S A W E R I G A D I N G

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DEVELOPMENT OF FORMATIVE ASSESSMENT BASED ON EDUCATIONAL GAMES INTEGRATED WITH QR CODE ON POPULAR SCIENTIFIC ARTICLE MATERIAL

Pengembangan Asesmen Formatif Berbasis Game Edukatif Terintegrasi QR Code pada Materi Artikel Ilmiah Populer

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Abstract

The Indonesian language subject presents various types of text-based materials. One of the less popular topics among students is popular scientific articles. This material is taught in Grade VIII of junior high schools across Indonesia. A key factor contributing to students' lack of interest in this topic is the continued use of conventional assessment methods by teachers, which makes the evaluation process less engaging. To address this issue, a more creative approach such as implementing educational game-based formative assessment can help increase students' interest and understanding of popular scientific articles. This study aims to describe the feasibility, practicality, and effectiveness of a QR code integrated educational game-based formative assessment on the topic of popular scientific articles. This research and development was conducted following the steps developed by Thiagarajan through the 4-D model, which includes four stages: Define, Design, Develop, and Disseminate. The results of the study show that the feasibility validation of the QR code-integrated educational game-based assessment reached 87%, indicating a very feasible level. In terms of practicality, it achieved a score of 92%, categorized as very practical, and for effectiveness, the score was 76.25%, falling into the effective category.

Key Words: *Development; Formatif Assesment; Educational Games; Qr Code; Popular Scientific Article Material.*

Abstrak

Mata pelajaran Bahasa Indonesia menyajikan berbagai jenis materi dalam berbasis teks. Salah satu materi yang kurang diminati oleh siswa yaitu materi artikel ilmiah populer. Materi ini diajarkan di kelas VIII jenjang SMP di seluruh Indonesia. Salah satu faktor utama yang menyebabkan rendahnya minat siswa terhadap materi ini adalah guru masih menggunakan metode penilaian konvensional, yang membuat proses evaluasi menjadi kurang menarik. Untuk mengatasi masalah ini, pendekatan yang lebih kreatif seperti penerapan asesmen formatif berbasis *game* edukatif dapat membantu meningkatkan minat dan pemahaman siswa terhadap materi artikel ilmiah populer. Penelitian ini bertujuan untuk mendeskripsikan kelayakan, kepraktisan, dan keefektifan asesmen formatif berbasis *game* edukatif yang terintegrasi *qr code* pada materi artikel ilmiah populer. Penelitian dan pengembangan ini dilakukan dengan mengikuti tahapan model 4-D yang dikembangkan oleh Thiagarajan, yang meliputi empat tahap: *Define* (pendefinisian), *Design* (perancangan), *Develop* (pengembangan), dan *Disseminate* (penyebarluasan). Hasil penelitian menunjukkan bahwa validasi kelayakan asesmen berbasis *game* edukatif yang terintegrasi *qr code* mencapai 87%, yang menunjukkan kategori sangat layak. Dari segi

kepraktisan, diperoleh persentase sebesar 92% yang termasuk dalam kategori sangat praktis, dan dari segi keefektifan, persentase yang dicapai adalah 76,25%, yang tergolong dalam kategori efektif.
Kata Kunci: Pengembangan; Asesmen Formatif; Permainan Edukatif; Kode QR; Artikel Ilmiah Populer.

INTRODUCTION

The current state of education in Indonesia is like a double-edged sword. On the one hand, there has been significant progress, such as increasing education participation rates and expanding access to education. On the other hand, there are still many challenges that need to be addressed in order to create a quality and equitable education system. The government has made efforts to address this, one of which is by implementing the independent curriculum. The independent curriculum is a curriculum that provides educators with the freedom to create quality learning according to the needs and learning environment of students, including the development of assessments.

The Indonesian language subject is a compulsory subject studied from elementary school to college. The goal is for students to have good and correct Indonesian language skills. The Indonesian language materials taught at junior high school level are: descriptive texts, fantasy story texts, procedural texts, news texts, fiction and non-fiction books, personal and official letters, observation report texts, advertisements, slogans and posters, speech texts, explanatory texts, report texts, literary works, and popular scientific articles. Of the various materials studied by students at SMP Negeri 3 Palopo. The dominant material that is less popular with students is the popular scientific article material studied in class VIII.

According to Romli in (Ks, Sukardi, 2016) popular scientific articles are articles containing the results of scientific studies, views, and arguments presented in popular language so that they are easily understood by the general public. Popular scientific writing is writing that adheres to scientific standards, but is presented in general language so that it is easily understood by the general public. This is in line with the opinion of (Yunita, 2024) who said that popular scientific articles are writings that convey research results in a simple, concise, and easy-to-understand language style.

The popular scientific article material in the independent curriculum studied by students in grade VIII of junior high school is a written work that contains scientific knowledge and is written in light and easy-to-understand Indonesian. The material is studied by students in grade VIII of SMP Negeri 3 Palopo, the material is stated in chapter III of the Indonesian Language book published by the Ministry of Education, Culture, Research and Technology. The popular scientific article material studied in grade VIII of junior high school is different from the scientific article material that is to be published in national or international journals, such as in the Sinta, Scopus or Google Scholar journals. The popular scientific article material studied in grade VIII of SMP Negeri 3 Palopo is very simple with the following characteristics: the opening paragraph describes the author's opinion on the topic raised in the article, then the author presents evidence that supports the author's opinion in the previous paragraph, then the author explains the reasons that support the paragraph in easy-to-understand language. After the article written by the students is finished, the article can be pasted on the school bulletin board or posted to social media, mass media or websites.

There are various materials studied by students in the Indonesian language subject, but of the various materials studied by students at SMP Negeri 3 Palopo, the least popular material is popular scientific articles. This can be seen from the results of student achievement in the 2023/2024

academic year in class VIII-A of SMP Negeri 3 Palopo. The number of students in class VIII-A of SMP Negeri 3 Palopo is 30 people. Of the 30 students, those who achieved the KKTP (Learning Objective Completion Criteria) in the popular scientific article material were 11 students (36.66%), while those who had not achieved the KKTP were 19 students (63.33%).

There are several factors that cause students not to achieve the KKTP (Learning Objective Completion Criteria), including: students are less interested in popular scientific article material because the language is too formal, students' lack of interest in scientific topics, lack of basic understanding of science in terms of theory regarding popular scientific article material, and the assessment methods used by teachers still use conventional methods so that the evaluation of assessments is less interesting. To overcome this, a more creative approach such as the use of formative assessments based on educational games or interactive learning methods can help increase students' interest and understanding of popular scientific article material.

According to (Kristina, 2024), the assessment process needs to pay attention to advances in science and technology, so that the availability of various current technological media can be utilized. Digital-based assessments can reduce the level of cheating compared to non-digital assessments (Hairida, 2025). In the field of education, technology is a tool used to facilitate learning and help achieve the desired results (Ariza, 2024). Therefore, researchers have the initiative to increase student interest when carrying out learning assessments, namely by developing innovative assessments, such as educational game-based assessments integrated with QR codes which are expected to maximize the achievement of learning objectives in class VIII students of SMP Negeri 3 Palopo.

According to (Ningtiyas, 2023) educational games are one of the technology-based learning media that aim to help the learning process, so that students are expected to understand the material presented more easily. In line with that (Windawati & Koeswanti, 2021) said that educational games aim to foster students' interest in learning material in which there is a game so that with a happy feeling it is hoped that students can more easily understand the subject matter that has been delivered by the teacher in learning activities. In addition, educational games also have benefits for improving critical thinking skills and increasing students' learning motivation because they are presented in an interactive and fun way (Oktary, 2024).

SMP Negeri 3 Palopo is one of the public schools in Palopo City. This school is the place of research that the researcher has determined, because in this school there are indications of problems/phenomena that occur and the researcher should be able to find solutions to the indications of these problems. SMP Negeri 3 Palopo has 32 classes, including: class VII with 11 classes, class VIII with 10 classes and class IX with 11 classes. The focus of the class that the researcher will make the object of research and will be used as a trial class in this study is class VIII-A.

The development of technology-based assessments for popular scientific article materials has never been carried out at SMP Negeri 3 Palopo. The assessments used still tend to be conventional, such as written tests and direct assessments by teachers, which are less able to optimally explore students' potential. Therefore, this study aims to develop an assessment on popular scientific article materials that is appropriate to the learning context at SMP Negeri 3 Palopo. The development of this assessment is expected to improve students' writing skills, as well as help them better understand and master popular scientific article materials in a more effective and interesting way. According to Wiratmojo P

and Sasomohardjo in (Tsurayya, 2023), the use of learning media in the teaching and learning process such as educational games can arouse new desires and interests, arouse motivation and stimulate students' learning activities.

One of the easy-to-use websites for developing games is Scrath. Scratch is a visual programming language used to create creative projects such as animations, games, and interactive stories. The application of educational games as a game-based assessment instrument is expected to create a fun learning atmosphere and make students learn Indonesian easily so that mastery of the material becomes more optimal.

(Dewi, 2018) stated that game-based learning has good potential to be used as an effective learning media because it can stimulate the visual and verbal components of students. This is in line with the results of interviews conducted with Indonesian language learning practitioners at SMP Negeri 3 Palopo, it is known that media that can attract students' attention are digital or multimedia media. Students tend to focus their attention when using media related to visuals such as photos and videos and things they have just encountered.

According to (Afidah & Subekti, 2024) digital technology such as digital educational games in teaching and learning activities can increase students' enthusiasm in pursuing learning activities so that it has an impact on improving student learning outcomes. However, this study is different from previous studies because it integrates three different elements, namely educational games and QR codes in one integrated assessment system. Previous studies have explored the use of educational games and QR codes separately, but there has been no study that combines the three in an assessment context. This study fills this gap by developing an educational game-based assessment integrated with QR codes, which is expected to have a significant positive impact on the quality of learning and student assessment in class.

Based on the description that has been explained, the researcher is interested in conducting a study entitled "Development of Formative Assessment Based on Educational Games Integrated with QR Codes on Popular Scientific Article Materials at Junior High School Level".

THEORETICAL FRAMEWORK

4-D Model Development

This study uses the theory of research and development by Thiagarajan using the 4-D model. The 4-D model is an abbreviation of Define, Design, Development and Dissemination developed by S. Thiagarajan, Dorothy S. Semmel, and Melvyn I. Semmel in 1974. The 4-D development model is one of the learning device development models that is suitable for the Indonesian education system and tends to be chosen and used in educational research.

This selection is also based on the consideration that the 4-D model research design is systematic and based on the theoretical basis of educational product design in the form of learning devices, learning models, media, and learning applications so that the resulting product has a standard of eligibility. Research and development of the 4-D model has a clear procedure that will make it easier for researchers to produce a new product in the realm of education or develop old educational products to be better, more practical, more complete, and more effective. The 4-D research and development model also requires researchers to test the effectiveness of the products they produce before disseminating them (Mesra, 2023).

Understanding Assessment

The word assessment comes from the English loanword, namely assessment, which means evaluation. Assessment is an important process in education that aims to collect information to make appropriate decisions regarding students, curriculum, programs, and educational policies

(Munaroh, 2024). Assessment has a strong influence on what and how subject matter is delivered (Inovatif, 2024). In the Independent Curriculum, assessmentisa series of activities that include data collection, data analysis, and data interpretation that aim to determine the level of student understanding and performance during the learning process (AP, 2025). The independent curriculum is an evolution of the previous curriculum which was designed to optimize learning outcomes according to student needs (Ardiansyah et al., 2023).

Formative assessment is an assessment conducted to provide information or feedback to teachers and students in order to improve the learning process. This assessment is conducted at the beginning of learning, in the middle of learning, at the end of learning, or throughout the learning process (Anggreaena, 2022). Formative assessments conducted at the beginning of learning aim to provide information to teachers regarding students' readiness to learn the subject matter, as well as their readiness to achieve the planned learning objectives. This means that this assessment is not used for the purpose of assessing student learning outcomes reported in report cards (Wilman Juniardi, 2023).

Assessment Objectives in the Independent Curriculum

According to (Kumparan, 2024) assessment aims to determine the level of understanding and open the learning process. In addition to aiming to determine the level of understanding and performance of students during the learning process, assessments in the Independent Curriculum can also be used as a tool to evaluate a learning process. Later, the results of this evaluation can be a reference for teachers in helping to improve student learning outcomes.

According to (Wilman Juniardi, 2023) the objectives of the independent curriculum assessment are as follows: (1) Provide information to teachers regarding student learning styles. (2) Provide more detailed information regarding student progress in learning. (3) Showing the progress of students' individual learning outcomes from the learning process they have participated in. (4) Provide information regarding the effectiveness of the learning carried out. (5) Provide space for teachers to provide feedback to students. (6) Motivate students to improve or maintain their learning outcomes. (7) Makes it easier for teachers to know students' potential and interests.

Benefits of Formative Assessment

According to (Muktamar et al., 2024) the benefits of formative assessment for teachers include: (1) Providing information about students' learning needs; (2) Knowing the level of mastery of the material and students' weaknesses as well as the units of material that have not been mastered; (3) Knowing the level of student understanding and making it easier for teachers to predict the level of student success during summative assessment; (4) Being able to estimate the success or failure of a learning program when given to students; (5) Making it easier for teachers to plan and determine learning topics; (6) Being evaluation material to create a better learning process.

Meanwhile, for students, formative assessment also provides the following benefits: (1) Providing information about the level of student understanding of a subject matter; (2) Making it easier for students to know the challenges or things that make it difficult for them to understand the subject matter; (3) Making it easier for students to determine the steps that need to be taken to achieve good learning outcomes; (4) Making students appreciate the learning process more and not just focus on the final results (Muktamar et al., 2024).

Popular Scientific Articles

Popular scientific articles are usually published through mass media consumed

by the general public. There are various opinions expressed by experts about the definition of popular scientific articles or popular scientific writing. Popular scientific articles are articles containing the results of scientific studies, views, and arguments presented in popular language so that they are easily understood by the general public.

Romli in (Ks, Sukardi, 2016) says that popular scientific writing is a written work that adheres to scientific standards, but is presented in common language so that it is easy for the general public to understand. With this understanding, it is true to say that popular scientific articles are a means of communication between science and the general public. Saipurrahman in (Ks, Sukardi, 2016)

According to Wardani in (Ks, Sukardi, 2016) Popular scientific works are scientific works presented in a popular or relaxed language style so that they are easily understood by the public and interesting to read. From the various opinions above, it can be concluded that popular scientific articles are writings that present facts carefully, honestly, neutrally, and systematically presented in popular language so that they are easily understood by the public and interesting to read.

Characteristics of Popular Scientific Articles

According to (CNN Indonesia, 2025), there are four characteristics of popular scientific articles: (1) Presence of the Author's Opinion. The first characteristic of a popular scientific article is the presence of the author's opinion. The author's opinion reflects their perspective or evaluation of a particular issue. (2) Supporting Evidence. The next characteristic is the inclusion of evidence within the statements that support the author's opinion. (3) Reasoning. Another characteristic is the presence of reasoning, which includes explanations of the statements and the supporting evidence. Popular scientific articles are sometimes also accompanied by scientific information. (4) Easily Understood Language. Popular scientific articles use the Indonesian language in a way that is widely liked and easy to understand, hence considered a "popular" language style.

Popular Scientific Article Structure

The structure of popular scientific articles tends to be quite short, concise, and clear. Therefore, popular scientific articles consist of only four parts, namely title, introduction, content, and conclusion. The following is the structure of popular scientific articles (T. H. Putri et al., 2024): (a) Title. The titles of popular scientific articles are generally simpler and attract readers' interest, but the title of the article must still reflect the contents of the text. (b) Introduction. Introduction is the part that explains the introduction or opening of a popular scientific article. This section can also be filled with the background or reasons why the author discusses this topic or problem. (c) Contents. In this section, the author's views, evidence, and reasons regarding the topic discussed are stated in detail. Usually the author will add some arguments from experts and data that support a writing. (d) Closing. The conclusion contains the author's conclusions about a topic that has been analyzed.

Steps for Writing Popular Scientific Articles

Here are the steps for writing popular scientific articles (T. H. Putri et al., 2024): (a) Determine the topic of the article. (b) Determine the purpose of writing the article. (c) Determine how to obtain the required information. (d) There are several ways to get information. Here are three ways that can be done to get information: (1) Interview, which is a question and answer activity with someone who can provide information (source); (2) Questionnaire, which is giving a list of questions to a number of people to obtain the information needed; (3) Literature study, which is by reading other people's

writings that are related to or contain the information we need. Write your opinion based on the information found; (4) Writing an article based on all the information that has been found.

Games

According to (Hanafri et al., 2015), *Games*is a word that comes fromLanguageEnglish meaning game or match, or can be interpreted as a structured activity that is usually done for fun.

According to the meaning of Indonesian, game means game, while education is education. Educational games are one of the game genres used to provide teaching/increase user knowledge through a unique and interesting media. There are several criteria for an ideal educational game, namely Nurrun Muchammad in (Esa, 2016): (1) Curiosity, fantasy and user control. (a) Intrinsic motivation, fun to use. Users have control over the game. (b) Integration between educational materials and fantasy aspects of the game. (c) Encourage curiosity, users can explore freely, the game contains hidden secrets. (d) Success is determined by knowledge, not chance. (e) Realistic simulation of the world. (f) Educational materials are adapted to real-world materials. (2) Challenges. (a) Challenges are given continuously but are adjusted to the player's level of understanding. (b) Provide hints and instructions to help users. (3) Children and Special Needs Users. (a) Images, objects, screens are neatly arranged. (b) The game itself is an important activity (play for the sake of play). (c) Inspire children, even after the computer is turned off.

Scratch

Scratch is a visual programming language used to create creative projects such as animations, games, and interactive stories. Scratch is very easy to use because unlike other programming applications that use text to create a program, Scratch uses a system called coding block. Coding block is a system that makes coding into blocks (Irna, 2023).

Scratch is one of the programming languages developed by MIT (Massachussetts Institute of Technology). Scratch is a graphical programming language that allows the creation of such things (computer games, animated stories, or science simulations) to be easily achieved. According to (Darmawan, 2024) Scratch is a visual language, namely the creation of projects using an intermediary in the form of images. The program arrangement pattern with images is a differentiator between Scratch and other text-based programming languages such as PHP, C, and Pearl which seem more complicated (Darmawan, 2024).

According to (Darmawan, 2024) states that Scratch has the following advantages: (a) Scratch has a different programming language. Small size compared to other languages. (b) The interface is very simple and easy to use for children. (c) It is easier for children to learn programming logic without having to complicate it with writing. (d) Syntax in programming languages in general. (e) Scratch helps kids create interactive stories, animations and games. (f) Scratch allows anyone to easily combine images, sound and video. (g) Without having to have special skills in programming. (h) Animations can be created, executed and controlled. (i) Scratch can be run on Windows, Linux and Macintosh operating systems. Scratch is very useful for children in the development of logical thinking.

Qr Code

Qr code is an abbreviation of quick response code which means quick response code. This code contains a two-dimensional barcode that can provide various types of information directly. QR code is a communication technology that can encode all types of information that has been managed by certain software (Putra, 2022). To open it can be done by scanning or scanning using a smartphone. Many of the

latest smartphones embed scanner technology in the cellphone camera. So, using a qr code can be operated very easily. One of the conveniences felt is when shopping online. However, in this study, so that students can easily access the website page, the qr code feature is used, which contains the assessment that has been made Trujillo in (Anas, 2020).

Qr codes have many functions, namely: (1) storing information quickly and easily. (2) Increasing efficiency and speed in communicating. (3) Helping to manage data better. (4) Simplifying the account verification process (Sierra, 2022). The information contained in a QR code varies depending on the user's wishes, for example, on sites on the internet, QR codes usually contain download links or links to certain sites. Smartphones that have a QR code scanning feature can directly download or visit the link easily. Users only need to direct the scanner on the smartphone towards the existing QR code. The development of smartphone technology has made the use of QR codes increasingly widespread and is used in encrypting passport codes, visas, ID cards, and connecting to an application Trujillo in (Anas, 2020).

METHOD

This research is a type of research and development, known as the R & D (Research and Development) model. According to Gay in (Mesra, 2023), development research is research that has the aim of developing new products or updated old products that are effective for use in schools.

The R & D research model design that will be used is the 4-D development model by Thiagarajan. The researcher chose to use the 4-D model because this development model is highly suitable for the type of product being developed in the study. In addition, the 4-D research design is systematic and grounded in a theoretical foundation for designing educational products, whether in the form of learning tools, instructional models, media, or educational applications. Therefore, the resulting product meets feasibility standards. The 4-D research and development model has a clear procedure, which facilitates the researcher in producing a new product in the field of education or improving an existing educational product to make it more practical, comprehensive, and effective. Furthermore, the 4-D research and development model also requires the researcher to test the effectiveness of the developed product before dissemination.

According to Thiagarajan in (D. A. E. (Universitas M. M. Y. Putri & Elviana, 2023), 4-D development model consists of four stages of development. The first stage is define or often referred to as the needs analysis stage, the second stage is design, namely preparing the conceptual framework of the model and learning tools, then the third stage is Development, namely the development stage involving validation tests or assessing the feasibility of the media, and the last is the Disseminate stage, namely implementation on the actual target, namely the research subject.

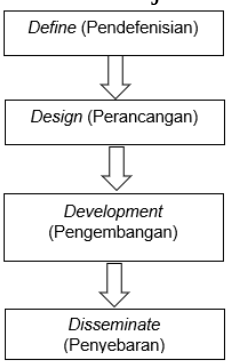

Figure 1 4D Development Steps

The research data that researchers use in this study are very diverse, namely: assessment feasibility data, practicality data, and effectiveness data. Feasibility data was obtained from questionnaires that had been filled out by expert media validators and assessment experts.Practicality data was obtained from questionnaires filled out by teachers and students after the trial activity. Effectiveness data was obtained

from the results of students' pretests and posttests. Student pretest data is data obtained by researchers when conducting initial observations by analyzing students' KKTP achievement results on popular scientific article material. Post-test data is data on student achievement results after using educational game-based assessment products integrated with qr codes on popular scientific article material.

The sources of this research data are validation experts (assessment experts and media experts), practitioners/teachers and students of class VIII-A SMP Negeri 3 Palopo.

Trial subjects in this study are divided into two, namely, small group trial subjects and large group trial subjects. Small group trial subjects consist of 5 students and 1 practitioner/teacher of class VIII-A of SMP Negeri 3 Palopo. After the trial was conducted on a small group, students provided responses and assessments of the product being developed. Student responses became input and revisions to the product being developed. Furthermore, the researcher will conduct a large group trial on 10 randomly selected students and 1 practitioner.

Based on the trial, if the student's response states that the integrated educational game-based assessment using QR codes is interesting, practical and good to use, then the product being developed has been completed and produces a final product.

The data collection techniques used in this study were observation, documentation, questionnaires and tests.The data collection instruments used in this study were validation sheets (assessment experts and media experts), practicality sheets, and student assessment result sheets. The data obtained were then used to determine the validity, practicality, and effectiveness of the formative assessment based on integrated qr code educational games developed.

Data Collection Procedures: (1) Observation. Observation was carried out by observing the learning process as it took place. Based on the observation results, students tended to show a lack of interest in learning when the topic of popular scientific articles was taught. This was caused by several factors, one of which was the continued use of conventional assessment methods. (2) Documentation. Documentation was carried out during the initial observation by analyzing the ATP (Teaching Learning Plan), Teaching Modules, KKTP (Minimum Mastery Criteria), and teaching materials. (3) Questionnaire. Questionnaires were used to obtain data on the validity and practicality of the product. The types of questionnaires used included: (a) Validation Sheet: given to assessment experts and media experts to evaluate the content validity, design, and feasibility of the product. The evaluation was conducted using a Likert scale (scale of 1–5), and the results were used to determine the level of product validity. (b). Practicality Sheet:g iven to teachers and students after a limited trial. Teachers assessed the ease of use, clarity of content, and suitability with the learning process. Students evaluated the attractiveness, ease of using the product, and their understanding of the assessment content. This data was used to determine the product's level of practicality. (4) Test A test was given to students to measure the effectiveness of the product after the implementation of the QR code-integrated educational game-based formative assessment. The students' test results before and after using the product were analyzed to determine the improvement in their understanding of the popular scientific article material. This test was used to measure the product's level of effectiveness.

The research data were analyzed using descriptive statistical analysis. The validation aspects assessed by experts or practitioners were made in the form of an assessment scale. The type of scale used was a Likert scale with a score of 1-5. This scale provides flexibility to the validator in

assessing the learning media that has been developed. The categorization of the assessment given by the validator is shown in the following table:

Table 1. Assessment Categories by Validator

Assessment Score	Category
5	**Very good**
4	**Good**
3	**Pretty good**
2	**Not good**
1	**Not good**

Source: Adapted from Endang Mulyatiningsih in (Winda Fajar Qomariah, 2023)

Data obtained from each validator through the formative assessment product validation instrument based on integrated educational games with QR codes from the assessment items in the validation instrument, then the average score of each component is calculated. Akbar in (Winda Fajar Qomariah, 2023)

The average score for each component is calculated using the formula:

$$\bar{x} = \frac{\sum X}{N}$$

Information:

$\bar{x}$ = Average score

$\sum X$ = Total scores awarded

N = Number of questions

Then the data obtained is analyzed using the formula:

$$Vp = \frac{Tsa}{Tsh} \times 100\%$$

Information :

Vp : Respondent score

Tsa : Total empirical score from experts

Tsh : Total maximum expected score

The criteria based on the results of the analysis and validation can be seen in the following table:

Table 2 Validity Assessment Criteria

Interval	Validity Level
86% – 100%	**Very Worth It**
76%-85%	**Worthy**
66%-75%	**Quite Decent**
55%-65%	**Less Worthy**
<54%	**Not feasible**

Source: Adapted and modified from Akbar in (Winda Fajar Qomariah, 2023)

DISCUSSION

The development of the formative assessment product based on educational games integrated with QR codes on the topic of popular scientific articles was carried out using the 4-D model, which consists of four stages: define, design, development, and disseminate.

Stage I: Define

The define stage in the 4D development model is the initial stage or planning stage in the learning media development process. In the define step, front-end analysis and concept analysis are carried out. The purpose of this stage is to determine and define the requirements for developing formative assessments based on integrated educational games using qr codes on popular scientific article materials for class VIII students of SMP Negeri 3 Palopo.

Educational games were developed based on the results of a needs analysis conducted at an educational unit at SMP Negeri 3 Palopo in Salekkoe Village, Wara Timur District, Palopo City. The findings of the field study that were successfully collected were in the form of data obtained through learning observations and analysis of learning outcomes.

1. Front End Analysis

Observations of learning in class VIII-A of SMP Negeri 3 Palopo, showed that the assessment was still paper-based and carried out conventionally, making it less interesting for students. Of the 30 students, only 11 (36.66%) achieved the KKTP, while 19 (63.33%) had not achieved the KKTP. Students showed low interest in popular scientific article material and preferred technology-based assessments. This finding indicates the need to develop more interesting and up-to-date

assessments to improve students' understanding and motivation to learn.

2. Concept Analysis

Concept analysis was conducted by reviewing ATP, teaching modules, KKTP, and popular scientific article materials to compile relevant assessments. This activity involved FGD with teachers and lecturers to obtain input. The results of the analysis showed that only 11 out of 30 students (36.66%) of class VIII-A had achieved KKTP, while 19 students (63.33%) had not. Therefore, a formative assessment based on educational games integrated with QR codes was developed that was more interesting and suited to students' needs.

Stage II: Design

After conducting a needs analysis at the definition stage, the next step is to design at the design stage. This design stage aims to design a formative assessment based on educational games integrated with qr codes on popular scientific article materials at SMP Negeri 3 Palopo. This planning stage includes:

1. Media Selection

The media selection is done to adjust to the characteristics of the material and the needs of the students. The media chosen is an educational game created through coding on the Scratch website. This game is adjusted to the learning objectives, covering questions in categories C1–C3 and HOTS questions. The game link is then connected to a QR code as quick access, so that students can take part in technology-based assessments effectively and enjoyably.

2. Format Selection

The selection of the format is done with the aim of designing materials, setting learning objectives, and designing assessments. Cognitive assessment uses educational games based on visual coding via Scratch. The material is arranged in PPT format integrated with QR codes, containing objectives, materials, pretests (conventional), and post-tests (educational games). Assessment access is done via QR codes. The use of this format facilitates access and increases the effectiveness of learning and assessment of class VIII students of SMP Negeri 3 Palopo.

3. Initial Design

The initial design is the initial design of a formative assessment based on an integrated educational game QR code before being tested by validators and practitioners. Compiled based on the results of the analysis of the curriculum, materials, and interests and needs of students.

Design activities are carried out with the following steps: (1) Compiling a question grid for popular scientific article material. (2) Designing 10 cognitive questions (C1–C3) to be included in the educational game. (3) Arrange HOTS questions in quiz form. (4) Designing the flow mechanism for making educational games.

Stage III: Development

Product development is based on preliminary studies and designs that have been carried out. Product development will include popular scientific article materials and formative assessments based on integrated qr code educational games. The development of educational game product designs refers to the learning objectives flow in ATP which is adjusted to the independent curriculum teaching materials published by the Ministry of Education, Culture, Research and Technology.

The product is developed according to the materials and designs that have been made. After that, the product is then designed with the Microsoft Powerpoint application and also programs that support the creation of other multimedia. In general, the development of educational game-based assessments will be described as follows: (1) Assessment in the cognitive domain using educational games created with visual-based coding on the scratch application. (2) The assessment is developed based on technology by utilizing

the available multimedia creation program. The assessment is created with a QR code that can help students access the assessment page easily and effectively. (3) Assessment in the cognitive domain based on educational games is developed in the following manner: (a) Prepare questions in categories C1, C2, and C3 as well as HOTS questions on popular scientific article material that have been adjusted to the grid. (b) Visit the website https://scratch.mit.edu. (c) Login using the belajar.id account from Kemdikbudristek. (d) Create educational games by compiling visual-based coding. Educational games contain questions on popular scientific article material in categories C1, C2, and C3. Meanwhile, quizzes on popular scientific article material contain HOTS questions that begin with question stimuli, questions, and question options. Educational games can be used on laptops/computers. Meanwhile, quizzes on popular scientific article material can be used on mobile phones, laptops, and computers. (e) After the assessment of the scientific article material in the cognitive domain is complete, then click share. After clicking share, a game link will appear. Next, the link is copied, then visit the website https://www.qr-code-generator.com/ to enter the link that has been copied to be converted into a QR code. (4) Developed Product View.

Figure 1 Educational Game Initial View
(Rahayu, 2025)

In Figure 1, the image shows the initial display of the developed educational game-based assessment product. The initial screen features the title "Formative Assessment Based on Educational Games." In the center of the screen, there is a "Start" button; when clicked, the assessment will begin presenting questions along with answer options. On the right side of the screen, there is an "Instructions" section, which contains usage guidelines for the educational game-based assessment. At the bottom right of the screen, there is a "Notes and Credits" section, which provides additional information about the creator of the educational game-based formative assessment.

Figure 2 Display of Questions in Educational Games

Figure 2 is an image containing the presentation of questions in the educational game. The questions presented in this educational game are in accordance with the material being taught, namely popular scientific article material for grade VIII of junior high school. The questions will appear at the top of the screen with 4 options a, b, c, and d.

Figure 3 Display Options on Educational Games
(Rahayu, 2025)

Figure 3, contains a dog animation that acts as a game user who runs and is ready to jump. When the game user presses the space bar on the laptop or computer keyboard, the dog animation will jump. Above the dog animation there are 4

options A, B, C, and D, which are colorful in the form of circles that move from the right side of the screen to the left side of the screen. The game user must carefully read the questions in Figure 2, and remember the answers to the options. After that, the game user must press the space bar, so that the dog animation jumps right above the option circle. If the dog's head touches the option circle with the correct answer, the score will increase by 10 points. However, if it is wrong, the value will not decrease. After that, the next question will appear followed by the colorful circle option. And so on until all the questions have been answered, then the formative assessment based on the integrated qr code educational game has been completed.

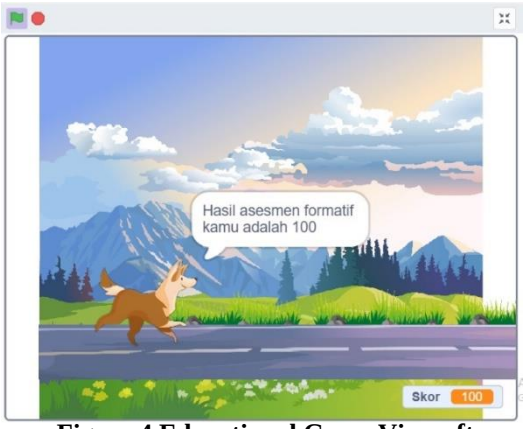

Figure 4 Educational Game View after Assessment is Completed
(Rahayu, 2025)

When the educational game based formative assessment is complete, a text will appear informing the student of their score.

1. Product Validation by Experts

A. Product Validation by Assessment Expert

Product validation by assessment experts aims to determine the feasibility of educational game based assessments integrated with qr codes. The feasibility of the assessment is assessed from an assessment instrument consisting of several aspects, namely the aspect of content feasibility, presentation aspect, practicality aspect, and readability and clarity of language aspects.

Data obtained from each validator through the formative assessment product validation instrument based on integrated educational games using QR codes from the assessment items in the validation instrument, then the average score for each component is calculated.

In this study, the value of the product feasibility developed was determined to have a minimum interval of "76-85%" with the category "Feasible". Validation activities were carried out by showing educational game-based assessment products and assessment sheets/validation sheets to assessment experts (validators). The following are the results of the assessment from the assessment expert in the assessment feasibility test:

Table 3 Expert Assessment Test Results

Validators	Question Number/Questionnaire Result Score															Amount (S)	Maximum Score (N)	Percentage (%)	% average
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15				
Assessment Expert	5	5	5	5	5	4	4	4	4	4	4	4	5	4	4	66	75	88%	87 %
Amount (S)	5	5	5	5	5	4	4	4	4	4	4	4	5	4	4				
Maximum Score (N)	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5				
Percentage (%)	100%	100%	100%	100%	100%	80%	80%	80%	80%	80%	80%	80%	100%	80%	80%				
% average	88%																		

Based on the data obtained, from 15 statements, 6 statements got a percentage of 100% with a very good category, 9 statements got a percentage of 80% with a good category. So, overallThe percentage for expert assessment validation is 88% with a very reasonable level of validity.

B. Product Validation by Media Experts

Validation by media experts aims to determine the feasibility of learning media in terms of appearance and program. This validation is carried out using a media expert validation questionnaire.

The purpose of media expert validation is to evaluate the level of validity of the media that has been developed, to find out the feasibility of learning assessment media seen from the appearance and program aspects, and to obtain information regarding the quality of the media being developed from the perspective of media experts.

In this study, the value of the developed media feasibility was

determined to have a minimum interval of "76-85%" with the category "Feasible". Thus, if the results of the media expert assessment give a final value with an interval of "76-85%" with the category "Feasible", then the development product is feasible to be used as a learning assessment.

Validation activities are carried out by showing educational game-based formative assessment products along with assessment sheets/validation sheets to media experts (validators).

Table 4 Media Expert Eligibility Test Assessment Results

Validators	Question Number/Questionnaire Result Score																Amount (S)	Maximum Score (N)	Percentage (%)	% Average
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16				
Media Expert	5	5	4	5	5	5	4	4	4	4	5	5	5	4	5	4	73	80	91 %	91%
Amount (S)	5	5	4	5	5	5	4	4	4	4	5	5	5	4	5	4				
Max Score (N)	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5				
Percentage (%)	100 %	100 %	80 %	100 %	100 %	100 %	80 %	80 %	80 %	80 %	100 %	100 %	100 %	80 %	100 %	80 %				
% average	91%																			

Based on the data obtained, from 16 statements, 9 statements got a percentage of 100% with a very good category, 7 statements got a percentage of 80% with a good category. So, overallThe percentage for media expert validation in stage II of the knowledge domain was 91% with a very reasonable level of validity.

2. Product Trial

A. Small Group Product Trial

The purpose of small group trials is to find out whether the product or design is feasible and practical to use, to find out to what extent the product or design can achieve targets and objectives, to find out whether errors are still found in the product or design, and to get suggestions for improvement based on the obstacles found by students.

Small group product trials were conducted by 5 students of class VIII-A of SMP Negeri 3 Palopo, and 1 teacher/practitioner. After the trial of the educational game-based formative assessment product was completed. Practicality questionnaires were distributed to students and teachers to determine students' responses to the educational game.

The results of the calculation of the practicality questionnaire in the small group trial can be seen in the following table:

Table 5 Results of Practicality Assessment in Small Group Trial Activities

No.	Trial Participants	Question Number/Questionnaire Result Score													Amount (S)	MaxScore (N)	Percentage (%)	% average
		1	2	3	4	5	6	7	8	9	10	11	12	13				
1	A-1	5	5	5	5	5	5	5	5	5	5	5	5	5	65	65	100%	91 %
2	A-2	4	5	4	5	5	5	5	3	3	4	5	5	5	58	65	89%	
3	A-3	4	4	5	4	5	5	4	5	4	4	5	5	5	59	65	91%	
4	A-4	4	4	5	4	5	5	4	5	4	4	5	5	5	59	65	91%	
5	A-5	4	5	4	5	5	5	5	3	3	4	5	5	5	58	65	89%	
6	A-6	5	4	4	5	5	4	3	4	5	4	5	4	3	55	65	85%	
Amount (S)		26	27	27	28	30	29	26	25	24	25	30	29	28				
Maximum Score (N)		30	30	30	30	30	30	30	30	30	30	30	30	30				
Percentage (%)		87 %	90 %	90 %	93 %	100%	97 %	87 %	83 %	80 %	83 %	100%	97 %	93 %				
% average		91%																

Based on the data obtained, from 13 statements, 10 statements get an interval of 86% -100% with a practicality level of very practical. 3 statements get an interval of 76% -85% with a practicality level of practical. Thus, overall the average percentage of practicality in the small group trial activity of formative assessment based on integrated qr code educational games is 91% with a very practicality level.

B. Large Group Product Trial

The large group product trial was conducted by 11 people. 10 students of class VIII-A of SMP Negeri 3 Palopo, and 1 teacher/practitioner. During the large group product trial activity, students used educational game-based formative assessment. After the educational game-based formative assessment product trial was completed. Furthermore, a practicality questionnaire was distributed to students and teachers to determine students' responses to the formative assessment.

The results of the calculation of the practicality questionnaire in the large group trial can be seen in the following table:

No.	Trial Participants	Question Number/Questionnaire Result Score													Amount (S)	Maximum Score (N)	Percentage (%)	% average
		1	2	3	4	5	6	7	8	9	10	11	12	13				
1	A-1	5	4	5	5	5	5	5	5	5	5	5	5	5	64	65	98%	92 %
2	A-2	5	5	4	5	5	5	5	3	3	4	5	5	5	59	65	91%	
3	A-3	4	4	5	4	5	5	4	5	4	4	5	5	5	59	65	91%	
4	A-4	4	4	5	4	5	5	4	5	4	4	5	5	5	59	65	91%	
5	A-5	4	5	4	5	5	5	5	3	3	4	5	5	5	58	65	89%	
6	A-6	5	5	4	5	5	5	5	5	5	5	5	5	5	64	65	98%	
7	A-7	5	5	4	5	5	5	5	3	3	4	5	5	5	59	65	91%	
8	A-8	5	5	5	4	5	5	4	5	4	4	5	5	5	61	65	94%	
9	A-9	4	4	5	4	5	5	4	5	4	4	5	5	5	59	65	91%	
10	A-10	4	5	4	5	5	5	5	3	3	4	5	5	5	58	65	89%	
11	A-11	5	4	4	5	5	4	3	4	5	4	5	4	3	55	65	85%	
Amount (S)		50	50	49	51	55	54	49	46	43	46	55	54	53				
Maximum Score (N)		55	55	55	55	55	55	55	55	55	55	55	55	55				
Percentage (%)		91%	91%	89%	93%	100%	98%	89%	84%	78%	84%	100%	98%	96%				
% average		92%																

Table 6 Results of Practicality Assessment in Small Group Trial Activities

Based on the data obtained, from 13 statements, 10 statements get an interval of 86% -100% with a practicality level of very practical. 3 statements get an interval of 76% -85% with a practicality level of practical. Thus, overall the average percentage of practicality in the large group trial activity of formative assessment based on integrated qr code educational games is 92% with a very practicality level.

3. Product Effectiveness Analysis

Analysis of the effectiveness of developing formative assessments based on integrated qr code educational games is to measure the effectiveness of the products created. To what extent is this product effective in improving student learning outcomes in popular scientific article material. What is done to measure this effectiveness is by measuring the increase in student achievement from the beginning before treatment (initial ability test/pretest) to the target learning outcomes after being given treatment (post test).

Table 7 Product Effectiveness Results Analysis

No.	Sample Code	Mark		*Post Test-Pretest*	Ideal Score-Pretest	N-Gain Score	N-Gain Score %
		Pretest	*Post test*				
1	A-1	80	100	20	20	1.00	**100.00**
2	A-2	90	100	10	10	1.00	**100.00**
3	A-3	80	100	20	20	1.00	**100.00**
4	A-4	70	100	30	30	1.00	**100.00**
5	A-5	80	100	20	20	1.00	**100.00**
6	A-6	30	70	40	70	0.57	**57.14**
7	A-7	20	70	50	80	0.63	**62.50**
8	A-8	30	60	30	70	0.43	**42.86**
9	A-9	20	60	40	80	0.50	**50.00**
10	A-10	20	60	40	80	0.50	**50.00**
Average		52	82	30	48	0.76	**76.25**

Based on the data of students' learning outcomes during the pretest and posttest. Thus, the results of the N-Gain score test or the results of the analysis of the effectiveness of the product development of formative assessments based on integrated educational games with qr codes on popular scientific article materials at SMP Negeri 3 Palopo were obtained, with an average n-gain score of 76.25% in the effective category.

4. Valid Products

After the development of a formative assessment product based on an integrated educational game with a QR code on popular scientific article material, then a validation/feasibility test was carried out by a validator (Assessment expert, material expert, and media expert). After that, revisions and trials were carried out on small and large groups. The response from the trial participants stated that the product developed was good for use. Therefore, the product of developing a formative assessment based on an integrated educational game with a QR code on popular scientific article material has been declared valid. The product is valid, meaning that the product can be distributed to other educators.

Stage IV: Disseminate

After the product is declared valid, the next stage is to disseminate the results of the assessment development.educational game-based formative integrated qr code. At this stage, product distribution is carried out online and offline. Online, namely by downloading educational game-based formative assessments that have been formatted in qr code which are distributed via messages on social media. Offline, namely educational game-based formative assessments integrated qr code are distributed through training/technical guidance/seminars to educators regarding how to use educational game-based formative assessments integrated with qr code that have been created.

CONCLUSION

The conclusions obtained based on the research that has been carried out are as follows: (1) The formative assessment product based on educational games integrated with QR codes on popular scientific article material for class VIII students of SMP Negeri 3 Palopo was declared suitable for use in learning assessments according to assessment experts, media experts and material experts.

(2) Formative assessment products based on educational games, g-forms and spreadsheets integrated with qr codes on popular scientific article materials for grade VIII students of SMP Negeri 3 Palopo have a very practical level of practicality with a percentage of 92%. This indicates that these three assessments are very practical to use. (3) Formative assessment products based on educational games integrated with QR codes on popular scientific article materials for class VIII students of SMP Negeri 3 Palopo have an effective level of effectiveness with a percentage of 76.25% with an effective category. Game-based formative assessment products have an effective level of effectiveness because there is an increase in student learning outcomes after using the developed assessment products and students are more motivated when taking part in the learning assessment of popular scientific article materials for class VIII students of SMP Negeri 3 Palopo.

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