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Development of biology smart card learning media based on character education in immune system material

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Abstract

Character education and learning media are essential in improving education quality and shaping a better generation. Smart cards are a biology learning media used to support the learning process that can integrated with character education values. This study aimed to develop character education-based biology smart card learning media that are valid, practical, and effective. This research method is Research and Development (RnD) with the 4D approach model (Define, Design, Development, and Disseminate). This study produced character education-based biology smart cards with a very valid category and obtained a percentage score from media experts of 92%, 94% from material experts, and 87% from character education experts. The results of practicality are categorized as very practical, with a percentage score of 91% obtained from teacher responses and a percentage score of 87% from student responses. Biology smart cards are declared effective based on paired sample t-tests and the results of student character value questionnaires, obtained sig level. 2 (tailed) 0.01 <0.05 there is a significant difference, while the assessment of student character in the initial tabulation is 55% and the final tabulation is 74% with the difference in the increase in the initial and final tabulations of student character values by 19% so that the character education-based biology smart card developed is feasible and practical to use in learning activities and effective in influencing student character.

Abstrak. *Pendidikan karakter dan media pembelajaran memiliki peran penting dalam meningkatkan kualitas pendidikan dan membentuk generasi yang lebih baik. Kartu pintar menjadi salah satu media pembelajaran biologi yang dapat digunakan dalam mendukung proses belajar yang dapat di integrasikan dengan nilai pendidikan karakter. Tujuan dari penelitian ini untuk mengembangkan media pembelajaran kartu pintar biologi berbasis pendidikan karakter yang valid, praktis dan efektif. Metode penelitian ini adalah Research and Development (RnD) dengan model pendekatan 4D (Define, Design, Development, dan Disseminate). Penelitian ini menghasilkan kartu pintar biologi berbasis pendidikan karakter dengan kategori sangat valid, didapat skor presentase dari ahli media 92%, 94% dari ahli materi, 87% dari ahli pendidikan karakter. Hasil kepraktisan dikategorikan sangat praktis dengan skor presentase 91% yang didapat dari tanggapan guru dan skor presentase respon peserta didik 87%. Kartu pintar biologi dinyatakan efektif berdasarkan uji t sampel berpasangan dan hasil angket nilai karakter peserta didik, di peroleh taraf sig. 2 (tailed) 0,01 < 0,05 terdapat perbedaan secara signifikan, sedangkan penilaian karakter peserta didik pada tabulasi awal sebesar 55% dan tabulasi akhir 74% dengan selisih peningkatan pada tabulasi awal dan akhir nilai karakter peserta didik sebesar 19%, sehingga kartu pintar biologi berbasis pendidikan karakter yang dikembangkan layak dan praktis digunakan dalam kegiatan pembelajaran, serta efektif dalam mempengaruhi karakter peserta didik.*

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A. Introduction

In this era, Indonesia faces many cases of moral decline, including the decline in the younger generation's knowledge about the limits of good or bad behavior in the environment (Malaifani, 2023). Character education problems for adolescents such as lying, skipping school, cheating, fighting, running away from home, hurting others, and even harming themselves (Zhang, 2023). Thus, character education must be a top priority today, given the many problems due to juvenile delinquency (Salirawati, 2021).

Character education is cultivating character values in students, which includes the willingness to implement values, manners, and morals into students (Putra, 2019). Character education includes activities to empower students to behave independently and have a noble character in developing all their potential so that it can create a school environment that helps students develop ethics through exemplary universal values (Erwenta et al., 2018; Marasabessy et al., 2022).

Today's moral crisis conditions drive the urgency of implementing character education in learning. There are many behavioral deviations from existing cultural values and social rules, such as consumerist, hedonistic, instant, and fun lifestyles (Pontoh et al., 2021). Implementing character education programs through learning activities can significantly reduce students' negative behavior (Kim et al., 2018). The implementation of character education also positively impacts the quality of fstudents' relationships with teachers and others (Garwood, 2022).

The implementation of biology learning in integrating character education is not something new. By the nature of science learning, it is possible that through learning biology, religious attitudes, honesty and responsibility, and various other scientific attitudes will be developed (Chastanti, 2017). For this reason, character education is very important in the learning process in all subjects, including biology. This stated in Permendikbud No. 59 of 2014, which states that the values or attitudes in biology learning include two elements, namely Godly attitudes and social attitudes (Permendikbud, 2014). In line with Siregar & Ulfa (2022), biology is one of the general subjects that play a role in developing character education because biology also embraces character education in addition to being a product and process.

Furthermore, the grand design of character education in Indonesia has formulated by the Kemendiknas (2010) to include 18 character values as follows, "(1) religious, (2) honest, (3) tolerance, (4) discipline, (5) hard work, (6) creative, (7) independent, (8) curiosity, (9) democracy, (10) national spirit, (11) love for the country, (12) respect for achievement, (13) friendship or communication, (14) love of peace, (15) love to read, (16) care for the environment, (17) social care, and (18) responsibility" (Nasional, 2010). Three main character values prioritized based on the learning media to develop: Religion, honesty, and responsibility (Suwardani, 2020).

The value of character education is also contained in the Book of Ta`līm Al-Muta`allim by Sheikh Burhanuddin Az-Zarnuji saying "know, indeed a student will not gain success in learning and the benefits of a knowledge except by honoring knowledge and the knowledgeable must also honor the teacher". The book of Ta`līm Al-Muta`allim shows that education is not just a process of disseminating knowledge, but the most important thing is the formation of student character and the deterioration of student behavior, in other words, the book of Ta`līm Al-Muta`allim is a book that discusses manners in studying knowledge which can be relied upon for character education (Rachman, 2021). Good character's value in humans exemplified by God's most noble messenger, the Prophet Muhammad SAW. As in the Qur'an Surah Al Ahzab verse, 21 as follows

لَقَدْ كَانَ لَكُمْ فِيْ رَسُوْلِ اللّٰهِ اُسْوَةٌ حَسَنَةٌ لِّمَنْ كَانَ يَرْجُوا اللّٰهَ وَالْيَوْمَ الْاٰخِرَ وَذَكَرَ اللّٰهَ كَثِيْرًا ٢١

Meaning: "Indeed, in the Messenger of Allah there is indeed a good example for you, for those who hope for the mercy of Allah and the Last Day, and who remember Allah much" (Al-Ahzab 33:21).

The verse explains that the Prophet is a role model for humans who teach and instill noble character values to his people. The best human being is a good character, and the best example of character education is the example of the Prophet. There is no doubt that everything in the personality of the Prophet can imitated (Solihin et al., 2023). So, character education must be integrated into all subjects, including biological material.

Biology teaching materials that can used to instill character values (religious, honest and responsible) are smart cards. Smart cards are visual media that produce products from a learning material with brightly colored ornaments to stimulate interest in learning (Efendi et al., 2023). This smart card media can contain character values in a learning material by presenting material that provides examples of behavior (Tomi & Jamilah, 2020). The advantages of smart card media are that besides being practical to carry because of its small size, it presents information visually and easily understood by students (Mulya et al., 2023). In addition, this smart card equipped with QR code videos and learning articles, integration of Al-Qur'an verses and character values that can help students understand learning concepts better. This shows that character education should inserted in a learning material that is poured into an appropriate learning media, so that learning media can facilitate education mora (Muthy & Pujiastuti 2020).

Based on observations and interviews with biology teachers at SMA PAB 4 Sampali, it known that teaching materials that often used in learning biology are LKS, LKS made for students have never been inserted with character values, while many biology or science concepts contain character values. Likewise, biology teachers at SMA PAB 4 Sampali still very rarely apply the value of character education in biology learning, even though there are various problems in the school related to poor student behavior, it must addressed by the application of learning that integrated in the value of character education, thus it is necessary to develop a learning media based on character education.

The selection of immune system material because according to the opinion of the biology teacher at SMA PAB 4 Sampali, immune system material is one of the materials considered difficult for students. This is in line with (Syamsurizal & Ardianti, 2021) which states that immune system material is difficult material, because the material is abstract, making it difficult for students to imagine or imagine the concepts in it, especially in the material on the mechanism of action of the immune system. The study also mentioned that teachers find it difficult to design learning strategies due to the short learning time for immune system material and the lack of learning media to help students understand.

Learning media developed by researchers, is a biology smart card that contains a packaging box as a container of cards equipped with a QR Code that can scanned using a smartphone, contains information from articles and learning videos and contains integration of Qur'anic verses and character education values such as religious values, honesty and responsibility associated with immune system material. Then it contains information about the material to be learned according to the Core Competencies and Basic Competencies and learning indicators, also equipped with instructions for use. Research related to smart card development has been previously researched by Ulfah & Wiyatmo (2017), showing that using smart card learning media can improve student learning outcomes. Lubis et al. (2023), research developed smart cards, which are digital-based biology smart cards. Agustin (2019) developed smart biology cards to improve HOTS. Emawati & Haka (2022) developed a biology smart card with augmented reality technology. Syifa et al. (2021), developed a biology smart card based on Islamic values.

In previous research, no research has found that specifically discusses the development of character education-based smart card learning media. Therefore, there is an opportunity for researchers to conduct research that focuses on developing biology smart card learning media that integrates character education on immune system material. This character education-based biology smart card expected to provide changes in behavior or better attitudes, so that students can build attitude and skill formation. Based on the background exposure and the problems found, this study aims to develop a character education-based biology smart card learning media.

B. Material and method

Researchers use the research and development method (Research and Development) because this research will produce a product (Sugiyono, 2015) with the 4-D development model proposed by (Thiagarajan, 1974), namely Define, Design, Development, Disseminate. However, this approach model is limited only to the development stage, the reason is due to limited time and money, shown in Figure 1. This research conducted at SMA PAB 4 Sampali, located at Pasar Hitam Street No. 119, Kec. Percut Sei Tuan, Kab. Deli Serdang, North Sumatra. The sample in this study was XI-IPA class students with 36 respondents.

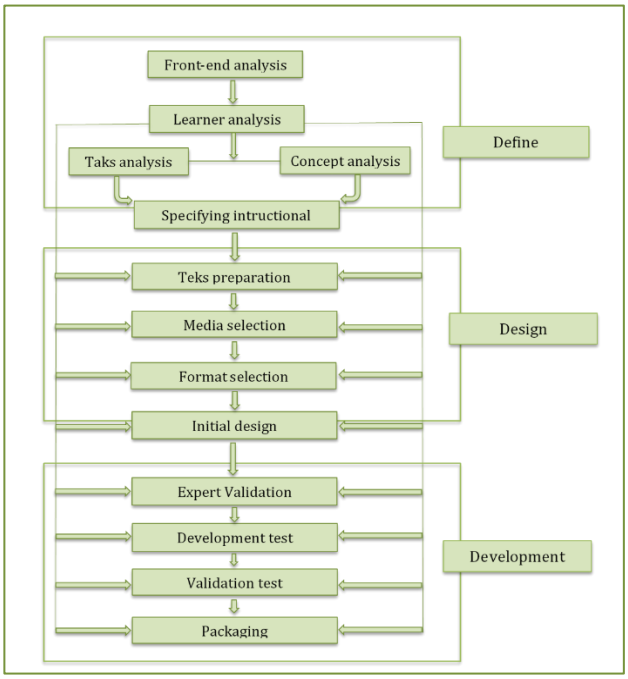

Figure 1
4-D model design (source: Thiagarajan et al., 1974)

The research procedure begins at the define stage, which consists of (1) front-end analysis: at this stage, looking for potential and problems to develop the desired product. (2) learner analysis: this stage carried out by distributing questionnaires in the form of analyzing student needs which contain various questions relevant to student problems, (3) Concept analysis: this stage determined by an interview with a biology teacher regarding what biological material is constrained or difficult to teach and determining the content of the material in the learning media to developed, (4) Task analysis: this stage is to thoroughly ascertain the tasks in the material which will later obtain an overview of the tasks required in

learning according to the Basic Competencies for skills. Skill identification obtained from the Basic Competencies for KI. 4.14 by conducting a campaign on social media, by uploading a poster on insta story instragram with the theme of immune system disorders and how to overcome them (5) Specifying intructional: this stage determines the indicators of learning achievement based on the attachment of Permendikbud Number 37 of 2018 concerning the Core Competencies & Basic Competencies of biology subjects as a basic reference when designing learning media (Permendikbud, 2018).

The design stage, at this stage, consists of (1) text preparation: reviewed based on the context of the content on the learning media material which adjusted from the class XI biology package books based on the 2013 Curriculum. (2) media selection: adjusted to students' needs to overcome existing problems. (3) format selection: smart card media is designed using two applications, namely Canva and pixelLab with a size of 9 cm x 13 cm using 200 gram typed paper, has a thickness of 2.3 mm, smart card media uses a combined font consisting of tan tankwood, sans serif and handyman font types with a combination of black, green, and white font colors. (4) initial design: the design stage includes each card equipped with images, QR codes containing information from articles and videos and biology smart cards containing character values such as, cultivation of religious values, honesty and responsibility related to immune system material.

Stage development: at this stage consists of (1) expert validation: consists of expert validation of media, material and character education (2) development test: carried out by limited product distribution only to XI-IPA class students at SMA PAB 4 Sampali. (3) validation test: reviewed based on teacher and student response questionnaires to the biology smart cards developed and (4) packaging.

The instruments used are (1) interview and teacher observation sheets, to find information related to the learning process in the classroom; (2) media expert validation sheets; (3) material expert validation sheets; (4) linguist validation sheets, aiming to assess product validity; (5) student response questionnaires, and; (6) teacher response questionnaires, aiming to assess product practicality; (7) character value questionnaires, aiming to measure students' religious, honest, responsible attitudes in learning biology and assessing product effectiveness.

Data analysis techniques in the study aimed to obtain valid, practical, and effective smart cards using quantitative data (validity, practicality, and effectiveness) and qualitative data (comments, criticisms, and suggestions). The validity analysis uses validator results from media expert validators, material experts, and character education experts. Then, the sheet validated by the instrument validator first. Then validation is carried out, the results are analyzed using a Likert scale as in Table 1.

Table 1 Likert scale rating guidelines

Score	Assessment criteria
4	Very good
3	Good
2	Less good
1	Not very good

(Source: Sugiyono, 2015)

The formula for calculating the validation sheet uses Formula 1 by Ikhwani & Kuntjoro (2021). The validation results are then calculated based on the percentage criteria, as shown in Table 2.

$$\text{Index } 100\% = \frac{Score\ obtained}{Maximum\ score} \times 100 \ldots \text{Formula 1}$$

Table 2 Validation assessment criteria

Percentage (%)	Assessment criteria
76-100	Verry valid
56-75	Valid
40-55	Less valid
0-39	Invalid

(Source: Sugiyono, 2015)

Analysis of the practicality of smart cards can be seen based on the results of student and teacher responses regarding the assessment of learning media, which can seen in Table 3. The student character assessment results aim to determine the high, medium, or low character in students, as seen in Table 4.

Table 3 Practicality level criteria

Percentage (%)	Assessment criteria
81-100	Very Practical
61-80	Practical
41-60	Less Practical
21-40	In practical

(Source: Sugiyono, 2015)

Table 4 Character value assessment criteria

Percentage (%)	Assessment criteria
80,1-100	Very High
60,1-80	High
40,1-60	Medium
20,1-40	Low
0,0-20	Very Low

(Source: Arikunto, 2010)

Smart cards are declared effective based on the paired tample t-test on student character value data before and after learning. Data analysis was generated from a character value questionnaire with two trials on the same questionnaire to determine significant differences in student character values before and after using biology smart cards in learning. Comparison of the initial tabulation of character values and the final tabulation of character values calculated using the paired sample test formula in the SPSS 28 for Windows application.

The decision-making criteria are as follows: (1) if the significance value (2-tailed) <0.05 indicates a significant difference between the initial variable and the final variable. H_0 rejected & H_1 accepted. (2) if the significance value (2-tailed) > 0.05 indicates that there is no significant difference between the initial variable and the final variable. H_0 accepted & H_1 rejected.

Description:
H_0: There is no difference between the two values
H_1: There is a difference between the two values.

C. Results and discussion

The results of the biology smart card developed through pre-existing research, namely the 4D development model with the following stages: the initial stage is define. At this stage is an initial analysis, where researchers find a problem in students who have difficulty understanding biology lessons when biology teachers only use textbooks and LKS as the main learning media, other problems that schools often face are bad behavior by students, such as skipping school, missing class hours, and even not doing assignments so that it becomes a reference for researchers in developing a character education-based biology smart card product, intending to instill religious, honest and responsible character values.

In the next stage, researchers conducted a concept analysis, namely curriculum and student needs analysis. Curriculum analysis is related to the 2013 curriculum because, conceptually, the 2013 curriculum is suitable for media development with a character education approach. Student needs analysis is reviewed regarding the accuracy of the learning media to be used, by developing a learning media that can influence student character. Furthermore, researchers adjusted the material's content on the card media used by the core competencies, basic competencies, and achievement indicators for a teaching process. In this case, researchers chose immune system material accompanied by images and subject matter information.

The next stage of the researcher formulates or specifies learning objectives. The curriculum and concepts analyzed by the learning achievement indicators based on the attachment of Permendikbud No. 37 of 2018 concerning KI & KD of biology subjects as a basic reference when designing learning media. The immune system material is in KD 3.14, namely analyzing the immune system's role in physiological processes in the body. Therefore, the researchers formulated several learning objectives that must be achieved, namely: (1) students are expected to be able to provide an explanation of the meaning of the immune system and the function of anti-genes and anti-bodies in the body, (2) students are expected to be able to identify nonspecific and specific body defense mechanisms, (3) students are expected to be able to analyze various disorders of the immune system.

The next stage, design with the card media design stage using two applications, namely Canva and pixelLab, then designed through four aspects, namely the pre-preface, introduction, content section and activity column as follows: (1) pre-preface: this section is in the form of a packaging box/card container equipped with a QR Code that can scanned using a smartphone. The QR code contains information from articles and learning videos that integrate Qur'anic verses and character education values related to immune system material. (2) introduction: contains information about the instructions for using the card and the material to study, such as core competencies, basic competencies and indicators. (3) content section: contains immune system material consisting of the definition of the immune system, antigen and antibody functions, nonspecific and specific body defense mechanisms and abnormalities in the immune system combined with character education values. (4) activity column: contains assignments per group to upload a poster on insta story instragram, with the theme of immune system disorders and how to overcome them.

The next stage is the development stage. This stage is the development of smart card products after being validated by three validators: media experts, material experts and character education experts. The results of the validation researchers used as a reference to improve and refine the product after being validated by material experts, media experts and character education experts. The results of product revision can see in Figures 2, 3, 4, and 5. The improvement of front cover of the card pack is customized directly to the topic of the material to discussed and the logo of the campus institution on the back cover of the card container is placed at the very top (see Figure 2). Relate religious values derived from the hadith or sunnah of the Prophet about the recommendation to fast to increase the body immunity (see Figure 3). Discuss more about character education values such as (religious, honesty, responsibility) which adjusted to the material of the immune system (see Figure 4). Customize the command sentences in student assignments that include indicators of competency achievement (see Figure 5). This follows Mailani & Wulandari (2022), that the results of the analysis of the validator's assessment of a teaching material aim to show the feasibility of the content of the teaching material.

A recapitulation of the validation results of material experts, media experts, and character education experts presented in Tables 5, 6, and 7. Based on the media expert validation results, 92% obtained in the "very valid" category. Material expert validation obtained a percentage value of 94% with the category "very valid." Character education expert validation obtained a percentage value of 94% in the "very valid" category. From the percentage results from the validators, biology smart cards are said to be feasible in terms of media, material, and character

education values developed according to the criteria covered during the validation process. In addition to assessing the feasibility of expert validators, they also provide comments and suggestions to improve the media that has designed. This is in line with Mursalina et al. (2014) that the results of the assessment of material expert validators and media experts have said that to meet valid criteria, there will still be further suggestions or input for the perfection of the media developed. So, it can be interpreted that the character education-based biology smart cards that researchers develop have very feasible criteria to use as a tool in teaching and learning activities on immune system material for class XI high school students.

Figure 2
The front cover before (A) and after (B) revision (in Indonesian)

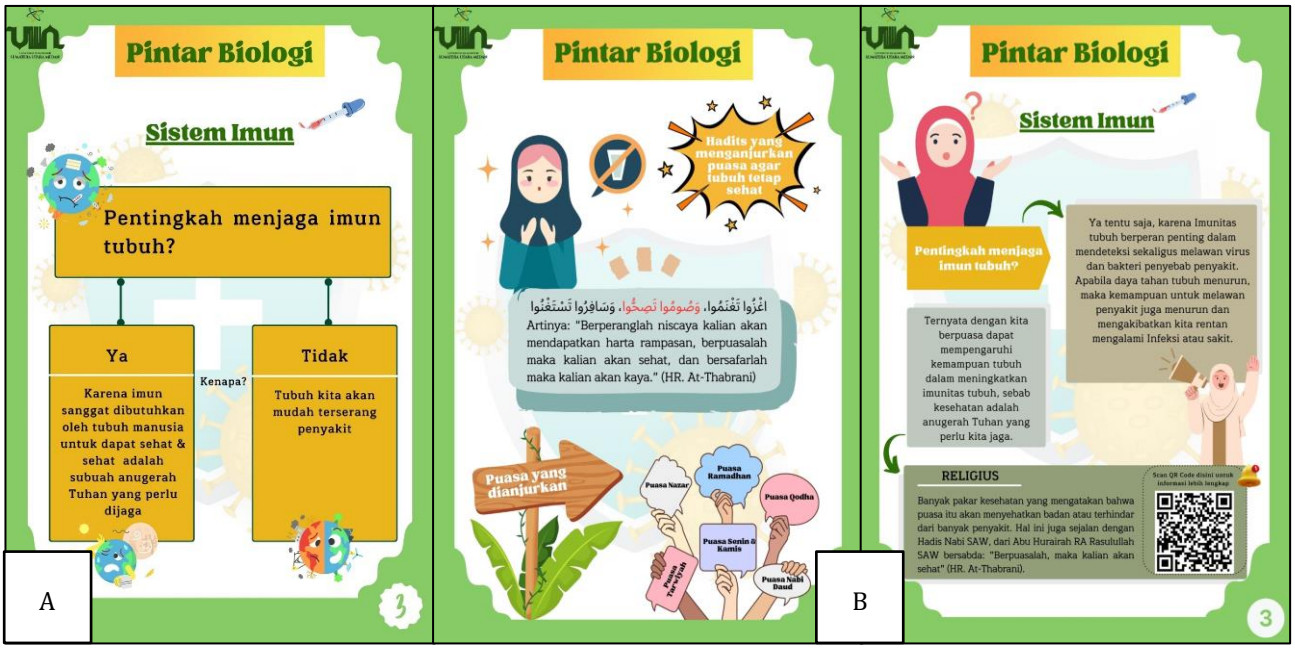

Figure 3
Relating religious values before (A) and after (B) revision (in Indonesian)

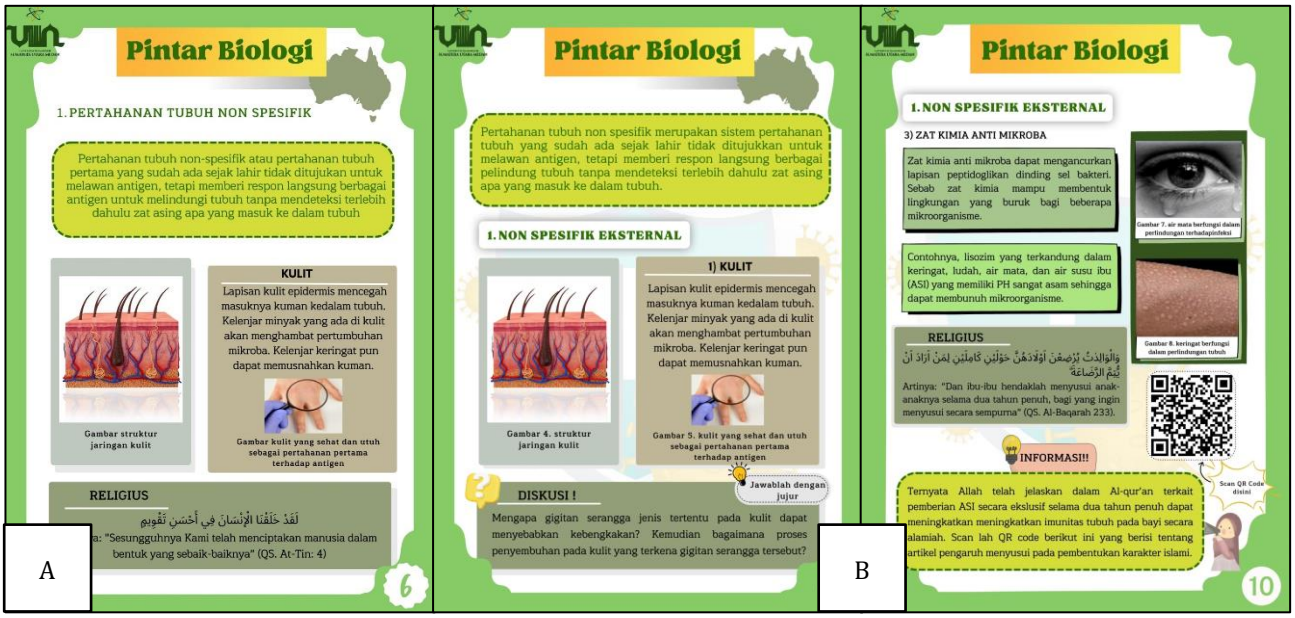

Figure 4
Further discussion of character education values according to the immune system material before (A) and after (B) revision (in Indonesian)

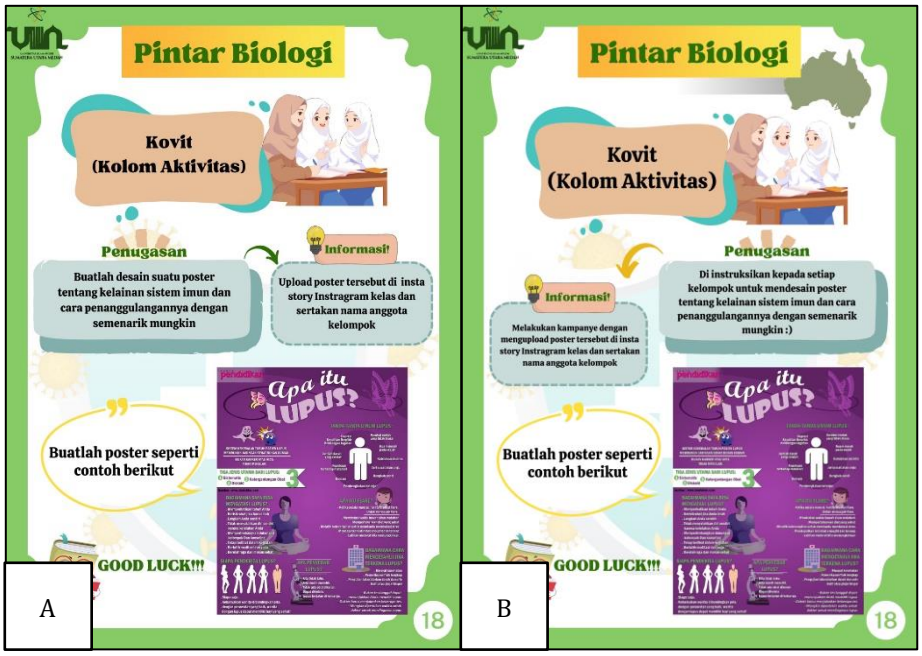

Figure 5
Adjustment of command sentences in student assignments including competency achievement indicators before (A) and after (B) revision (in Indonesian)

Table 5 Media expert validation results

Aspect	Score obtained	Maximal score	Percentage	Category
Graphics	30	32	93%	Very valid
Presentation	29	32	90%	Very valid
Score obtained		**59**		
Maximum score		**64**		
Percentage		**92%**		
Category		**Very valid**		

Table 6 Material expert validation results

Aspect	Score obtained	Maximal score	Percentage	Category
Content of material	46	48	95%	Very valid
Presentation	7	8	97%	Very valid
Score obtained		**53**		
Maximum score		**56**		
Percentage		**94%**		
Category		**Very valid**		

Table 7 Character education expert validation results

Aspect	Score obtained	Maximal score	Percentage	Category
Suitability of material with character values	32	36	89%	Very valid
Language	13	16	81%	Very valid
Score obtained		**45**		
Maximum score		**52**		
Percentage		**87%**		
Category		**Very valid**		

Table 8 Results of teacher response questionnaire

Aspect	Score obtained	Maximal score	Percentage	Category
Fill	29	32	91%	Very practical
Character value	9	12	75%	Practical
Graphics	31	32	97%	Very practical
Presentation	30	32	94%	Very practical
Score obtained		**99**		
Maximum score		**108**		
Percentage		**91%**		
Category		**Very Practical**		

Table 9 Results of student response questionnaire

Number of respondents	Score obtained	Maximal score	Percentage	Category
36	1.506	1.728	87%	Very practical

Table 10 Results paired sample t-test on student character values

		Paired differences							
					95% Confidence Interval of the Difference				
		Mean	**Std deviation**	**Std. error mean**	**Lower**	**Upper**	**t**	**df**	**Sig. 2 (tailed)**
Pair 1	Initial tabulation Final tabulation	-7,889	3,353	559	-9,023	-6,754	-14,116	35	0,01

Table 11 Tabulation results and initial and final student character scores

Character type	Initial score	Final score	Maximal score	Initial percentage	Category	Final percentage	Category
Religious	251	329	432	58%	Medium	76%	High
Honest	302	415	576	52%	Medium	72%	High
Responsibility	238	321	432	55%	Medium	74%	High
Initial score				**792**			
Final Score				**1.065**			
Maximal score				**1.440**			
Initial percentage				**55%**			
Final percentage				**74%**			

The practicality of smart card learning media obtained from the results of the teacher and student response questionnaire with statements and responses to assess the smart card media developed, this stage carried out after expert validators have validated the smart card. Then the data obtained from the biology teacher of SMA PAB 4 Sampali based on Table 8, obtained a total score of 99 and a maximum score of 108, the percentage value of 91% with the category "very practical". The results of the student response questionnaire based on Table 9, with a limited class test, on 36 students from class XI SMA PAB 4 Sampali by obtaining a total score of 1506 and a maximum score of 1728, the percentage value is 87% with the category "very practical". This shows that the media developed meets the criteria of practicality. This finding is in line with research by (Hasan & Susilowibowo (2012), that the data obtained from the results of student responses when conducting trials of smart card media development in a limited class with a total of 20 students in class X Accounting SMAN I Ngawi can already meet the practicality test standards. The results of student responses are categorized as very practical because students predominantly give point (4) in the questionnaire, where point (4) stated to strongly agree with the statements listed in the student response questionnaire. Therefore, this character education-based biology smart card is very helpful in learning.

The effectiveness of character education-based biology smart card learning media can be seen in Table 10 using a paired sample t test, from the results of the character value questionnaire after and before using biology smart cards in learning, obtained a sig. 2 (tailed) of 0.01 <0.05. Therefore, H_0 is rejected and H_1 is accepted. So it can be concluded that the results of the initial tabulation assessment and the final tabulation on using character education-based biology smart cards are significantly different. In other words, learning using smart card media integrated with character values can increase the value of religion, honesty and responsibility in students.

The assessment results of student character education calculated using a student character value questionnaire which aims to determine the development of character education values in students, containing 10 statements related to the character values developed, namely religious, honest and responsible. The results of the questionnaire assessment obtained from XI science class students at SMA PAB 4 Sampali with 36 students as respondents. Based on Table 11, the results of students religious character values in the initial tabulation with a percentage of 58% which classified as moderate criteria. After students carry out group discussion activities using biology smart cards, there is an increase obtained from the results of distributing the second questionnaire after the product trial of 76%, classified as high criteria. This can seen when students begin with prayer, polite attitude, and behavior before starting learning. In addition, the religious character in smart cards teaches students to fast to strengthen the body's immunity and be grateful for all the blessings that Allah SWT has given. This aligns with research by Muhammad et al. (2021), stating that learning media can improve students' religious character.

The assessment results of student character education calculated using a student character value questionnaire which aims to determine the development of character education values in students, containing 10 statements related to the character values developed, namely religious, honest and responsible. The results of the questionnaire assessment obtained from XI science class students at SMA PAB 4 Sampali with 36 students as respondents. Based on Table 11, the results of students' religious character values in the initial tabulation with a percentage of 58% classified as moderate criteria. After students carry out activities

The value of honest student character in the initial tabulation was a percentage of 52%, which classified as moderate criteria. After students carry out group discussion activities using biology smart cards, there is an increase obtained from the results of distributing the second questionnaire 72%, classified as high criteria. This can see during the learning process; students work according to the procedures specified in the biology smart card media, and students are also able to mention and provide suggestions for the biology smart card media used during the learning process. Strengthening honest character values on this biology smart card can be seen from the exemplary story of Prophet Ayub AS, who lost his son Yusuf because Prophet Ayub AS expressed his deep sadness by continuously crying for his lost son until it caused his eyes to go blind. However, it successfully healed by Yusuf's shirt containing sweat, which turned out to be able to recover because the content of sweat is one of the components of the immune system. This story teaches students always to express things as they are, especially if learning is not understood. This aligns with research conducted by Komariah (2019), stating that audio-visual media influences students' value of honest character.

The character value of responsibility at the beginning with a percentage of 55%, classified as medium criteria. After students carry out group discussion activities using biology smart cards, there is an increase obtained from distributing the second questionnaire of 74%, which classified as a high criterion. This can seen when students use the media by the instructions provided. Strengthening the character value of responsibility in this character education-based biology smart card, students taught to maintain a healthy body with a balanced diet, maintain cleanliness, and carry out activities that support immunity, such as vaccination and exercise so that it can bring up a sense of responsibility to maintain a

healthy body. In line with research by Suwanda et al. (2023) which shows that strengthening the character value of responsibility is found in character education-based biology digital comics, students are taught to maintain a healthy lifestyle to bring up a sense of responsibility to maintain a healthy body.

The results of research conducted by distributing the second questionnaire on the character value of students obtained a percentage of 74%, classified as high criteria. This shows that character education-based biology smart card media can affect students' character with a percentage increase of 19% with initial data on student character values of 54%. This is in line with research conducted by Zafirah et al. (2018), as the use of congkak games used as learning media is proven, can be used by teachers in instilling student character education. Likewise, research conducted by Rina et al. (2020), this study shows that the comic media developed is effective for increasing the character values of students in the learning process. It is also supported by research Candiasa et al. (2021), explaining that learning media can increase independence and honesty. Therefore, it can conclude that there is a novelty in this character education-based biology smart card development research, namely that no previous researchers have developed biology smart cards associated with character values.

Researchers hope that the development of character education-based biology smart card learning media can make students able to build attitude formation and knowledge with the right presentation of the content of the biology smart card. This can help educators create more varied learning media and provide opportunities for students to explore knowledge in the field of biology or science, into examples of character values in everyday life.

The final results of all validity, practicality and effectiveness tests on character education-based biology smart cards on immune system material are declared valid, practical and effective. Based on this statement can answer the existing problems. The problem is the unavailability of supporting teaching materials, in addition to LKS and package books, it turns out that after the development of biology smart cards can overcome these problems. The next problem can also resolve which is indicated by the results of data obtained from student character values, there is a significant difference through the t test, namely the sig level. 2 (tailded) 0.01 <0.05, thus there is a difference in student character values when using biology smart cards and there is also an increase in the percentage of student character values by 19%. This shows an increase in the value of student character education at SMA PAB 4 Sampali.

C. Conclusion

This research produces character education-based biology smart cards that have undergone validity, practicality and effectiveness tests. Based on the results of the validity analysis, the biology smart cards were declared very valid, with a percentage score of 92% from media experts, 94% from material experts, 87% from character education experts. Biology smart cards are declared very practical, based on the practicality test with a percentage score obtained from the teacher response questionnaire of 91% and a percentage score of student responses of 87%. Biology smart cards are declared effective, based on the results of the paired sample t test of 0.10 <0.05, so there are differences in student character values when using biology smart cards in the learning process. Furthermore, based on the student character assessment questionnaire in the initial tabulation of 55% and the final tabulation of 74%, the difference in the increase in the initial and final tabulations was 19%. Thus, the character education-based biology smart card media is stated to be able to influence student character.

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