rauschenbach *et al*. [33] stated that poster designed by students in inquiry-based project learning can improve their scientific communication skills. Likewise, Mayfield *et al*. [35] reported that a student-designed poster is an effective tool to improve students' ability to communicate the value of scientific resources to non-scientists.

Another benefit is the ability of students' creativity in designing and demonstrating each team member's contribution to the research project [20]. The original criteria in assessing creativity are not only in terms of the overall appearance but also based on the conducted original research. According to Coşkun and Eker [7], a poster is original research that students carry out a certain topic with their friends in class. Therefore, this medium enables learning for students to develop research and creative abilities [6]. Its purpose is partly to stimulate students' thinking about the poster design and to reinforce the message that the poster should be well thought out and clearly stated [36].

As described, most posters are used as group project assignments consisting of preparation and presentation. Project assignments [37] and poster presentations [38] are student-centered learning forms. Similarly, project and group work can be used to access this process [39]. Furthermore, presentations and projects are learning strategies that actively involve students in exploring lecture material [40]. Therefore, they actively participate and are interested in the learning process to acquire knowledge, and not as passive listeners or obedient recipients [39]. Therefore, the focus of this learning technique is the development of student competencies, the process of acquiring and constructing knowledge, and an active attitude towards learning [41]. The teachers act as guides and facilitators [42] by providing many resources for students to access information during learning [43]. In summary, creating digital posters can potentially increase student engagement [44].

The project assignment of making digital scientific posters is a learning activity to activates student involvement. By making digital scientific posters, students can develop their competencies, including creativity, strengthening concepts and communication skills. The proposed correlation hypotheses were: i) there is a correlation between concept strengthening and communication skills (H1); ii) there is a correlation between concept strengthening and creativity (H2); and iii) there is a correlation between creativity and communication skills (H3).

3. RESEARCH METHOD

3.1. Research method

This study applied the observation method because the observational data was positioned as a central component of the research design [45]. Observational data was collected first and then non-observational data was collected which was explicitly integrated in the final results [45]. Observational data were in the form of concept strengthening, creativity, and communication skills and non-observational data was in the form of student responses.

3.2. Participant and procedure

The participants were 86 3rd-semester students of the Biology Education Study Program divided into three classes, with 84% female. The digital scientific poster made by students was a product of a plant systematics course project assignment. Those in three groups completed the project assignment on plant systematics research, and the results were used as poster content.

Students went through three main stages during the 10-week meeting, including research project assignment, producing a poster, and presentation session. Figure 1 provides a summary flow chart of the three main stages. The first (week 1-7) was used to determine the research objectives, design, conduct, and make reports. The research topics included diversity at the varietal or species level, character variations including morphology, anatomy, reproductive biology, phytochemistry, character markers, and phenetic kinship relationships.

The second stage (weeks 8 and 9) involved planning, designing, and uploading the poster. This stage started with the lecturer explaining how to make a digital poster sequentially and delivering a rubric for assessing a digital scientific poster. The third stage (week 10) was a presentation session attended by the whole class where the lecturer acted as a facilitator, and then students carried out activities sequentially. The presentation session was scheduled in two meetings at the end of the semester with the following activities: i) students looked at the poster uploaded in the google classroom stream; ii) the various groups explained the content for 3 minutes using an LCD projector screen; iii) questions were asked through the google classroom

stream; iv) some provided the answers orally; and v) classical discussions were directed by the lecturer. The assessment was carried out by two lecturers who supported courses through observations at the presentation stage. Observations were also made to record the discussion process related to the material asked and the answers given by the presenter.

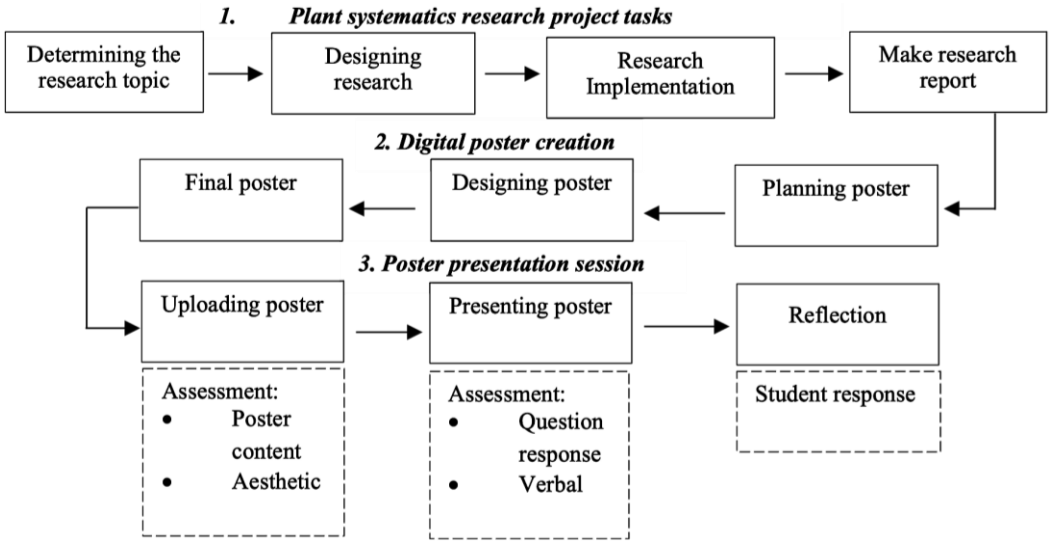

Figure 1. Flowchart of the poster project procedure for the plant systematics course

3.3. Data collection and analysis

Data related to the objectives of making a scientific poster, namely strengthening concepts, training students' creativity, and practicing communication skills, were obtained from the assessment of poster content and responses to questions that focused on the concept of plant systematics, aesthetics, and originality. The criteria for the aesthetic component include balance, visual effects, correct grammar, and spelling, and flow of information [46]. Communication skill was assessed based on display, content, and verbal presentation. According to Allen and Tanner, the criteria for evaluating the display content include the overall appearance, layout, pictures and tables, and writing [47]. The content includes title criteria, abstract, introduction, methods and materials, results, discussion, and conclusions [33]. Verbal presentation criteria include the presenter's response [26] and the way of speaking [33]. A 4-point Likert scale of 1, 2, 3, and 4, poor, slightly good, good, and very good, was used to score each criterion. The results were analyzed descriptively by determining the average score and standard deviation. The average score of the assessment was interpreted in categories of 3.28-4.00, 2.52-3.27, 1.76-2.51, and 1-1.75, which denote very good, good, slightly good, and poor [48].

After the presentation, students were asked to participate in an anonymous survey to provide feedback on the project assignment. The survey was conducted by filling out an online questionnaire using a google form consisting of 13 questions (α=0.955) using a 5-point Likert scale whereby 5, 4, 3, 2, and 1 denote strongly agree, agree, neutral, disagree, and strongly disagree. These questions covered experiential learning aspects of making posters, practicing communication, reinforcing concepts, and developing creative abilities. Subsequently, students provided comments or suggestions openly. The responses to each question were analyzed descriptively by determining the average score, which was used to interpret the category with a range of 1.00-1.80, 1.81-2.60, 2.61- 3.40, 3.41-4.20, and 4.21-5.00, which denote strongly disagree, disagree, neutral, agree, and strongly agree [49].

4. RESULTS

4.1. Digital scientific poster as project assignment product

A total of 29 digital posters were uploaded to the Google Classroom stream as an assignment product for the plant systematics course project. The topic selected by the students followed the scope of plant systematics with the object of tropical and native fruit plants in Indonesia. The selected fruit plants include pineapple, papaya, avocado, tomatoes, sugar apple, dragon fruit, mango, breadfruit, durian, guava, and rambutan. Most posters (22) were made using Microsoft PowerPoint, while the remaining seven used the Canva application.

Figure 2 is an example of a digital scientific poster made by students, which presents content concisely arranged in two vertical columns. The content is in the form of research on pineapple phenetic relationship, which consists of title, abstract, background, method, results, discussion, and conclusion. The poster is also equipped with a QR code to access research reports, hence other students can get information unavailable on the device. The visual appeal lies in the morphological characteristics of the fruit, flowers, thorns on the stem, and the anatomical structure of the lamina. Research data in the form of chlorophyll and vitamin C content are presented in the table and the similarity index of varieties in the phenogram. Besides the images, content messages are conveyed in the abstract, background, discussion, and conclusion sections.

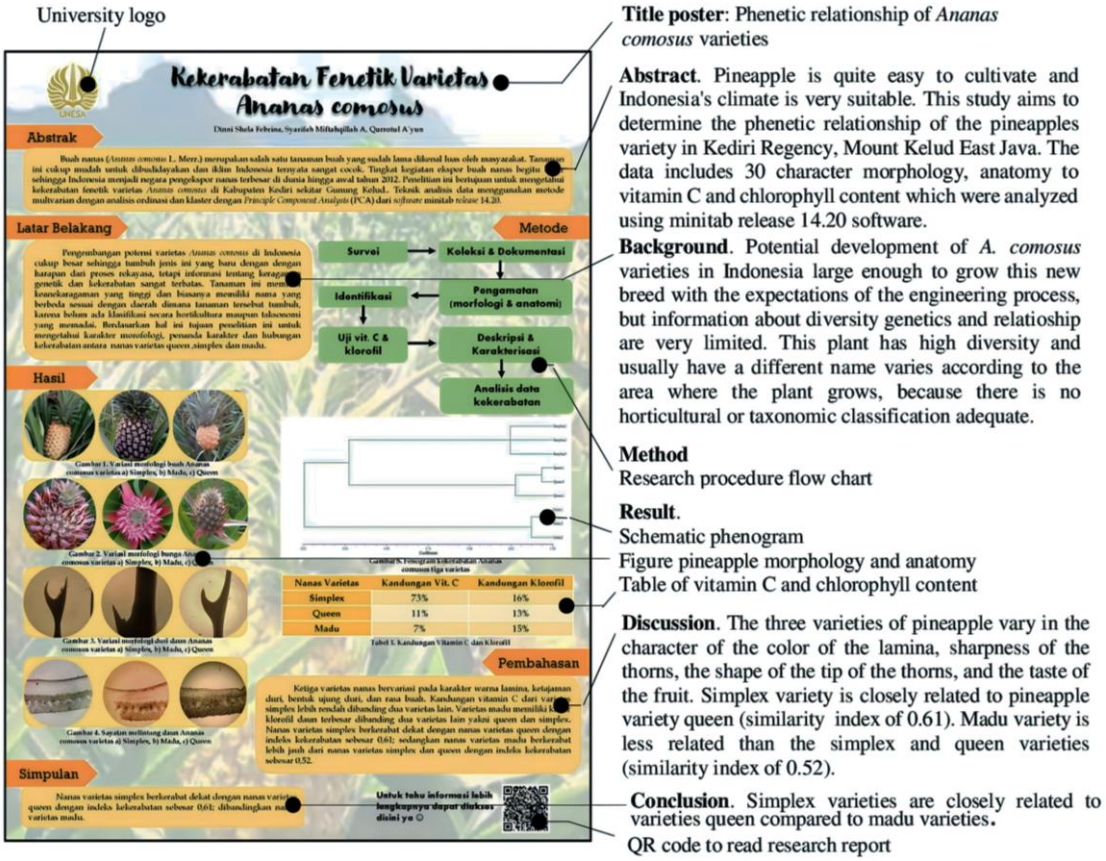

Figure 2. Examples of digital scientific posters with content in the form of plant systematics research

4.2. Strengthening concepts, creativity, and communication

The poster assessment results included the criteria for strengthening concepts, creativity, and communication skills presented in a bar graph, as shown in Figure 3. The three assessment criteria were in the very good category, but creativity obtained a higher average score of 3.57±0.26 than concept strengthening and communication at 3.42±0.49 and 3.41±0.25, respectively. The originality is one of the assessments that obtained the highest score compared to other aspects, namely 3.76±0.36. Three aspects of communication skills are in the very good category, these include verbal presentation, poster content, and concept reinforcement, with averages of 3.55±0.51, 3.38±0.36, and 3.39±0.33. Concept reinforcement was obtained from the accuracy of the concepts conveyed by the content and the responses to questions, which obtained a higher average score of 3.47±0.72 than content at 3.38±0.36.

The Spearman correlation coefficient test between concept strengthening and communication skills was positive (r_s=0.539) at a P-Value of 0.01. Likewise, the correlation between communication skills and creativity was positive (r_s=0.327) at p-value=0.01. This correlation coefficient implied that the relationship was positive, substantial, and significant, hence the hypothesis is accepted. However, the Spearman correlation revealed a significant negative correlation between concept reinforcement and creativity (r_s=-0.37) at a p-value of 0.01. This implies that there is no correlation between concept strengthening and creativity.

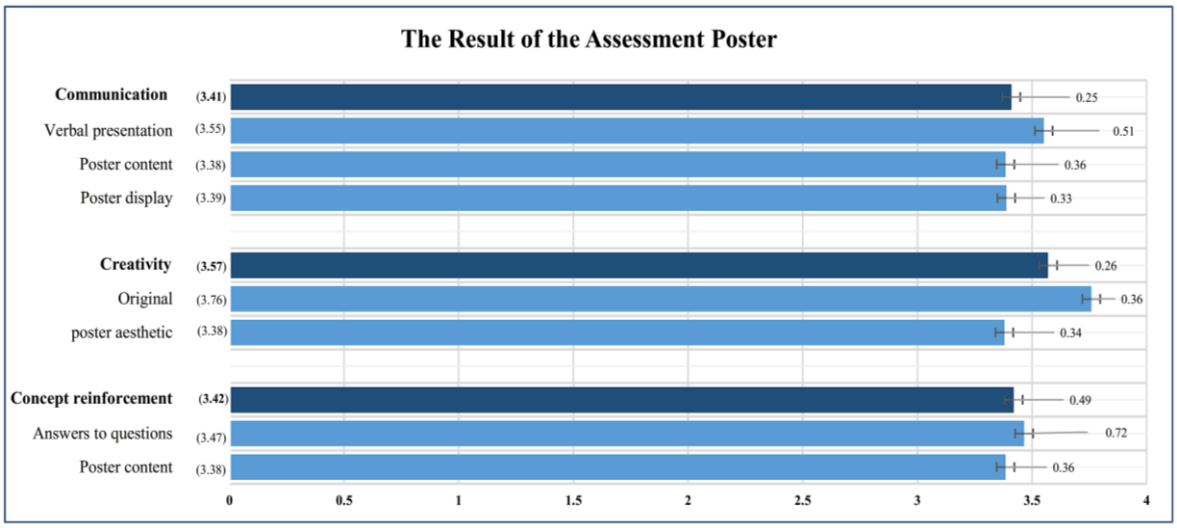

Figure 3. The assessment of digital poster assignment with the topic of plant systematics (Category: 3.28-4.00=very good; 2.52-3.27=good; 1.76-2.51=slightly good; 1-1.75=poor)

In the recorded observations in the poster session, 43 questions related to factual knowledge (10) and conceptual (33) were asked by students. Overall, nine concepts were asked and discussed in the presentation session. The concepts that were often asked were the concept of character markers as identification (10), variation between varieties and species (7), and classification of varieties and species (5), as shown in Table 1. Meanwhile, the concepts with the least number of questions (1) were anatomy, ecology, and phytochemistry as taxonomic evidence.

Table 1. Questions related to the concepts presented and discussed in the presentation session

Concept	Number of questions
Character markers as identification characters.	10
Variation between varieties and species	7
Classification of varieties and species	5
Morphological characters, such as cymose inflorescences, multiple fruit, and simple fruit	3
The difference between phenetic and cladistic relationship	3
Good character as the basis for similarity analysis	2
Anatomy as taxonomic evidence	1
Ecology as taxonomic evidence	1
Phytochemistry as taxonomic evidence	1

4.3. Student response

Table 2 shows that the average Likert scale score of student responses is above 4, except for the criteria as a knowledge transfer medium (3.91±0.88) and a new way to convey information (3.91±0.93). This illustrates that students respond well to posters as project assignments in plant systematics learning by strongly agreeing with the preparation for making posters (4.37±0.78) and their presentations (4.44±0.73). Likewise, they strongly agree that posters can strengthen the concept of plant systematics studying, especially during the presentation session (4.44±0.73). The original criteria were also highly agreed upon as the main consideration when making posters (4.53±0.71). Students also gave positive responses on aspects of communication skills on the criteria of meaningful messages, self-confidence, and academic debate at values of 4.51±0.71, 4.22±0.77, and 4.26±0.81.

Table 2. Student responses to posters and poster presentations in plant systematics learning (n=86)

No	Items	Mean	SD	Interpretation
Learning experience in making posters				
1	Poster preparation helps me select important points for the presentation.	4.13	0.89	Agree
2	The preparation of posters and presentations encourages interaction with my group.	4.37	0.78	Strongly agree
3	The poster presentation allows me to demonstrate my involvement in Plant Systematics research in a meaningful and appropriate way.	4.44	0.73	Strongly agree
4	I'm happy when the audience asks about my Poster.	4.58	0.80	Strongly agree
Concept reinforcement				
5	Posters are an effective medium for knowledge transfer.	3.91	0.88	Agree
6	Its content conveys in-depth information about plant systematics research to the audience.	4.61	0.68	Strongly agree
7	The question-and-answer session at the poster presentation session is an activity to demonstrate mastery of the concept of plant systematics.	4.48	0.74	Strongly agree
Creativity ability				
8	My group and I created a poster emphasizing visual attraction rather than text.	4.20	0.84	Agree
9	My group and I made a poster by emphasizing the value of originality.	4.53	0.71	Strongly agree
Communication skills				
10	Posters effectively convey a meaningful message to the audience.	4.51	0.71	Strongly agree
11	I feel confident to speak after I conducted a Poster presentation.	4.22	0.77	Strongly agree
12	Posters allow authors to present academic debates.	4.26	0.81	Strongly agree
13	For me, poster introduces a new way of sharing information.	3.91	0.93	Agree

Note: 5=strongly agree; 1=strongly disagree)

5. DISCUSSION

This research described the learning outcomes of Biology Education students in the 3rd semester after working on the digital scientific poster. The majority of posters produced were created using Microsoft PowerPoint, recommended by Christenbery and Latham [26] for students as beginners. However, at scientific meetings, PowerPoint is also widely used to prepare posters, for example, at the "Complex Life of mRNA" conference [23]. This is because it provides templates that are easy to use [50] with numerous traditional contexts [16]. However, all the students stated that posters were a new way to share information. This response is similar to the research by Ross *et al*. [50] that 175 or 77% of the first-year students used posters to introduce new ways to share information with others.

A scientific poster is one way for students to communicate their research because it provides a visual summary to convey the essence of the message. Therefore, most learners highly favor poster presentations, and adopt by education practitioners worldwide [11]. It is a task-based activity where students develop research topics, ask questions, collect and analyze data for presentation [51]. Similarly, Biology Education students adequately completed the digital poster assignment and responded positively to this learning strategy. As stated in the research, poster assignment offers positive student learning experiences, namely strengthening concept mastery, improving communication skills and creativity.

The communication skill assessment is very good in terms of verbal presentation, content, and display. This is relevant to Rauschenbach *et al*. [33] research that students achieved the objectives of Microbiology learning after the poster project and effectively communicated research findings scientifically. Similarly, previous studies [13], [28] reported that most students thought poster activities improved their presentation and communication skills.

The results of this study indicate that communication skills were positively correlated with concept reinforcement. Like communication skills, strengthening the concept of Biology Education is in the very good category. Kelsch and Werremeyer [32] stated the same result through a research poster project using PharmD students, who demonstrated a very good understanding of public health topics and principles. Concepts related to poster topics were tested during a question-and-answer session with classmates to determine their mastery of the concepts. Kinikin and Hench [30] found that poster presentation requires students to have more than a superficial knowledge of their research topic to answer questions and explain the findings successfully. In other words, the conversations during the presentation session can foster a sense of accomplishment in students, enabling them to demonstrate their understanding of the problem and their experiences [46]. Most Biology Education students believe that posters are effective for conveying information and for the occurrence of academic debate. This is in line with Arslan *et al*. [19] research that 131 or 64% of respondents agree that posters are a good medium for knowledge transfer.

The digital poster assignment positively affected Biology Education students and developed their creative abilities. Cook and Fenn [44] stated that almost all first-year Bachelor of Science units students have a positive opinion of a digital posters, especially regarding creativity. From the aesthetic aspect, the poster highlights visual appeal more than text. According to Arslan *et al*. [19], 70% of 131 respondents agreed that

the appearance of a poster can help attract more viewers' attention. Furthermore, graphic design and physical appearance can determine success in promoting knowledge transfer [52]. This is supported by most students' opinion that posters can improve skills in the graphical representation of data [11].

The poster made by students is attractive in terms of appearance because they also consider the material's content in the form of the results of plant systematics research. Therefore, it belongs to the original study poster type, and its authenticity is one of the considerations for originality, thereby placing it in the very good category. Coşkun and Eker [7] stated that originality has a positive impact as it enables students to make and present their posters in a classroom environment. A good scientific poster though complex and time-consuming, should be readable, informative, and visually aesthetic [53].

The plant systematics learning strategy by implementing a digital poster project assignment shows the varied active participation of students in collaborating, cooperating, discussing, asking questions, communicating, conducting research, and making reports, posters and presentations. Students' active participation by interacting with the content and learning environment contributes to personal cognition [54]. Therefore, digital poster project assignment includes student-centered learning where students actively participate in knowledge acquisition [39], [41] and material exploration [40]. In this case, plant systematics and diverse lecture materials are important knowledge and concepts. Furthermore, they can develop competencies [41] such as creative and communication skills.

6. CONCLUSION

The application of digital poster project assignments in plant systematics learning includes student-centered learning, which helps to promote active student involvement in its planning, designing, uploading, and communicating processes. This is evidenced by the acquisition of a very good category for assessing competence in strengthening concepts, creativity, and communication, as well as students' positive response during learning. The results showed a positive correlation between communication skills and concept strengthening as well as between communication skills and creativity. However, there was no correlation between concept strengthening and creativity. Therefore, digital poster as an educational tool has the potential to develop students' knowledge and skills. Further research is expected to be conducted on the relationship between digital poster project assignments and student motivation to prevent the prolonged time and series of activities before the preparation process.

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BIOGRAPHIES OF AUTHORS

Wisanti is a senior lecturer from the Biology Department, Faculty of Mathematics and Natural Sciences, Universitas Negeri Surabaya, Indonesia. Her research interests lie in plant systematics and biology education. Deeply on education, she pays attention to innovative learning and pedagogical competencies of students with prospective of being a teacher. She can be contacted at email: wisanti@unesa.ac.id.

Novita Kartika Indah is a senior lecturer from the Biology Department, Faculty of Mathematics and Natural Sciences, Universitas Negeri Surabaya, Indonesia. Her research interests lie in plant systematics and ethnobotany. Recently, she works on plant identification, especially for useful plants. She can be contacted at email: novitakartika@unesa.ac.id.

Eva Kristinawati Putri is a lecturer from the Biology Department, Faculty of Mathematics and Natural Sciences, Universitas Negeri Surabaya, Indonesia. Having research interests in plant biosystematics, she is now getting her PhD in Leiden University. By combining both NGS and AI, she wants to speed up revision work and increase student's interest into plant taxonomy. She can be contacted at email: evaputri@unesa.ac.id.