RESEARCH ARTICLE

Developing of Pteridophyte smart card as ferns learning media based on playing card

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Abstract: Many ferns learning in higher education were organized conventionally and relied only on textbooks. Moreover, it is not in accordance with the characteristics or learning styles of Generation Z (Gen Z). This research aims to produce Pteridophyte Smart Cards (PSC) as a learning media by integrating cards containing real images of ferns with QR Code technology connected to Google Drive. This research and development uses the ADDIE model. This research involved three experts to validate the product's validity. As many as 26 Biology Education students at the University of Muhammadiyah Malang were involved as research subjects and were divided into six groups in the small group practicality test. Furthermore, there are 20 students taking charge to test the product's practicality and attractiveness. The instruments used were questionnaires, observation, and interview sheets. The results show that the product feasibility was 96.67%, media 97.06%, and design 94.44%, so it was declared very feasible. Based on the results of the practicality test, it is classified as a very practical category because the results of the small group test received a score of 85.71% and the class test was 90.89%. The attractiveness test results were 91.25% so it was declared that the products are very attractive. Therefore, it can be used as a learning media for ferns that are interesting, fun, and in accordance with the characteristics or learning styles of Gen Z students.

Keywords: ferns; innovative learning media; playing card; Pteridophyte smart card

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Introduction

Ferns (Pteridophyte) are a group of cormophytes that produce spores as the main means of reproduction (Muswita, Yelianti, et al., 2020; Yuskianti et al., 2018). However, ferns can also reproduce using rhizomes which can branch and grow into new shoots (Efendi & Iswahyudi, 2019). Therefore, ferns can grow easily and are widely spread in various places so that they become one of the dominant vegetation components (Prasani et al., 2021). Moreover, ferns have the ability to live and grow well in soil, on rocks, in epiphytes and in water (Lestari et al., 2019).

In universities, learning about ferns is one of the materials in plant taxonomy courses. Some universities also include it in plant botany or biodiversity courses. Uniquely, all of these courses are mandatory courses for students. However, based on various previous research reports, it was found that many students had difficulty recognizing and identifying ferns (Muswita, Yulianti, et al., 2020). It is known that the ability of STKIP-PGRI Lubuklinggau Biology Education study program students in recognizing and identifying ferns is mostly in the poor to sufficient category. This was confirmed by Pranita (2017) who reported her findings at the State University of Malang, that students taking plant diversity courses also experienced difficulty in identifying ferns.

In a different period, Abrori (2020) reported that the ability of Biology Education students at the University of Borneo to identify ferns was still quite low. Based on the tests given, the students' level of accuracy in recognizing ferns was below 50%. There are even 50% of ferns that students don't recognize at all. This condition was exacerbated by the learning loss phenomenon that occurred during online learning during the Covid-19 pandemic, which caused learning not to run optimally (Andriani et al., 2021). Anisa (2022) also reported that students of the Biology Education study program at UIN Ar-Raniry Banda Aceh also experienced difficulty in distinguishing ferns.

Several researchers have identified the causes of this problem, such as learning which is still often

carried out using conventional methods (Fitriani & Wardianti, 2014) and focuses on the teacher (Sulisetijono et al., 2023). Apart from that, the use of learning media tends to use textbooks which generally contain lots of narrative but minimal pictures (Muswita, Yelianti, et al., 2020), lack real pictures (Illahaqi & Aloysius, 2019), or recent photos (Renita et al., 2020). As a result, learning becomes uninteresting and makes students bored more quickly and this has an impact on their motivation and learning outcomes (Parmini et al., 2022; Syahriani & Sofyan, 2020). Liunokas (2020) states that these conditions prevent students from studying and identifying plants optimally. Moreover, identification material is included in the category of material that is considered to have very high complexity. Including starting from the morphological characteristics of plants, habitat, and physical characteristics to classification.

On the other hand, the characteristics of students currently faced are an average of 20-21 years old who are classified as generation Z (Gen Z). Currently, Gen Z is the largest generation of Indonesia's population (27.94%), according to the Central Statistics Agency (BPS) ranking (BPS, 2021). This means that learning must adapt to the characteristics and learning styles of Gen Z who tend to prefer and more easily understand learning in visual form (Daud, 2020; Othman et al., 2021). Hastini et al (2020) also said that Gen Z is more interested in learning through practical activities rather than just reading or listening to lectures. Apart from that, Gen Z has a very low average attention span or level of concentration in learning, which is only eight seconds, or lower than the millennial generation (Bunardi & Prestianta, 2023; Shatto & Erwin, 2016). Vizcaya-Moreno and Pérez-Cañaveras (2020) said that Gen Z prefers learning in the form of games because it is considered more fun so learning becomes more effective.

The results of the initial analysis, based on randomly distributing questionnaires to biology education students at the University of Muhammadiyah Malang, revealed that 83.3% of students needed fern learning media in the form of games and displaying photos of real ferns. Apart from that, they also complained that fern learning tends to be less suited to the characteristics or learning styles of Gen Z and the majority of literature is in the form of textbooks or scientific journals.

Based on the facts mentioned above, it is important to create fern learning media that suits the characteristics or learning styles of Gen Z students in order to facilitate learning appropriately and hopefully produce optimal learning. Therefore, this research aims to produce learning media for ferns in the form of PSCs based on playing cards which are equipped with real photos ranging from complete images to detailed parts which are characteristic of fern species and integrated with digital components via a QR Code connected to Google Drive. So that fern learning can be carried out independently, actively, fun, interesting, anywhere and anytime.

Method

This research is a type of research and development using the ADDIE model which is an acronym for analyze, design, develop, implement, and evaluate (Branch, 2010) with the following development procedures (Figure 1).

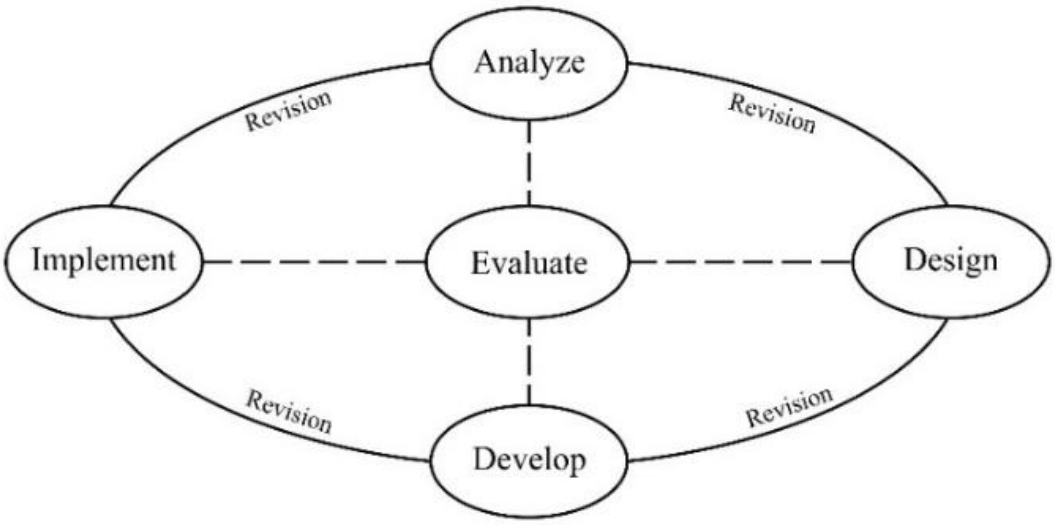

Figure 1. ADDIE model stages

The subjects in this research consisted of material, media and design experts for the feasibility test as well as 26 Biology Education students at the University of Muhammadiyah Malang. As many as six

students in the small group test and 20 students in the feasibility test, practicality test and product attractiveness test. The data obtained from experts is then analyzed to determine the feasibility level of PSC by collecting scores from experts and then converting them into percentages using the following Formula (1) (Efrialda & Subiantoro, 2022).

$$\text{Eligibility (\%)} = \frac{Answer\ score}{Maximum\ score}\ x\ 100 \quad (1)$$

The results of the data analysis were then interpreted and concluded in accordance with the design eligibility criteria according to Munawaroh et al (2023) as in the Table 1.

Table 1. Learning media eligibility criteria

Percentage (%)	Categories
81 – 100	Very eligible
61 – 80	Eligible
41 – 60	Enough
21 – 40	Unqualified
<21	Very unqualified

Furthermore, the practicality of the PSC was tested on a small group of six people and a large group of 20 students. The scores obtained from the two tests were obtained by referring to calculations according to (Milala et al., 2021). The results were then interpreted and concluded in accordance with the practicality criteria (1) (Irawan & Hakim, 2021).
Measurement of the attractiveness of PSC is carried out only if eligibility and practicality have been met. The attractiveness test was carried out on 20 students and the results were interpreted as referred to (Fajri, 2020) in Table 2 and Table 3.

Table 2. Learning media practicality criteria

Percentage (%)	Categories
81 – 100	Very practical
61 – 80	Practical
41 – 60	Enough
21 – 41	Impractical
0 – 20	Very impractical

Table 3. Learning media attractiveness criteria

Percentage (%)	Categories
80 – 100	Very attractive
60 – 79	Enough attractive
50 – 59	Less attractive
0 – 49	Not attractive

Results and Discussion

The development of this PSC uses the ADDIE model so that the development process has gone through several stages according to the model (Figure 1). Initial analysis was carried out using secondary data obtained from previous studies. It is known that learning (1) still tends to be carried out conventionally (Fitriani & Wardianti, 2014) such as lectures and notes so that learning focuses on the lecturer (Sulisetijono et al., 2023), (2) many rely on textbooks with minimal pictures (Muswita et al., 2020), (3) are rarely equipped with original photos (Illahaqi & Aloysius, 2019) or recent photos (Renita et al., 2020), and (4) tend to be boring (Syahriani & Sofyan, 2020) thus affecting motivation and learning outcomes students (Parmini et al., 2022). This finding is strengthened by primary data obtained from randomly distributing questionnaires to biology education students.
The initial results of analysis show that learning about ferns tends to be less able to accommodate the characteristics or learning styles, especially of Gen Z students, so it becomes less interesting. On the other hand, Gen Z prefers attractive learning (Magano et al., 2020; Vizcaya-Moreno & Pérez-Cañaveras, 2020). Moreover, the students' average level of concentration in learning is poor (Bunardi & Prestianta, 2023; Shatto & Erwin, 2016). Gen Z tends to be inseparable from smartphones and the internet and is therefore called the digital native generation (Magano et al., 2020). Therefore, PSC was developed taking these conditions into account. The development results are as Table 4.

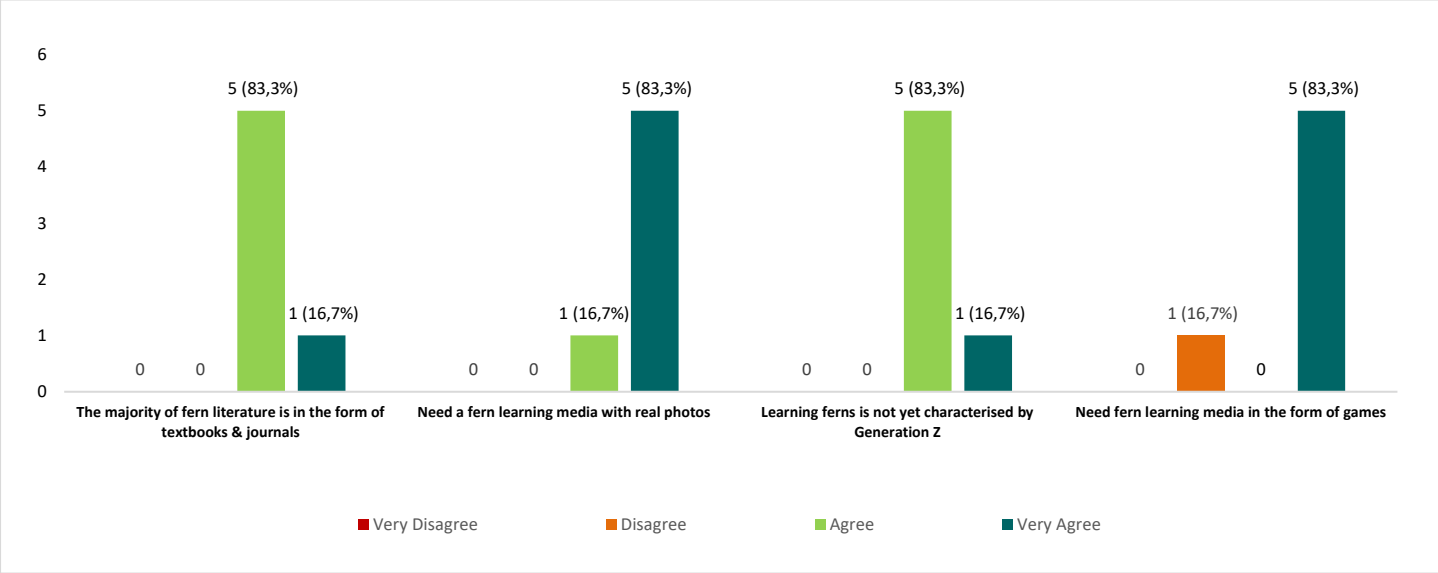

Figure 2. Biology education students' perceptions of fern learning

Table 4. PSC development results

Aspects	Display	Description
Packaging		▪ Consists of two parts, i.e. cover (set box) and (2) inner packaging (primer). ▪ One set box contains of three primary packs consisting of ferns family series, i.e. Pteridaceae, Polypodiaceae, and mixed series.
Print Card	 (1) Answer card (2) Clue card (a) Front Display	▪ PSC has two main components, i.e. the print and digital component. ▪ The printed component consists of 30 species of ferns, each of which has three clue cards and one answer card. ▪ The back side of the answer card is blue. The green one is for the clue card. ▪ On the back side, there is a QR Code to access more

Aspects	Display	Description
	 (1) Answer card (2) Clue card (b) Back Display	information about the species (digital components)
Codification		▪ The answer cards have a number codification from 1 - 30 as a distinction between one species and the others. ▪ Meanwhile, the clue type cards have letter codes A, B and C which contain special characteristics of fern species to indicate that the cards are their pairs. ▪ Codification is intended so that users can easily distinguish fern species from each other.
Digital Components		▪ PSC was equipped with a digital component that contains detailed explanations and photos of ferns. It also includes a classification of each fern species and a glossary.
User Manual		▪ Each box set comes with a user manual.

The results of the PSC feasibility test by experts showed that the percentage was 96.67% in the highly eligible category. Assessment of three components including content suitability, language feasibility, and photo quality showed excellent results. The feasibility test results are as described in Table 5.

Table 5. Material expert validation results

No	Aspect	Indicator	Score	
			Max	Validation
1	Content suitability	Content suitability with learning objectives	4	4
		Quality of information or content	16	15
2	Language feasibility	Straightforward	8	7
		Suitability with language rules	12	12
3	Photo of ferns	Clarity of fern photos	8	8
		Coherence of photos and explanations	4	4
		Novelty and originality of fern photos	8	8
		Total	60	58
		Eligibility (%)	96.67	
		Category	Very eligible	

The results as explained in Table 5 show that PSC is declared very suitable for use as a learning sources. This means that the information contained in the PSC being developed is correct and does not deviate from the fern lesson material. Mawaddah et al (2019) and Munawaroh et al (2023) state that the accuracy of the information contained in a learning media must be accurate and reliable to avoid students' misunderstandings in understanding and interpreting any information presented.

The accurate information in learning media would be a benchmark for the quality of media. So, the better the quality of media, the more impact it will have on achieving student learning outcomes. Therefore, quality learning media is an important factor in improving the quality of learning (Leow & Neo, 2014; Yücel & Usluel, 2016).

Table 6. Media expert validation results

No	Aspect	Indicators	Score	
			Max	Validation
1	Size and paper	Card size	8	8
		Paper quality	4	4
2	Hardware and software	Ease of card usage	4	4
		Card color	12	12
		Typography and language	8	8
		QR Code	8	7
		Digital components function properly	4	4
3	Codification	Card type differences	4	4
		Numeric and letter codification	8	8
4	Photo	Photos of ferns are clear and easy to observe	4	4
5	User manual	Clarity and ease of understanding	4	3
		Total	68	66
		Eligibility Percentage	97.06	
		Eligibility Category	Very eligible	

Meanwhile, the results of the feasibility test by media experts (Table 6) showed that SPC was very suitable for use as a learning medium (97.06%). Media experts stated that PSC was proven to fulfill the rules and principles of learning media. This is in line with Chrisyarani and Yasa (2018) who said that media expert validation is a product assessment process to measure its level of suitability as a learning medium.

Table 7. Design expert validation results

No	Aspect	Indicators	Score	
			Max	Validation
1	Size and paper	Card size	8	8
		Paper quality	4	4
		Photo size and description	4	4
2	Card design and digital info details	Card color	8	7
		Photo layout and explanation	12	12
		Typography	8	7
		QR Code	4	4
		Layout of digital component information	4	3
3	Codification	Card type differences	4	4
		Numeric and letter codification	8	8
4	Packaging	Packaging design	4	4
5	User manual	Design and layout of the user manual	4	3
		Total	72	68
		Eligibility (%)	94.44	
		Category	Very eligible	

The design expert validation results (Table 7) show that the PSC feasibility percentage is 94.44%. In other words, by design, PSC is very suitable for use as a medium for learning ferns. PSC displays that are designed using lots of pictures or visuals can help students' memory so that students can remember information better (Syahriani & Sofyan, 2020).
Validation by the three experts shows that PSC has met the criteria and is very suitable for use as a fern learning medium and can be tested on students. Efrialda and Subiantoro (2022) stated that learning media that has been categorized as appropriate by experts can be tested on users. However, before being tested, improvements and adjustments are made according to development suggestions from media experts in order to produce good, optimal, accurate, and trustworthy of products.

Table 8. Practicality test results of PSC

Item	Small Group		Class (Large Group)	
	Maximum	Empiric	Maximum	Empiric
Score	336	288	1120	1018
Practicality (%)	85.71		90.89	
Category	Very practical		Very practical	

Table 8 shows that the practicality of PSC is classified as very high. Respectively, the percentage of PSC practicality in the small group test and large group test was 85.71% and 90.89%. In other words, PSC is considered very practical to use as a medium for studying ferns. Milala et al (2021) stated that the level of practicality of a media being developed refers to the condition of ease of use by users, both students and educators so that the learning process is more meaningful, interesting, and fun, also stimulates creativity in learning. Ease of use will have an impact on students' ease of understanding (Kafah et al., 2020; Nurafifah et al., 2017).
The practicality of a learning media must also pay attention to several detailed aspects such as (1) format selection, interaction time during learning and media development costs; (2) suitability of the content, learning style, student development, and experience; and (3) the suitability of the media, in terms of its ability to facilitate student understanding (Madeali & Prahani, 2018; Pitt et al., 2019).

Table 9. Results of the PSC attractiveness test

No	Aspect	Score	
		Maximum	Empiric
1	Packaging	80	75
2	Print Card Components	80	73
3	Digital Components	80	73
4	User Manual	80	71
	Total	320	292
	Attractiveness (%)	91.25	
	Category	Very attractive	

The attractiveness of PSC is also one of the advantages that can optimize student learning experiences. The attractiveness test results show a percentage of 91.25% (very attractive). Furthermore, PSC is suitable for use as a learning medium for ferns. The appeal of PSC certainly cannot be separated from the adjustment between product development and analysis of user needs and the characteristics of Gen Z learning styles who prefer and find it easier to understand learning in visual form (Daud, 2020; Magano et al., 2020; Othman et al., 2021). Thus, students can learn with new experiences that suit their learning needs (Hastini et al., 2020). Apart from that, teachers do not need to worry about low levels of concentration in learning. These shortcomings can be packaged into important information in developing PSC so that it can be in line with the characteristics of the millennial generation (Bunardi & Prestianta, 2023; Shatto & Erwin, 2016).

As a learning medium, PSC can be integrated with game methods. The PSC character, which is equipped with real pictures or photos of ferns, starting from their overall appearance to their characteristics, is attractive to students considering that in the initial needs analysis, students wanted the learning media to be made in the form of a game and also equipped with real pictures (Figure 2). Moreover, according to Mawaddah et al (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. Apart from the game format, PSC has the concept of combining printed and digital cards using QR codes to make it easier for Gen Z who tend not to be separated from smartphones and the internet (Magano et al., 2020). Therefore, students can study independently anytime and anywhere. Based on the researcher's observations during the test, students looked interested and happy when studying ferns using PSC. After conducting interviews or dialogue with the students concerned, they thought that learning ferns using PSC tended to be more relaxed and fun because they were playing. This is in accordance with the character of Gen Z who prefers learning to be packaged in the form of games because it will be more fun so learning will be more effective (Vizcaya-Moreno & Pérez-Cañaveras, 2020).

Conclusion

The innovation and development of PSC which integrates cards containing real images of ferns with QR Code technology connected to Google Drive has been considered very feasible and very practical by experts so that it can be used as a medium for learning about ferns. From the aspect of attractiveness, PSC is also stated to be very interesting so that it suits the characteristics and learning styles of Gen Z. To increase the number of fern learning media that suit the learning styles of Gen Z, it is highly recommended that further research be conducted that can integrate with augmented reality technology and digital games or applications both website, desktop and Android based..

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Conflicts of Interest

No potential conflict of interest was reported by the authors.

Author Contributions

W.W. Efendi: Writing – original draft and editing; methodology; analysis. **A. Atiqoh:** Writing – review and editing. **H. Karyono:** Writing – review and editing.

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