



Implementation of the Pteridophyta Smart Card to Increase Students' Understanding of Fern Material

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ABSTRAK

Tumbuhan paku (*Pteridophyta*) merupakan salah satu materi yang wajib dipelajari oleh mahasiswa biologi maupun pendidikan biologi. Namun, berdasarkan penelitian terdahulu banyak mahasiswa yang masih mengalami kesulitan untuk mengenali atau mengidentifikasi tumbuhan paku. Kondisi tersebut disebabkan oleh pembelajaran yang masih dilaksanakan secara konvensional, mengandalkan buku teks minim gambar atau foto dan tidak sesuai dengan karakteristik atau gaya belajar mahasiswa generasi Z saat ini. Oleh karena itu, tujuan dari penelitian ini untuk menganalisis efektivitas dan kemenarikan *Pteridophyta Smart Card* sebagai media pembelajaran untuk meningkatkan hasil belajar tumbuhan paku. Penelitian ini berjenis penelitian kuantitatif menggunakan *One-Group Pretest-Posttest design* dengan subjek penelitian adalah 20 mahasiswa semester 4 program studi pendidikan biologi yang dipilih menggunakan *purposive sampling*. Pengumpulan data dilakukan dengan menggunakan *pretest* dan *posttest*, angket dan observasi. Data dianalisis dengan uji efektivitas yang dianalisis dengan rumus *gain score*, dan uji kemenarikan yang dianalisis dengan rumus hitung validasi pengguna. Hasil dari penelitian ini mengungkapkan bahwa media *Pteridophyta Smart Card* efektif digunakan sebagai media pembelajaran tumbuhan paku bagi mahasiswa dengan tingkat kemenarikan hingga mencapai 91,25% yang artinya bisa disimpulkan media *Pteridophyta Smart Card* sangat menarik bagi mahasiswa karena sesuai dengan karakteristik atau gaya belajar mahasiswa generasi Z, sehingga dapat meningkatkan hasil belajar tumbuhan paku mahasiswa. Penelitian ini memberikan implikasi secara teoritis dan praktis dalam hal peningkatan hasil belajar tumbuhan paku mahasiswa menggunakan media *Pteridophyta Smart Card*.

ABSTRACT

Ferns (*Pteridophyta*) are one of the materials that must be studied by biology and biology education students. However, based on previous research, many students still have difficulty recognizing or identifying ferns. This condition is caused by learning which is still carried out conventionally, relying on textbooks with minimal pictures or photos and is not in accordance with the characteristics or learning styles of current Generation Z students. Therefore, the aim of this research is to analyze the effectiveness and attractiveness of the *Pteridophyta Smart Card* as a learning medium to improve learning outcomes. This type of research is quantitative research using a *One-Group Pretest-Posttest design* with the research subjects being 20 4th semester students of the biology education study program who were selected using *purposive sampling*. Data collection was carried out using *pretest* and *posttest*, questionnaires and observations. The data was analyzed using an effectiveness test which was analyzed using the *gain score* formula, and an attractiveness test which was analyzed using a user validation calculation formula. The results of this research reveal that the *Pteridophyta Smart Card* media is effectively used as a learning medium for students with an attractiveness level of up to 91.25%, which means it can be concluded that the *Pteridophyta Smart Card* media is very attractive for students because it suits the characteristics or learning styles of Generation Z students, so that it can improve students' learning outcomes. This research provides theoretical and practical implications in terms of improving students' learning outcomes using *Pteridophyta Smart Card* media.

1. INTRODUCTION

Ferns are a group of cormophyte plants that produce spores as the main means of reproduction (Yuskianti et al., 2018) and can also reproduce using rhizomes (Efendi & Iswahyudi, 2019). Therefore, ferns can live and grow easily on soil, rocks, epiphytes and in water so that they can spread widely and become one of the dominant vegetation components (Prasani et al., 2021). Even, is the second most diverse group of plants after the angiosperm group (Nitta et al., 2022). In Indonesia, in 2018 reported by The Indonesian Institute of Sciences (LIPI) contains 2,197 species of ferns which contribute 21% to biodiversity (Widyatmoko, 2018). In universities, ferns are one of the materials or study topics contained in taxonomy coursesplant. There are also those who include it in plant botany or biodiversity courses. This material or course is a subject that must be taken by students majoring in biology or biology education. Plant taxonomy is a mandatory course that focuses on recognizing and differentiating plants (Aswin et al., 2018). However, several previous studies revealed that many students still have difficulty recognizing and differentiating ferns (Anisa, 2022; Muswita et al., 2021; Abrori, 2020; Fitriani & Wardianti, 2014). Difficulty or inability to recognize plants is generally referred to as plant blindness which refers to conditions such as being unable to recognize the unique aesthetic characteristics of plants and their role and function in life (Parsley, 2020).

The report of students' inability to identify ferns reveals the fact that fern learning has not been completely successful, because there is still a large number of fern learning conducted using conventional methods (Fitriani & Wardianti, 2014). Apart from that, they tend to use teaching materials in the form of textbooks which generally contain lots of narrative and minimal pictures (Muswita et al., 2020), or not equipped with real images and recent photos (Renita et al., 2020; Illahaqi & Aloysius, 2019). As a result of these conditions, fern material is uninteresting and makes students bored more quickly, thus affecting their learning motivation (Syahrani & Sofyan, 2020) and can influence the level of absorption of material by students (Parmini et al., 2022). This condition is in accordance with the results of random observations and interviews with biology education students at the University of Muhammadiyah Malang which stated that 83.3% of students need learning media that suits the characteristics or learning style of generation Z, namely those that present lots of real pictures or photos and are packaged in the form of game. It is important for learning that causes the problems mentioned above to receive serious attention and learning that is appropriate to the learning style or characteristics of generation Z students is needed to be more effective and optimal, because Generation Z has a very low average attention span or level of concentration in learning, namely only 8 seconds (Bunardi & Prestianta, 2023; Shatto & Erwin, 2016). Meanwhile, in terms of how to learn, we prefer to practice or pay attention, not by reading, let alone listening to lectures (Hastini et al., 2020). In addition, generation Z belonging to generations digital natives (Adriyanto et al., 2019), Which all daily life activities tend to be inseparable from smartphones and the internet (Nawawi, 2020).

Based on the facts above, it can be seen that the fern learning media or methods are not optimal and do not suit the characteristics or learning styles of generation Z students, so there is a serious gap between the two. In fact, suitability of learning media to the characteristics of generation Z is very necessary because it is closely related to learning success (Prahani et al., 2020). Therefore, it is hoped that the Pteridophyta Smart Card media in the form of playing cards can be used to support the fern learning process so that it is more optimal because it suits the characteristics and learning styles of Generation Z who prefer learning in the form of games (Karina et al., 2021; Vizcaya-Moreno & Pérez-Cañaveras, 2020) combined with digital native (Nawawi, 2020; Adriyanto et al., 2019). Previous research found that the Pteridophyta Smart Card product was suitable for use as a learning medium for ferns (Efendi et al., 2023). The novelty of this research is that it presents Pteridophyta Smart Card media which is tested for its effectiveness and attractiveness in the learning process carried out by students. So this research aims to analyze the effectiveness and attractiveness of the Pteridophyta Smart Card as a learning medium to improve learning outcomes in ferns.

2. METHOD

This research is quantitative research using One-Group Pretest-Posttest design. The subjects in this research were 20 fourth semester students of the biology education study program at the University of Muhammadiyah Malang who were selected using purposive sampling. Data collection was carried out using pretest and post-test, questionnaires and observations. The student is the subject study. Then, their initial understanding of the fern material was measured using a pretest. After learning using media Pteridophyta Smart Card post-test was carried out. The instrument used in this test is to use a test in the form of presenting questions and/or statements that have been validated by previous fern content/material experts to determine students' ability to identify, analyze and evaluate the characteristics of fern species, as in Table 1.

Table 1. Pretest and Post-Test Instrument Grid

No	Question Aspect	Number of Questions
1	Able to recognize fern species and write the names of fern species in the Pteridaceae family group correctly.	3
2	Able to recognize fern species and write the names of fern species in the Polypodiaceae family group correctly.	3
3	Able to recognize fern species and write the names of fern species in the families Blechnaceae, Cyatheaceae and Davalliaceae correctly.	3
4	Able to analyze the characteristics of each species of fern in the Pteridaceae family group.	5
5	Able to analyze the characteristics of each species of fern in the Polypodiaceae family group.	5
6	Able to analyze the characteristics of fern species in the families Blechnaceae, Oleandraceae, Dryopteridaceae, Nephrolepidaceae and Thelypteridaceae.	5
7	Able to evaluate errors in the characteristics of fern species	6
Amount		30

The students' pretest and posttest scores were then analyzed using the Gain score formula (Laksono et al., 2023). The results of the gain score analysis is then interpreted based on Table 2.

Table 2. Interpretation of Gain Score Values

Gain Score Value	Category
$X > 0.7$	High
$0.3 > X < 0.7$	Medium
$X < 0.3$	Low

(Efrialdia & Subiantoro, 2022)

Apart from effectiveness, the level of attractiveness of the media was also tested Pteridophyta Smart Card which is used as a learning medium for ferns using a questionnaire that has been validated by design experts as shown in Table 3.

Table 3. Attractiveness Test Questionnaire Grid

No	Aspect	Statement	Amount
1	Packaging	Attractive packaging design	1
2	Printed Card Components	Attractive design and easy to understand coding	1
3	Digital Components	QR Codes are easy to scan and digital components are easy to access	1
4	User Manual	The design and layout of the book are attractive	1
Amount			4

The scores obtained from students are then analyzed using the V-pg formula (Irawan & Hakim, 2021). The results are then interpreted and concluded in accordance with the practicality criteria in Table 4.

Table 4. Product Attractiveness Criteria

Percentage	Category
80-100	Very Attractive
60-79	Attractive
50-59	Attractive less
0-49	Not Attractive

(Fajri, 2020)

3. RESULT AND DISCUSSION

Result

This research uses Pteridophyta Smart Cards, which are an innovation of playing cards or more commonly known as playing cards as a learning medium for ferns. It is equipped with real photos ranging from complete images to detailed parts that are characteristic of fern species and is integrated with digital components via a QR Code that is connected to Google Drive.



Figure 1. Pteridophyta Smart Card Media

As a learning medium, it is necessary to know its effectiveness in increasing students' understanding of fern material. So, an effectiveness test was carried out using One-Group Pretest-Posttest design, namely with 20 biology education students from the University of Muhammadiyah Malang. Before being given media Pteridophyta Smart Card, students first measure their initial understanding of ferns using a pretest. Next, the students carried out learning using Pteridophyta Smart Card media. After this intervention, the students were then given a posttest as a form of measuring the results after using the Pteridophyta Smart Card media so that the impact of its use on increasing students' understanding of fern material could be known. The effectiveness test was carried out in a learning-like manner but designed by playing using Pteridophyta Smart Card media. Each student was given the Pteridophyta Smart Card product by grouping them into 6 teams with each consisting of 3 students and 1 team consisting of 2 students. After each student is asked to play the Pteridophyta Smart Card product according to the applicable game rules. This implementation was carried out in 1 meeting with 3 repetitions with details, 1 initial simulation and 2 playing times, so that the results obtained were as stated in Table 5.

Table 5. Pteridophyta Smart Card Media Effectiveness Test Results

No.	Subject	Mark		Gain Score	Category
		Pretest	Post-test		
1	Subject 1	30	91	0.87	High
2	Subject 2	40	96	0.93	High
3	Subject 3	32	54	0.32	Medium
4	Subject 4	39	51	0.20	Low
5	Subject 5	38	56	0.29	Low
6	Subject 6	25	50	0.33	Medium
7	Subject 7	49	71	0.43	Medium
8	Subject 8	41	80	0.66	Medium
9	Subject 9	44	50	0.11	Low
10	Subject 10	49	69	0.39	Medium
11	Subject 11	43	77	0.60	Medium
12	Subject 12	38	51	0.21	Low
13	Subject 13	20	61	0.51	Medium
14	Subject 14	60	67	0.18	Low
15	Subject 15	52	70	0.38	Medium

No.	Subject	Mark		Gain Score	Category
		Pretest	Post-test		
16	Subject 16	55	74	0.42	Medium
17	Subject 17	47	81	0.64	Medium
18	Subject 18	23	62	0.51	Medium
19	Subject 19	33	77	0.66	Medium
20	Subject 20	52	53	0.02	Low
Average		40.5	67.05	0.43	
Effectiveness Category				Medium	

The pretest and posttest scores obtained in the effectiveness test were analyzed using the gain score formula to determine the increase in learning outcomes for each student who was the subject of the research. The gain score obtained is then interpreted using the effectiveness criteria as in Table 2. Because the gain score is 0.43, the effectiveness level of the Pteridophyta Smart Card product as a learning medium for ferns is in the medium category. Apart from its effectiveness, the Pteridophyta Smart Card media was also measured for its attractiveness to students. Because as a learning medium it must also make students feel interested in using it so that it can influence the learning process. The results of the attractiveness test are presented in Table 6.

Table 6. Pteridophyta Smart Card Product Attractiveness Test Results

No	Aspect	Maximum Score	Empirical Score	Percentage of Attractiveness Per Aspect	Attractiveness Category Per Aspect
1	Packaging	80	75	93.75%	Very Attractive
2	Printed Card Components	80	73	91.25%	Very Attractive
3	Digital Components	80	73	91.25%	Very Attractive
4	User Manual	80	71	88.75%	Very Attractive
Total		320	292		
Attractiveness Percentage		91.25%			
Attractiveness Category		Very Attractive			

Discussion

Based on the effectiveness test results, it appears that the average initial understanding of students regarding fern material is 40.5 with the lowest score being 23 and the highest being 60. Meanwhile, after learning using the Pteridophyta Smart Card media it has increased to an average of 67.05 with the lowest score being 51 and the highest was 96. So after analyzing and calculating the gain score between the pretest and posttest results, the score was 0.43% or the level of effectiveness was categorized as medium. The gain score results which are included in the medium category are due to learning only carried out in 3 repetitions of the Pteridophyta Smart Card game. Considering that the way to play this Pteridophyta Smart Card product is a game like playing cards which is played competitively by 3 students in 1 team or group, the probability of each student being able to collect all pairs of cards is not too big. So it could be that in one game group, one student can only collect 3 - 4 species of ferns because each student competes with each other to collect pairs of cards that contain complete information about fern species. Therefore, in order to get more optimal results, there should be more repetitions of playing so that the probability of each student encountering or succeeding in collecting many species of ferns is greater.

Based on the gain score which shows an increase in students' understanding of fern material, this means that the Pteridophyta Smart Card media is effectively used as a fern learning medium. Pteridophyta Smart Card, whose basic concept is a playing card, makes the learning process easy and fun, because Generation Z students prefer learning in the form of games (Karina et al., 2021) and not in a wayread or listen to a lecture (Hastini et al., 2020).What's more, generation Z has a very low average attention span or level of concentration in learning, namely only 8 seconds (Bunardi & Prestianta, 2023; Shatto & Erwin, 2016). The packaging of Pteridophyta Smart Card media in the form of a card game provides space and opportunity for students to play an active role in learning so that it has a positive impact (Muniandy et al., 2023), specifically in developing students' understanding of ferns.

Equipped with Pteridophyta Smart Card media with real images or photos of ferns from their complete appearance to their characteristic parts, it is attractive and easy to understand for students because students need media that is equipped with real images or recent photos (Renita et al., 2020; Illahaqi & Aloysius, 2019). The use of photos or images can strengthen the information presented, so it is very

effective for learning that is limited by space and time (Mawaddah et al., 2019). This is in accordance with the research results Syahrhani & Sofyan (2020) who reported that learning media in the form of fern comics can provide maximum understanding to students because these comics highlight the visual appearance of images, making it easier for students to remember and understand the material. Apart from comics, learning about ferns can also be done well using media in the form of popular scientific books developed based on local potential (Nurlita et al., 2021) and effective for improving critical thinking skills (Ridhana et al., 2021). Local potential or the surrounding environment can be used as a good learning medium because the environment is a very rich learning resource and can be compiled into a fern field manual as a student guide in studying ferns in the field (Siregar, 2021). Based on research results from Muswita et al (2021) also stated that learning about ferns using booklet media was also reported to make learning about ferns easier as well as increasing the understanding of biology education students so that they could improve their learning outcomes.

Based on the results of this research and supported by previous research, learning about ferns is more effective if done with media that displays visual images or real photos of ferns because students will be able to more easily understand each characteristic of fern species. So that it can increase student understanding which will have an impact on students' ability to identify and analyze the characteristics of each fern species (Efendi et al., 2023). Apart from that, with students' skills in identifying and analyzing, then can increase their knowledge of ferns and at the same time increase their motivation in learning (Susilaswati & Sugandi, 2018). Therefore, quality learning media is an important factor in improving the quality of learning (Hasan et al., 2021).

Apart from displaying real images or photos, this Pteridophyta Smart Card media also has advantages for integrate between printed and digital cards. So that it can according to the characteristics or learning styles of generation Z students which is a generation digital natives (Adriyanto et al., 2019), Which all activities of daily life tend cannot be separated from smartphones and the internet (Nawawi, 2020). This suitability is very important because is closely related to learning success (Prahani et al., 2020).

As a medium that is declared effective in increasing students' understanding of ferns, it will never be separated from how interesting the media is for students who use it. Therefore, this research also measures the level of attractiveness Pteridophyta Smart Cards seen in Table 4 which states that the level of attractiveness reaches 91.25% which means it is very attractive to students. This is in line with observations and interviews during the use of Pteridophyta Smart Card media, students seemed interested and happy when learning. Students think that learning about ferns is more relaxed and fun because it is packaged in the form of a game, so students find the Pteridophyta Smart Card media very interesting. Apart from being a game, this attraction is also due to the fact that it is equipped with real photos of each species of fern as well as the integration of print and digital components which can accommodate the habits of generation Z students who tend to be unable to be separated from their devices. The attractiveness of a learning media cannot be separated from its good appearance and packaging, where this will be directly proportional to the learning motivation of students who use it (Sutrisno et al., 2023). The more interesting the learning media used, the more students will be able to follow and understand the material, so this has implications for improving the quality of learning (Azzahra et al., 2023).

This research has theoretical and practical implications in that the use of Pteridophyta Smart Card media can be a solution to improve student fern learning outcomes. Although the Pteridophyta Smart Card media has been proven to be effective and attractive, it is still limited to only 30 species of ferns. Therefore, it is necessary to increase the number of species so that more information is presented so that students can have a broader understanding and be able to identify fern species better because in Indonesia, in 2018 reported by The Indonesian Institute of Sciences (LIPI) contains 2,197 species of ferns (Widyatmoko, 2018). In addition to numbers, digital components Pteridophyta Smart Cards are still limited to using QR Codes and Google Dive, so innovation in form is needed Android applications, websites, augmented reality and artificial intelligence to adapt to current developments and the characteristics of generation Z.

4. CONCLUSION

Based on the results of this research, it can be concluded that Pteridophyta Smart Card effectively used as a learning medium for ferns for students and very interesting because it suits the characteristics or learning styles of generation Z students, so it can have implications for the quality of learning which can improve students' understanding and learning outcomes regarding fern material. In order to produce optimal fern learning, it is recommended that educators, especially those who focus on fern material, use or develop fern learning media that is appropriate to the characteristics of the generation of students at both the tertiary and secondary school levels while still paying attention to the appropriateness of the level of learning achievement. Apart from that, it is hoped that future research can develop learning media for ferns

that are more complex but interesting and easy to use in digital form in accordance with current developments and the characteristics of generation Z.

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