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Development of Digital Teaching Materials with a STREAM Approach on Biotechnology Materials to Improve Students' Science Literacy and Bioentrepreneurship Interes

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Abstract

The development of digital teaching materials using STREAM approach is needed on biotechnology material due to lack of digital teaching materials, low scientific literacy and lack of bioentrepreneurship material. This research aims to present the characteristics, validity and effectiveness of digital teaching materials using the STREAM approach on biotechnology to increase students' scientific literacy and interest in bioentrepreneurship. The results of questionnaire analysis using aiken-V show that digital teaching materials received very valid scores from 4 validators, namely religious experts with score of 1, entrepreneur experts with score of 0.94, material experts with score of 0.95 and media experts with score of 0.98. The results of students' scientific literacy are shown by the N-gain value, namely 0.71 in the high category. The results of students' bioentrepreneurship interest are shown by the N-gain, namely 0.73 in the high category. Biology teacher response results obtained a percentage of 92% with very good criteria. Students' responses after using digital teaching materials also received positive responses. Based on the results of this research, it can be concluded that digital teaching materials with the STREAM approach on biotechnology material can be used in learning to increase students' scientific literacy and bioentrepreneurship interest.

How to Cite

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INTRODUCTION

Teaching materials are material or subject matter that is systematically arranged and used by teachers and students in the learning process (Magdalena et al., 2020) Ideally, teaching materials will be adapted to the content used by the teacher, for students in the class in various forms and types, but all have the same learning objectives. Observations carried out by researchers at Darul Ulum Islamic High School Semarang showed that learning sources were printed and non-printed. Print sources include LKPD and textbooks, while non-print sources include videos and Powerpoint files. The source of LKPD is a printed book given to each student and paper leaflets. There are no LKPD in digital or e-book form yet. Referring to the results of these observations, it is necessary to develop digital teaching materials as new learning sources, especially in the natural science (science) learning process, because science learning, especially in biotechnology, is inseparable from objectivity, accuracy, precision, pursuit of truth, problem solving in studying it.

The development of digital teaching materials on biotechnology can be done through FlipBook software, namely Heyzine, so that students can operate them independently using computers, laptops and others (Khasanah & Nurmawati, 2021). It is also important to develop digital teaching materials on biotechnology using an interdisciplinary Science, Technology, Religious, Engineering, Art, and Mathematics (STREAM) approach based on projects to develop critical thinking skills, be creative in solving problems and produce products (Sartono et al., 2020). The development of digital teaching materials on biotechnology using the STREAM approach will certainly complement the 5 pillars of education in Indonesia to achieve national education goals, namely Learning to know, Learning to do, Learning to be, Learning to live together in peace, and Learning to believe in God. Likewise, the presence of a religious element makes learning to strengthen faith, devotion and noble morals (Agustina et al., 2018; Azizah et al., 2019), because the teaching materials are intended for Islamic High School students and Islamic high school teachers association.

The development of digital teaching materials on biotechnology using the STREAM approach also makes teachers play a role in planning or designing learning, interacting with students, looking for student uniqueness and assessing students transparently. Students as learning objects play a role in learning new concepts, thinking, expressing ideas, asking questions, conducting simple research, applying learning results through action, carrying out social interactions, and applying religious aspects as a manifestation of strengthening character education (Asdar et al., 2021; Azizah et al., 2019). The important thing is the development of students' scientific literacy from the development of digital teaching materials on biotechnology using the STREAM approach, this is because scientific literacy is related to students' ability to understand information, science and facts that exist in everyday life. Individual achievements in scientific knowledge and skills can further have implications for their readiness to face the era of using advanced technology in the future (OECD, 2017). Scientific literacy is needed to understand scientific issues, the benefits and risks of science (Fasasi, 2017) and with scientific literacy skills you can understand the social and environmental problems faced by society in this modern era, especially those that rely on knowledge and technology (Turiman et al., 2017).

Judging from the scientific literacy abilities of Darul Ulum Islamic High School Semarang students, it is still below standard. The proportion of students with literacy skills above the minimum competency is 37.78%, the proportion of students with literacy skills reaching the minimum competency is 42.22%, and the proportion of students with literacy skills below the minimum competency is 20.00%. This shows the importance of developing digital teaching materials on biotechnology with the STREAM approach to increasing students' scientific literacy. Lestari et al. (2023)stated that the digital teaching materials in the form of flipbooks that were developed were quite effective in improving students' scientific literacy skills. The development of digital teaching materials on biotechnology material using the STREAM approach, apart from increasing students' scientific literacy skills, also enables teachers to build students' positive perceptions about entrepreneurship, generate entrepreneurial motivation and, if possible, provide entrepreneurship skills by making certain products. So it can be a stimulus for students to pursue entrepreneurship and live independently. The use of bioentrepreneurship-oriented teaching materials is expected to increase students' interest in bioentrepreneurship so that it will motivate students to be better prepared from an early age to live independently in society.

Schools have an interest in trying to develop entrepreneurship-based learning to equip stu-

dents with skills after graduation. Interest in entrepreneurship can be built through education. If education is able to provide adequate knowledge and inspiration, interest in making entrepreneurship a career choice will increase. Educational institutions must encourage the development of creative entrepreneurial ideas.

Students need entrepreneurship-based education to foster interest in Bioentrepreneurship. Bioentrepreneurship, namely making activity choices, Feeling interested in becoming a bioentrepreneur, Feeling happy about being a bioentrepreneur, Desire to become a bioentrepreneur, Dare to take risks so as to obtain (Lukmayanti, 2018), various skills that can be used by students after graduating (Anwar et al., 2012). Research on the importance of developing teaching materials has been carried out by several researchers, research (Hidayah et al., 2023)states that the use of interactive digital teaching materials is effective in encouraging students to always think critically, be innovative, be able to collaborate and communicate the results of the discoveries they find to improve learning outcomes. Research related to the STREAM approach carried out by (Agustina et al., 2020)showed that STREAM-based textbooks/modules were suitable to be used as teaching guidelines and references for teachers and could strengthen students' scientific processes in accordance with science learning objectives. Research on the relationship between teaching materials and the STREAM Approach (Aryani, 2024)states that STREAM-based e-module media provides contextual learning experiences for students and presents innovative approaches to learning, as well as improving the quality and efficiency of the teaching and learning process.

Research related to teaching materials and scientific literacy conducted by (Fakhriyah et al., 2023; Septiani & Kasih, 2021; Suriyana & Novianti, 2021) stated that the development of multimedia interactive teaching materials based on scientific literacy with science content can help and provide support to students in the learning process that involves scientific literacy. Research related to STREAM with scientific literacy conducted by (Sisnodo, 2015)stated that the increase in scientific literacy skills who received learning using the STREAM approach was better than students who received learning using a scientific approach, while research related to learning with a bioentrepreneurship vision, conducted by (Sisnodo, 2015)stated that the teaching materials developed must be able to build students' positive perceptions of themselves regarding entrepreneurial activities, generate motivation for entrepreneurship, instill values. entrepreneurship.

The various research studies above are a form of development which specifically aims at using STREAM on teaching modules to develop partially both in developing scientific literacy skills and bioentrepreneurship interests, while researchers are more specific in developing digital teaching materials using the STREAM approach on biotechnology material which will simultaneously increase students' scientific literacy and bioentrepreneurship interests, so it is hoped that they can train students to develop scientific literacy and bioentrepreneurship interests, this is what is not studied. or researched in the research above. Based on the background of the problems that have been revealed, it is necessary to develop digital teaching materials with a STREAM approach to biotechnology material, so that it is hoped that it can increase students' scientific literacy.

METHOD

The method used to produce products and test product effectiveness in this research is research and development (R&D). The model used ADDIE (Analysis, Design, Development Implementation, and Evaluation) which is used to design and develop an effective and efficient product (Muruganantham, 2015). This development will be carried out in accordance with the procedure that Muruganatham has developed, which consists of five steps. The five steps are: Analysis, design, development, implementation, evaluation.

The research subjects consisted of religious material experts, business experts, material experts, media experts, teachers and students. The instruments in this research consisted of: questionnaire, expert validation, scientific literacy test questions, bioentrepreneurship interest questionnaire, teacher and student response questionnaire. Scientific literacy question instrument and bioentrepreneurship interest questionnaire. Data was collected through observation, documentation, interviews, questionnaires and tests. The data analysis techniques in this research consist of product data analysis, initial data analysis, and final data analysis.

Feasibility analysis was carried out by 4 expert validators to get input on product feasibility. Assessment is carried out using a Likert scale. The validation score results from each validator were analyzed using Aiken's Validity theory (Aiken's V). The formula used to assess the construct validity of the instrument to be used is as follows (Sugiharni & Setiasih, 2018).

$$V = \frac{\sum S}{n(C-1)}$$

Information:
V : Instrument Validity
S = r – lo
R : value given by the assessor
lo : lowest validation value
n : number of assessors
c : highest validity value

If the Aiken index is less than 0.4 then it is said to have low validity, an Aiken index between 0.4-0.8 is said to have medium validity and if it is more than 0.8 it is said to be high. Initial data analysis was carried out to determine the normality and homogeneity of data (Sudjana, 2015; Sugiyono, 2017b). This was done as a prerequisite for carrying out final data analysis. Initial data analysis was carried out on the students' pretest and posttest results.

Analysis of students' pretest and posttest results was carried out to measure students' scientific literacy and bioentrepreneurship interest before and after implementing digital teaching materials using the STREAM approach on biotechnology in the product trial and product implementation groups. The results of students' knowledge tests are analyzed using the formula (Sugiyono, 2017a).

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

Information:
P : Value
F : Value obtained
N : Maximum value

The criteria for assessing student knowledge are presented in the Table 2.

Tabel 1. Criteria for Assessing Students' Science Literacy and Bioentrepreneurship Interest

Value	Very good
$80 \leq P \leq 100$	Good
$60 \leq P \leq 79$	Enough
$30 \leq P \leq 59$	Need
< 30	Guidance

Analysis of students' pretest and posttest results was used to determine the effectiveness of implementing digital teaching materials with the STREAM approach on biotechnology in measuring the increase in scientific literacy and interest in bioentrepreneurship of students before and after learning through digital teaching materials with the STREAM approach on biotechnology. Analysis of students' pretest and posttest results was carried out using the N-Gain test with the help of the SPSS 25 program for statistical tests. Hake as quoted (Mas'ulah, 2019) explains the formula for calculating the N-Gain Score <g> as follows:

$$\langle g \rangle = \frac{(score\ posttest) - (score\ pretest)}{(score\ maximum) - (score\ pretest)}$$

After carrying out the calculations above, the results of these values were converted into the criteriDa for improving students' scientific literacy and bioentrepreneurship interests, which are presented in Table 2.

Tabel 2. N-Gain Calculation Criteria

Value	Category
<g> > 0.7	High
0.3 ≤ <g> ≤ 0.7	Currently
<g> < 0.3	Low

RESULT AND DISCUSSION

Characteristics of Digital Teaching Materials Using the STREAM Approach on Biotechnology Material

Digital teaching materials using the STREAM approach on Biotechnology material developed are based on a study of several relevant Biology textbooks and research articles. The material was taken from several sources of Biotechnology books and modified science textbooks for students. Images, news and data are taken from several journals and websites. STREAM Aspect Content includes Science, Technology, Religion, Engineering, Art, and Mathematics. Apart from that, the contents of the scientific literacy aspects included include: 1) science as a body of knowledge 2) Science as a way of investigation 3) Science as a way of thinking 4) Interaction of science, technology and society. The appearance of the digital teaching materials can be seen in several pictures below.

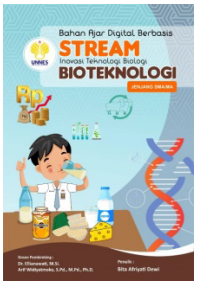

Figure 1. Teaching material cover

Figure 2. Science Content and Let's Learn

Figure 3. Fun Fact

Characteristics of teaching materials developed by researchers in the form of E-books which are used as companion books for students to learn easily. The existence of e-books is a very important means of increasing students' digital literacy in this modern era. By using e-books, students can easily access various types of literature and learning resources electronically through their digital devices. The advantages of e-books include their ability to present text interactively, making it easier to search for information (Sari et al., 2023). E-books are effective for facilitating students to practice digital literacy. Interactive e-books have great potential to increase student learning success compared by use conventional textbooks (Shinoda & Sianipar, 2019).

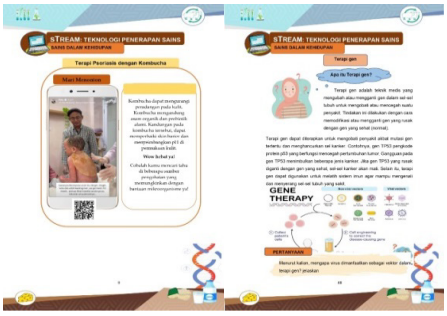

Figure 4. Applied Science Technology and Science in Life

Figure 5. Religion (Unity of Science) and Let's Think Scientifically

Figure 6. Engineering Science and Let's Try

Figure 7. Art and Let's Try

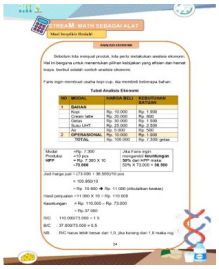

Figure 8. Math and Let's Think Scientifically

Digital teaching materials using the STREAM approach on biotechnology materials were developed based on a study of several relevant biology textbooks and research articles. The material was taken from several sources of Biotechnology books and modified science textbooks for students. Images, news and data are taken from several journals and websites. STREAM Aspect Content includes Science, Technology, Religion, Engineering, Art, Mathematics. Apart from that, the contents of the scientific literacy aspects included include: 1) science as a body of knowledge 2) Science as a way of investigation 3) Science as a way of thinking 4) Interaction of science, technology and society.

Figure 9. Kefir business opportunity

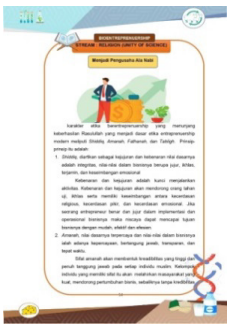

Figure 10. Bioentrepreneurship character

The differences between digital teaching materials developed and student textbooks are in the appearance of the teaching materials, attracti-

ve images, materials created using the STREAM approach and the practicality of using teaching materials because they are in digital/E-book form. The first part or cover displays a picture of a child drinking milk, presenting practicum that will be carried out, namely making kefir milk, several pictures of conventional and modern biotechnology products as well as entrepreneurship components. The use of pictures has a significant and strong relationship between visual design of picture books and students' reading comprehension (Arofah et al., 2017; Hartati & Subiyantor, 2018).

The benefits of visuals in learning include visuals that can motivate students by attracting their attention, maintaining attention and getting emotional responses. Apart from that, visuals can also simplify information that is difficult to explain in words. The role of visuals in learning is important to support written information and oral information (Adipta et al., 2016). E-books that utilize images can provide cognitive strengthening to students' analytical abilities (Prameswari et al., 2022).

The presentation of Science, Religion, engineering, Art, and mathematics can play an important role in improving students' understanding and skills (Pixyoriza & Widyawati, 2024). Digital teaching materials using the STREAM approach on biotechnology materials, developed based on being linked to the environment around students (Irwanto, 2018) state that teaching materials that are linked to contextual problems in the surrounding environment can improve learning outcomes and life skills. Digital teaching materials with a STREAM approach on biotechnology material using Flip PDF Professional software. Alwan (2018); Kustijono & Watin (2017) stated that using Flip PDF Professional software in e-books is effective for use in learning and has the potential to further develop into a good learning media.

The development of digital teaching materials on biotechnology materials so that they are suitable for use as learning resources in schools on biotechnology materials must first be validated by interpreters, entrepreneurs, material experts and media experts. Validation is carried out so that the product developed is based on development theory and ensures its validity for use in learning. Results of Validation of Digital Teaching Materials Using the STREAM Approach on Biotechnology Materials. Validity includes religious aspect validity. This validity assesses several rights related to the writing of the Quran and hadith, its correlation with biotechnology, and the opinion of fuqaha' figures which obtained a validity score of 1 with very high criteria (Table 3).

Table 3. Validation Table of Religious Elements

Aspects	V_{Value}	Information
Writing Qur'an and Hadith	1	Very high
Correlation of the Qur'an and Hadith with biotechnology materials	1	Very high
The opinion of fuqaha' figures	1	Very high

The validity of the entrepreneur element contains two aspects, namely suitable of content and eligibility. Both aspects obtained validity scores with very high criteria (Table 4).

Table 4. Entreprenuer Element Validation

Aspect	V_{Value}	Information
Suitability of content	1	Very high
Presentation eligibility	0.875	Very high

The validity of digital teaching materials with the STREAM approach on biiotechnology material measures aspects including suitability of content, eligibility, language, and scientific literacy with very high validity results.

Table 5. Validation of digital teaching materials using STREAM approach for Biotechnology materials

Aspect	V_{Value}	Information
Suitability of content	0.938	Very high
Presentation eligibility	0.786	Very high
Language	0.917	Very high
Scientific literacy	0.969	Very high

Beside that, the validity of digital biotechnology teaching materials by media experts measures aspects including graphics components, STREAM components, and language eligibility with very high validity results.

Table 6. Validation of digital biotechnology teaching materials by media experts

Aspect	V_{Value}	Information
Graphics components	0.972	Very high
STREAM components	1	Very high
Language eligibility	1	Very high

The material expert assessment received an average of 93.36% and the media expert as-

sessment received an average of 89.29%. Teaching materials that get a score above 80% have very valid qualifications so they are suitable for use in learning (Arikunto, 2017).

The initial ability test of students is carried out by giving pretest questions to the control and experimental classes. The pretest results for the experimental class and control class did not show any significant differences. The next stage is to carry out the final ability test after the learning process via posttest. The experimental class got an average posttest score of 83.75 which was higher than the average result of the control class, namely 68.5. The average value of the two has a different value based on the calculated t test = 6.340 and t table = 2.204, because t calculated > t table. The difference in scientific literacy abilities is that the experimental class is better than the control class because of the impact of using digital teaching materials using the STREAM approach on biotechnology materials developed by researchers in the experimental class.

The use of digital teaching materials using a STREAM approach on biotechnology contains material elements of Science, Technology, Religious, Engineering, Art, and Mathematics on biotechnology which invites students to discover their own knowledge and helps students achieve understanding more easily. In line with research by Alfieri, et al., (2018) which states that discovery-based learning stimulates students to provide positive feedback so that learning outcomes improve. Apart from that, textbooks are able to reduce dependence on teachers and students are able to learn independently (Azrai & Refirman, 2019).

The increase in learning outcomes through the N-gain test for experimental class and control class students experienced differences. The experimental class obtained an average increase of 0.80 in the high category, higher than the experimental class which obtained an average of 0.59 in the medium category. The increase in scientific literacy through the N-gain test of students for each aspect of scientific literacy showed that the experimental class increased higher than the control class in each aspect. This proves that digital teaching materials using the STREAM approach to biotechnology material are able to improve scientific literacy learning outcomes compared to textbooks that students usually use.

Increasing each aspect of students' scientific literacy is based on posttest question indicators consisting of 20 questions, each with a ratio of 3:2:2:3. The results of increasing scientific literacy for each aspect of the experimental class after using digital teaching materials using the STREAM approach on biotechnology material occupy two categories, namely high and medium. The aspect of science as a body of knowledge and the interaction of science, technology and society has increased to the high category. Aspects of science as a way to investigate and science as a way to think have increased to the medium category.

Aspects assessed by biology teacher as very good include the presentation of the material, the language used is easy to understand, the learning stages are coherent, scientific literacy and bioentrepreneurship are included in digital teaching materials which increase students' interest. The teaching materials developed received a positive response, this is because it helps teachers in the biotechnology learning process more easily, flexibly and cheaply because there is no need for printouts. In line with research Farhana et al., (2021) where the research results show that digital-based teaching materials that have been designed have the potential to be effective in improving learning and teaching outcomes as well as student interest, the same thing was also expressed in research (Anggriani et al., 2022) which produced digital teaching materials based on creative biology videos on the excretory system material suitable for use in the learning process.

So the STREAM approach is able to strengthen students' science and direct students to be able to think creatively. In the same vein, research Aryani (2024) showed that the results of STREAM based on e-modules were valid and practical to be applied to science learning. The integration of Al-Qur'an verses in the e-module helps connect science with religious values and is expected to provide a contextual learning experience for students and present an innovative approach to STREAM-based learning and improve the quality and efficiency of the teaching and learning process.

CONCLUSION

The characteristics of digital teaching materials using the STREAM approach on biotechnology were developed based on a study of several biology textbooks, material taken from several modified biotechnology and science textbook sources, images, news and data taken from several journals and websites. The content of the STREAM aspect consists of Science, Technology, Religious, Engineering, Art, and Math. Teaching materials present the relationship between Biotechnology material and aspects of scientific literacy including: 1) science as a body of kno-

wledge 2) Science as a way of investigation 3) Science as a way of thinking 4) Interaction of science, technology and society. Digital teaching materials with the STREAM approach on Biotechnology material are effective for increasing students' scientific literacy and interest in bioentrepreneurship.

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