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Genetic Box: Character, Validity, Practicality, and Effectiveness as A Learning Media

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Abstrak: *This study employed research and development (R & D) with a four-dimensional development model that includes four stages: define, design, develop, and disseminate. This research aimed to determine the characteristics, level of validity, practicality, and effectiveness of genetic box learning media for class XII genetic material at SMA Negeri 22 Bone. The genetics box learning media is a product that is being developed and will be tested through validity, practicality, and effectiveness tests. The research subjects were 29 class XII students at SMA Negeri 22 Bone. The instruments in this study included student and educator response questionnaires to obtain product practicality data, media characteristic sheets to obtain the characteristics of the developed genetics box media and learning achievement tests to obtain product effectiveness data. According to the findings of this study, the media have an appealing appearance, are clear and neat, and use appealing color combinations. Genetic box media is easy to operate and does not require electronic facilities or equipment to use. In addition, the genetics box has value in helping students understand the material and can provide a comprehensive learning experience. The genetics box media also has quite good tool durability because it is made of hard materials such as wood and boards. The genetics box media formulates learning objectives and refers to material items that support the achievement of those objectives. In addition, the genetics box learning media for class XII genetic material at SMA Negeri 22 Bone has a validity level of expert validity and a material expert value of 3.72 with a very valid category. The response of students and educators to the level of practicality is worth a total of 3.52 in the positive category. The learning achievement test of students using the genetics box learning media on genetic material for class XII at SMAN 22 Bone is in the effective category because it reaches 100%, so the genetics box learning media for class XII genetic material at SMAN 22 Bone is feasible to use because it meets valid, practical, and effective criteria.*

Keywords: *Development, Learning Media, Genetics box*

1. INTRODUCTION

Every human being's life is always associated with the learning process. Learning is a process of changing one's behavior through various actions, such as observing, reading, and practicing. Learning activities can occur if there is a reciprocal relationship between humans and their environment. So that learning activities can occur anywhere and anytime (Pito, 2018).

Learning is an event that has an interrelated relationship with educational activities. Learning can also be an event where there is a relationship between educators and students using learning methods, learning strategies, and learning media. This assertion positions learning as the core of education and, consequently, will serve as the key to equipping a generation of individuals with

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profound insights (Pane & Darwis Dasopang, 2017).

Biology is one of the subjects applied in high school, commonly abbreviated as high school, and based on improving students' skills (Mustami and Safitri, 2018). Nevertheless, a significant issue persists: students' learning achievements remain low (Mustami & Safitri, 2018). Numerous factors contribute to students' learning challenges, encompassing both internal and external influences. Among internal factors are students' learning goals, self-confidence levels, motivation, and grasp of the material. External factors encompass the learning environment, curriculum, and the inadequate availability of supportive learning tools, specifically learning media in this context (Lestari & Putri, 2020).

Media is one of several external factors that can influence learning activities. By applying learning media in every teaching and learning process, of course, it aids educators in effectively conveying information to students, enabling them to influence students' thoughts, emotions, attention, and learning aspirations. (Hafidzah et al., 2022) state that the use and application of learning media is something that can trigger the creation of an effective learning process.

Based on the results of observations and interviews by researchers with biology teachers at SMAN 22 Bone, it was determined that so far students lacked interest and motivation when studying genetic material. Educators are also known to convey material only by lecturing, causing the learning atmosphere to seem passive. As for the media that support learning activities, it is known that they still only use print media, and so far they have not used other media. Based on the results of these observations, it is also known that students have difficulty understanding genetic material, especially if only printed media. Some genetic material is hard to observe directly without sophisticated equipment and uses lots of symbols and terms, making it difficult for students to understand the concept of genetic material. As a result, the indicators of competence achievement remain unfulfilled. One way to overcome these obstacles is for educators to utilize innovative learning tools to attract students' learning desires and curiosity, one of which is the genetics box.

Based on the problems identified, an effort can be made to develop effective learning activities, such as creating learning media capable of stimulating students to be more active and focused on biology subject matter that is easy to understand. A learning media was created as part of this study, namely the Genetics Box learning media for class XII genetic material at SMA Negeri 22 Bone, which is valid, practical, effective, and has its own characteristics compared to other learning media.

2. RESEARCH METHODOLOGY

The type of research used in this research includes research and development. Research and development (R&D) are based on the Thiagarajan 4D model, which consists of the define, design, develop, and disseminate stages (Sugiyono, 2013). The researcher developed a product in the form of a genetic box. This research was conducted at SMAN 22 Bone, Tanabatue Village, Libureng District, Bone Regency, South Sulawesi. The test subjects were class XII MIPA 2 students.

The 4D model was chosen because it's well-organized, goes through different stages of development, and was focused on solving learning problems. It does this by creating teaching materials that match students' characteristics and their needs. (Ulfa et al., 2022) state that the 4D development model is arranged sequentially and systematically by focusing on solving learning problems. Besides that, the 4D development model is appropriate for developing learning tools.

The first stage, namely defining, consists of three stages: initial-end analysis, student analysis, material analysis, task analysis, and formulating learning objectives. We found that when students aren't very active and learning revolves around the teacher, their achievement tends to be low. The questions provided receive support from uncomplicated media and the lecture method.

The second stage is the design phase, which involves four steps: test preparation, media selection, format selection, and initial design. During this phase, the development of learning media commences. This is the point at which the genetics media box is conceptualized and chosen, including the selection of appropriate materials and colors tailored to the genetic media box. The genetics media box itself is crafted in the shape of a square cube measuring 45 x 45 cm, housing four

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distinct media components: the DNA helix model, the RNA model, various chromosome forms, and a representation of protein synthesis. These components used durable materials such as wood, plywood, or hardboard, which were then paired with engaging colors and accompanied by clear usage instructions and descriptions.

The genetics box media using applications such as Canva and Corel Draw, with the Calibri font type selected and standard font sizing adhered to.

The development stage, namely the genetics box media, is produced according to the directions of the experts. The development of this medium was based on the prototype 1 stage, where the initial product was produced, and the manufacture of instruments that will be used in research.

The dissemination stage is the stage of implementing the developed which is implemented at SMAN 22 Bone Class XII MIPA 2 to test the effectiveness of the media.

The technique of collecting data and measuring the quality of the media has been done by using instruments in the form of questionnaires and learning achievement tests. The media validity instrument was a questionnaire designed for expert validators. It's often called a validation sheet and helps assess how valid the media is. For practical purposes, a questionnaire was used. This questionnaire collects responses from educators and students. Another instrument, focused on effectiveness, was used to measure student understanding. It asks questions to gauge how well students grasp the material.

Data analysis techniques are applied to evaluate achievement in the genetics box learning media. The analysis used is the analysis of validity, practicality, and effectiveness characteristic data as follows:

a) Media Characteristics Data Analysis

Assessment of media characteristics developed using the Guttman scale. The Guttman scale is used to obtain consistent results for a problem in question (Gumanti & Teza, 2021).

Table 1. Scoring with the Guttman Scale

Answer	Skor
Yes	1
No	0

The steps that can be applied in analyzing media characteristics data are:

a. Recapitulate the values obtained from the experts in tabular form.
b. Calculating the percentage value of the characteristics of the developed media
.

$$P = \frac{F}{N} \times 100$$

Notes:
P = presentation number
F = Number of respondents' answers
N = Number of all respondents

c. Establish categories of media characteristics that were developed based on the following categories:

Table 2. Categories of Media Characteristics

Percentage	Category Characteristics
76% - 100%	Very good
56% - 75%	Pretty good
40% - 55%	Not good
< 40%	Not good

b) Validity Data Analysis

Validity data analysis is used to determine the level of validity of the media developed by looking at the average assessment results from experts and practitioners on the criteria with the formula:

$$\overline{Ki} = \frac{\sum_{j}^{n=1} V_{ij}}{n}$$

Notes:
$\overline{Ki}$ = average criterion
V_{ij} = score of the assessment result of the ith criterion by the j-evaluator
N = the number of raters

The validity category for each criterion, each aspect and all aspects is determined as follows:

Table 3. Criteria for the Level of Validity

Value	Criteria
X > 3,4	Very valid
2,8< X ≤ 3,4	Valid
2,2≤ X ≤ 2,8	Quite valid
1,6 ≤ X ≤ 2,2	Less valid
X≤ 1,6	Invalid

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c) Practicality Data Analysis

To find the total average (Xi) using the formula:

$$X_i = \frac{\sum_{i=0}^{n} Ai}{n}$$

Notes:
n = number of aspects
Ai = average aspect

Determine overall practicality criteria where criteria (Ki) or are average aspects (Ai) or total average (Xi) with predetermined practical categories. The average value is then entered into the interval to determine the degree of practicality of the model as follows:

Table 4. Practicality Level Category

Value	Criteria
$3{,}5 \leq X_i \leq 4$	Very Practical
$2{,}5 \leq X_i \leq 3{,}5$	Practical
$1{,}5 \leq X_i \leq 2{,}5$	Quite Practical
$0 < X_i \leq 1{,}5$	Not practical

d) Effectiveness Data Analysis

Determination of student learning outcomes is based on the values obtained and calculated by applying the following formula:

$$N = \frac{W}{n} \times 100$$

Notes:
N = Value obtained by students
W = Number of questions correct
n = Number of question items

Table 5. Category Level of Effectiveness

Completeness Percentage	Classification
> 80	Very effective
> 60 - 80	Effective
>40 – 60	Enough
>20 – 40	Not enough
≤ 20	Very less

3. RESULTS AND DISCUSSION

a) Results

The following is a discussion of the results and the description of the development of Genetics Box learning media and how it obtains effective, valid, and practical media.

1. Characteristics of Genetics Box Learning Media

The genetics box learning media development involves multiple stages, resulting in distinct improvements. Unlike previous versions, the new media pays attention to visual appeal, featuring pleasing color combinations. In the DNA helix model, we now include the nitrogenous base numbering. In content, the previous media fell short of meeting the learning objectives, especially for genetics in 12th-grade high school classes.

The enhanced genetics box learning media is characterized by its attractive, clear, and organized appearance. It's user-friendly and offers an alternative learning method. Moreover, it's convenient to incorporate into lessons and displays considerable durability due to its construction from sturdy materials like wood and boards.These characteristics are described in table 6.

Table 6. Characteristics of Media Genetics Box

Aspect	Media Characteristics
Display Media Genetics box	Model shape of chromosomes, RNA and DNA. Protein synthesis on Genetics box media is clear and neat. The right color combination on Genetics media box Chromosomes, DNA, RNA model presentation and protein synthesis are easy to understand. Media Genetics box is interesting from all sides. There is a description of each media presented. The size of the media in the Genetics box is simple
Media use Genetics box	Media Genetics box is easy to use. Genetics box media is harmless when used Genetics box media can be used as alternative learning
Ease of Genetics box	Media Genetics box does not require facilities or el ectronic devices in use Media Genetics box is easy to assemble and use

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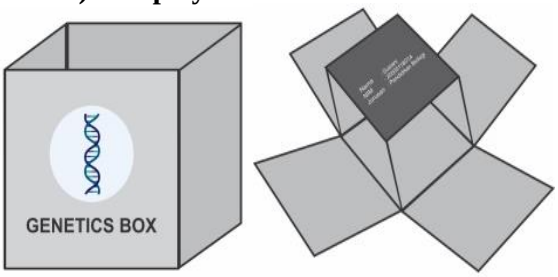
Aspect	Media Characteristics
Ease of Genetics box	The contents of the Media Genetics box contain learning materials
Resistance Genetics box	Media Genetics box has a fairly good tool durability

2. *Level of Validity of Genetics Box Learning Media*

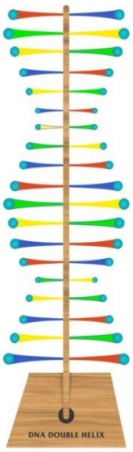
This stage aimed to determine the quality and validity of the genetic media box and several instruments that have been made by researchers before being tested in the field. The design of learning media that have prepared and made, create an item in the form of a product, where the initial product is called prototype 1. The genetics box media, which has previously received suggestions and instructions from the validator, was then used as a benchmark in improving the product in the form of learning media that will later be developed. The revised results on prototype 1 are called prototype 2. The following is a comparison of prototype I (before revision) and prototype II (after revision) presented below:

***Protorype* I (before revision)**

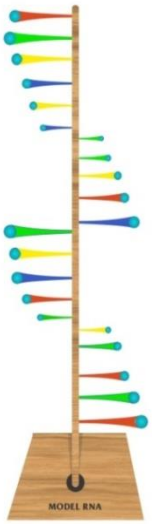
1) Display Box



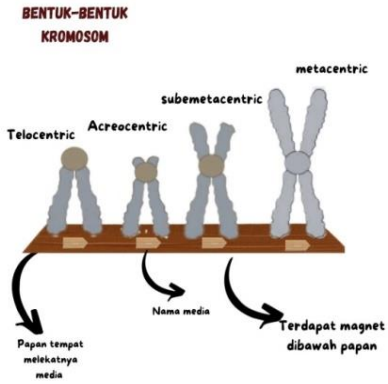
2) Model of DNA *Helix*



3) Model of RNA



4) Types of Chromosomes Based on the Location of the Centromere



5) Protein Synthesis Models

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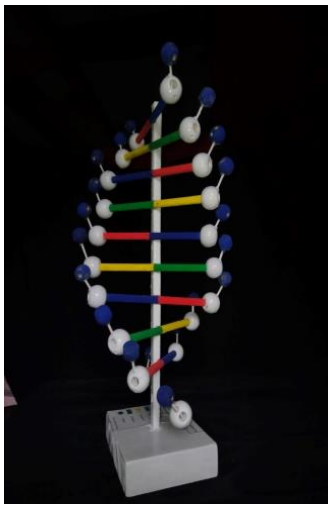
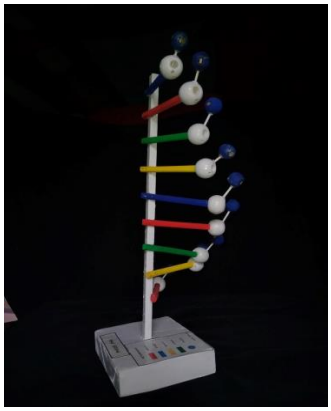
***Protorype* II (after revision)**

1) Display Box

2) Model of DNA *Helix*



3) Model of RNA



4) Types of Chromosomes Based on the Location of the Centromere

5) Model Sintesis Protein

The results of the validity level of the Genetics box learning media are included in the very valid category. The results of these data can be seen in Table 7.

Table 7. Results of the Validator's Assessment of Genetic Box Learning Media

Category	Rating result		Average	category
	Validator I	Validator II		
Media *Genetics box*	3	4	3,69	Very Valid
RPP	4	4	3,7	Very Valid
Student response questionnaire	3,66	3,66	3,83	Very Valid
Teacher response	3,6	4	3,76	Very Valid

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Category	Rating result		Average	category
	Validator I	Validator II		
questionnaire Question item	3	3,67	3,60	Very Valid
Media characteristics sheet	3,5	4	3,75	Very Valid
Final Average Total			**3,72**	Very Valid

Based on the results of the above analysis, the average total value at the validity level of the genetics box media is 3.72, which is included in the very valid category, so a conclusion of the research instruments and genetics box learning media is valid and sufficient to be applied to the learning process. The product in the form of prototype II, which has been declared valid, was then tested in a limited way on students of class XII MIPA 2 SMAN 22 Bone, which totaled 29 people. This activity aimed to determine the level of effectiveness and practicality of the products. The practical level of the media is seen from the questionnaire responses of students and educators after applying it, while the level of effectiveness is seen from the achievement of KKM scores after the media has been applied.

3. *Genetics Box Practicality Level of Learning Media*

The research instrument used to determine the practicality level of a developed media is by using a questionnaire instrument for the response of educators and students. The following presents the results of the responses of students and educators on aspects of the practicality level of the genetics box media:

Table 8. Overall Response Results

No.	Types of research	Average
1	Educator Response	3,49
2	Student Response	3,51
Total Average		**3,5**
Assessment criteria		**Positive**

The learning media genetics box is considered practical to apply in the learning process based on the data acquisition results from the response questionnaires of educators and students that were analyzed in the research trial phase. The overall average response value was 3.5, indicating that the respondents' results were practical.

4. *The Effectiveness Level of Genetics Box Learning Media*

Students took a learning achievement test consisting of 25 multiple-choice items to assess the effectiveness of the genetics box media. This was intended to evaluate the effectiveness of genetic box media. The subjects in this study were 29 students of class XII MIPA at SMAN 22 Bone. The following table lists the outcomes of the students' knowledge tests:

Table 9. Percentage of Completeness of Biology Learning Outcomes of Students

No	Score	category	Frequency	Percentation (%)
1	0 - 75	Not Complite	0	0%
2	76 - 100	Complite	29	100%
Amount				**100**

Students can be categorized as complete if they get a value from learning outcomes greater than the KKM value used by the school (Score ≥ KKM). The KKM value applied at the school where the researcher conducted the research is 76. The learning process is said to be effective and successful if at least 80% of students achieve complete marks.

4. DISCUSSION

The test results in this research aim to determine the fulfillment of the practicality, effectiveness, and validity categories of the genetic box media that was developed.

1. *Characteristics of learning media Genetics box*

a. Display aspect

The preparation of a learning medium must be able to influence students' interest in learning, namely by making valid and valid learning tools

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(H. P.S. Muttaqin et al., 2021). In this case, attention must be paid to aspects of media appearance by prioritizing designs that contain aesthetic values (Yanurizna, 2012). The media genetics box obtained characteristics from its appearance, where the shape of the chromosome model, DNA helix, RNA, and protein synthesis on the genetics box media was clear and tidy. Additionally, the presentation of the media on the model of chromosomes, DNA, RNA, and protein synthesis was easy to understand. Furthermore, the right color combination on the media, as well as a description of each media presented will pique students' interest in learning more about the material presented in the media. Thus, it is consistent with (H. P.S. Muttaqin et al., 2021) research, which states that interest will increase enthusiasm, interest, motivation, and enjoyment of learning.

b. Convenience Aspect

Genetic box media is a tool that can make it easier for educators to provide learning material to students. The ease of use of the media implies that the learning media is simple and does not need electronic devices.

c. Aspects of use

As a result of using the genetics box learning media, students will be better able to comprehend the lessons. Besides that, genetic box media is safe to use. The genetic box learning media can provide an overall learning experience for students. Students are required to understand the material in real terms during learning activities as well as focus on abstract concepts. Educators use genetic box learning media to make it easier for students to understand the whole material, which will later provide the same experience between educators and participants in learning (Nurnita, 2018).

d. Endurance Aspect

The media in the genetics box has quite good tool durability because it is made of hard materials such as wood and boards. When purchasing learning media, you should consider the quality of the media, and genetics box media are durable because they are made of wood and can be used repeatedly. According to Nurnita (2018), quality learning media is good learning media and can produce a good learning process too.

e. Content Aspect

The developed genetics box media can formulate learning objectives by referring to some detailed material coverage. This is to help achieve learning objectives. The media must referr to the learning objectives set to produce effective learning activities. Furthermore, students can easily understand the material presented by educators (Nurnita, 2018).

According to the description above, when developing a learning media, several rules or aspects of its characteristics must be considered. These principles include appearance, convenience, resilience, and the learning material. Mukminin in (Nurseto, 2012) expressed the idea that learning tools must pay attention to the visual aspect, which stands for the words visible, appealing, simple and beneficial, accurate, legitimate, and structured.

2. The validity of the Genetics box learning media

After the genetic box was developed, it was obtained after being validated, data was obtained with an average value of 3.69, the value was in the "very valid" criteria. $X > 3.4$.

Based on the results of the validation that has been carried out, the results of the validation of the genetics media box developed by the researcher have met the very valid criteria so that it can be tested with the consideration that there are slight revisions, this is in accordance with the theory put forward by Sugiono (2013) if the average value the validity is in the comparison value of $3.5 \leq M \leq 4$ it can be said that the media is very valid.

The genetics box media that has been developed is categorized as very valid in terms of aspects such as the suitability of the media with KD and learning objectives, the alignment of the media with the needs of students, the suitability of the material, and the consistency between media parts. In addition, when viewed as a whole, some of the things displayed in learning media are appropriate to be applied in learning activities both from design and language with an average validator assessment that is very relevant. This is in accordance with Nieveem's theory (1999) in Kadek Sembah's Thesis I that learning tools said to be valid if it meets the aspects of content validity and the construct validity. Content validity is the conformity of the product

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developed based on curriculum guidance, while the construct validity referred to here is the suitability of the theory regarding learning media and the theory of student characteristics in product preparation. Meanwhile, according to (Mustami, 2017b) media development research can be said to be valid if all aspects of the research tools and instruments are at least in the valid category. In line with this, it is also in accordance with the research that has been carried out by (Listiani & Prihatnani, 2018) where the acquisition of development research on learning tools is in very valid criteria due to several supporting things, namely material aspects, media and also the applied or currently implemented curriculum.

3. *Practicality of learning media Genetics box*

The practicality of a medium is measured using an instrument, namely a student response questionnaire. Based on the questionnaire, the student response questionnaire data value was 3.6, while the teacher response score was 3.49. Overall, the total value was 3.52 and was included in the practical criteria because it was in the value interval ($2.5 < Xi \leq 3.5$). Based on the acquisition of these data, it proves that the genetics box media is practical to apply to the learning process.

The developed learning media can be said to be practical when viewed from three aspects: (1) the attractiveness of the media, in this case the appearance of the media, which has a good appeal to students' motivation in self-development; (2) the content of the media, namely the material contained in the media is supported by visual aspects that make it easier for students to understand the material in it; and (3) the quality of the media. In this case, a media is good if it is easy to use and also easy to access because it has instructions for use that are considered clear and relevant (Milala et al., 2021). Regarding the practicality of learning media, (Mustami, 2017a) propose that students' interest in learning is influenced by the ease of using products. These products result from the development of learning activities, ensuring the attainment of learning objectives. As a result, students respond positively to activities utilizing the developed materials, enabling them to comprehend the content and actively participate in learning. A similar opinion expressed by (HAVIZ, 2016) in his research stated that the practicality of a medium measured by its ease of use, which can be a reference in increasing the achievement of learning objectives.

4. *The effectiveness of the Genetics box learning media*

The The effectiveness of the media is obtained from the test of student learning outcomes, which is given at the end of the lesson. The intended learning outcomes test is in the form of 25 multiple-choice test items. The developed medium is declared effective if the class completeness reaches 80%. The criteria for the completeness of students in the test is complete if the score is above the minimum competency completeness or KKM score, or the value is greater than the KKM standard applied at school. The KKM value applied in this school is 76, so based on the results in this study, the media is very effective to employ in class because the acquisition of the percentage of tests for students shows that all students consisting of 29 people are at an average value of 84. This indicates that the genetics box learning media is very effective because the value is above the KKM set by the school, especially in biology subjects.

Based on the results, the writer can conclude that the genetics box learning media has met the very effective criteria, as all students are in the pass category after being given a test at the end of learning using the genetics box media. This is because the development of genetics box learning media has an attractive appearance that builds students' curiosity. Besides that, the genetics box media helps improve learning outcomes. Student learning outcomes, especially on genetic material, are in line with the theory put forward by Van den Akker in (HAVIZ, 2016), saying that the success of a product developed depends on whether researchers can display results that are relevant to the learning direction shown through learning outcomes tests to participants.

5. CONCLUSION

Based on the results of the research and discussion, it can be concluded that the genetics box media exhibits an attractive appearance and employs aesthetically pleasing color combinations. It is user-friendly and does not require electronic equipment for operation. It demonstrates commendable durability due to its construction from robust materials like wood and

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boards. The media formulates clear learning objectives and aligns with material components that support the achievement of these objectives. The validity level of the genetics box media has met the valid category with the acquisition of data from all aspects, namely 3.69, so that this media is feasible to be applied in the learning process. Furthermore, the practicality level of the genetics box media meets the practical criteria with the acquisition value after being tested, namely 3.5, which indicates that this media is practical to use in learning. In addition, the level of effectiveness of the genetics box media after being developed is in the effective category with a percentage result of 100%.

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7. REFERENCE

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