JURNAL EDUKASI BIOLOGI
Volume 10 No 1, March, 2025, 27-41
ISSN: 2986-5484 E-ISSN: 2986-4828
DOI: 10.21831/edubio.v11i1.22558
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PENGEMBANGAN MEDIA PEMBELAJARAN ENVIRONBYTIKTOK DENGAN SOSIO-SCIENTIFIC ISSUES ALIH FUNGSI HUTAN IBU KOTA NUSANTARA UNTUK MENDUKUNG LITERASI LINGKUNGAN SISWA SMA

THE DEVELOPMENT OF *ENVIRONBYTIKTOK* LEARNING MEDIA ADDRESSING SOCIO-SCIENTIFIC ISSUES ON THE LAND USE CONVERSION OF THE NUSANTARA CAPITAL CITY FORESTS TO ENHANCE HIGH SCHOOL STUDENTS ENVIRONMENTAL LITERACY

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Abstract. The limitations of conventional learning media in improving the environmental literacy of high school students are a challenge in the digital era. To overcome this, media innovations, such as TikTok, are needed that are contextual and relevant to the habits of the younger generation. This study aims to determine the feasibility, practicality, readability, and effectiveness of TikTok-based biology learning media products with socio-scientific forest conversion issues in the Indonesian Capital City to support the environmental literacy of high school students. This research is a development research or Research and Development (R&D) with a 4D model (Define, Design, Development, Disseminate). The research subjects comprised material experts, media experts, biology teachers, and 36 SMA N 1 Godean students. The research instruments used were expert validation questionnaires, teacher assessment questionnaires, and student assessment questionnaires analyzed using qualitative and quantitative descriptive data analysis techniques, as well as pre-test and post-test assessments of students with N-Gain analysis. The results of the study showed that TikTok-based learning media with socio-scientific issues of forest conversion in the Indonesian Capital City to support environmental literacy of high school students was successfully developed in the form of EnvironByTikTok media. The EnvironByTikTok media was declared very feasible based on the results of the validation of material experts by obtaining a percentage of 96% and was also declared very feasible based on the results of the validation of media experts by obtaining a percentage of 88%. In addition, the assessment by teachers obtained a very practical category with an average assessment percentage of 100%, and the assessment from students obtained a very good category with an average percentage of 97.9%. The N-Gain score result of 0.675 indicates that the EnvironByTikTok media is effective with a moderate category to support the environmental literacy of high school students.
Keywords: Biology, EnvironByTikTok, Environmental change, Learning media

Received: 27 October 2024 Revised: 11 February 2025 Accepted: 11 February 2025 Published: 30 March 2025

INTRODUCTION

Along with the increasing human needs for resources and infrastructure, humans make every effort to meet them, which often has an impact on environmental change (Wang & Azam, 2024). The impact of this change is not always positive and can cause problems and even environmental damage (Awad et al., 2023). Environmental damage due to this change has generally occurred almost all over the world, including in Indonesia. The government of the Republic of Indonesia has determined the plan to move the capital city of the Republic of Indonesia from the Special Capital Region of Jakarta to the capital city of Archipelago, which is located in East Kalimantan. The purpose of moving the Capital City is to achieve the Vision of Golden Indonesia in 2045 through an economic transformation so that development is

realized evenly throughout Indonesia and is not only concentrated in western Indonesia. The issue of the problem of the development of the Capital City of the Archipelago related to the conversion of forest functions is one of the studies directly related to environmental problems. The development of the Capital City of the Archipelago is believed to be at risk of damaging the environment, especially the destruction of flora and fauna, which impacts city development, considering that Kalimantan is known as the world's lungs.

This relocation plan has raised many pros and cons, especially from a social and environmental perspective (Ramadhani & Djuyandi, 2022). In addition to being known as the world's lungs, the island of Kalimantan is also known as one of the islands with very high biodiversity. It is a habitat for various types of fauna and flora species. Therefore, the process of moving the Indonesian Capital City has the potential and impact on the environment on the island of Kalimantan (Fristikawati et al., 2022). The pros and cons of developing the Indonesian Capital City led to the problem of forest conversion. They became one of the portraits of environmental issues related to relocating the nation's capital city to the island of Kalimantan. The development of the Indonesian Capital City has a significant impact on environmental change and encourages the importance of environmental protection. Forest conversion inevitably occurs with large-scale deforestation, which can cause the loss of valuable and sensitive ecosystems and threaten environmental sustainability (Adnan et al., 2023).

Considering the challenges and environmental problems related to forest conversion in the development of the Indonesian Capital City, it is necessary to remember that environmental preservation is becoming increasingly fundamental. Effective environmental protection measures must be taken to mitigate the negative impacts of the development of the Indonesian Capital City. These measures include adopting green technology, efficient waste management, preservation of natural habitats, and community participation in environmental conservation efforts. Therefore, integrating the development of the Indonesian Capital City related to forest conversion into the learning process is very relevant. With a better understanding of complex environmental issues and possible solutions, the younger generation can become agents of change in maintaining environmental sustainability and responding positively to the challenges of the development of the Indonesian Capital City.

As stated by UNESCO, it is necessary to increase awareness and collaboration from all levels of society, one of which is through the implementation of environmental education (Husamah et al., 2025). According to Law of the Republic of Indonesia Number 32 of 2009 concerning the Protection and Preservation of the Environment, every citizen has the right and obligation to protect and manage the environment (Indonesia, 2009). Environmental protection and management are systematic and integrated efforts to preserve environmental functions and prevent environmental pollution or damage, including planning, utilization, control, maintenance, supervision, and law enforcement (Wahanisa & Adiyatma, 2021).

The increasing complexity of environmental problems related to aspects of life requires integrated education with an attitude of environmental care that includes environmental literacy. This condition follows the learning achievement targets of the Independent Curriculum for biology material phase E, namely that students can create solutions to problems based on local, national, or global issues related to understanding environmental change (Badan Standar, Kurikulum dan Asesmen Pendididkan, 2022). Environmental literacy has a significant role in maintaining environmental sustainability and building awareness of the importance of nature conservation (Marianingsih et al., 2021). Environmental literacy allows individuals to identify threats to the environment and play a role in protecting it. Environmental education activities in Indonesia still face significant challenges because the environmental care behavior of most people and students is still low (Sefty, 2022).

The relevance of the context of environmental issues in environmental education is important, considering that environmental issues are correlated with aspects of daily life

(Susilawati, 2022). The existence of this context in learning by reflecting on the surrounding reality experienced by students also encourages the implementation of knowledge, attitudes, and skills to overcome problems. This result is in line with the results of research conducted by Muthmainah et al. (2016), showing that the utilization and application of local biodiversity and conservation into learning will have a long-term impact on the formation of students' caring attitudes towards local biodiversity. Environmental change material must be packaged in more innovative learning because this material is very close to students' lives.

Learning using Socio-Scientific Issues differs from others because of ethical awareness and social scientific values towards the environment (Siska et al., 2020). In this case, Socio-Scientific Issues represent issues or problems in social life that are conceptually closely related to science. The issues or problems raised in Socio-Scientific Issues can be national issues that become environmental problems and impact humans so that they become social issues that can be studied scientifically (Isnaini & Rahayu, 2023). Thus, biology learning can be developed to facilitate students' abilities to create problem-solving solutions through the Socio-Scientific Issues approach to developing the Indonesian New Capital City.

Learning that integrates environmental context can be strengthened through various learning tools, including using learning media sourced from national realities. Modified TikTok-based learning media responds to technological developments and media consumption trends in the digital era. However, its use in learning has not been optimal, so because the use of social media, especially TikTok, is increasing among the younger generation, it is important to present educational materials in a format that is appropriate for the platform (Ramdani et al., 2021).

Learning media is compiled with socio-scientific forest conversion issues in the Indonesian Capital City as content feeds on TikTok. Each part of the biology material in the learning media is represented in an engaging content feed according to the material sub-chapter. Using illustrations, photographs, and creative writing styles can make students more interested, make it easy to understand, and help them learn about environmental and biological issues related to the development of the Indonesian Capital City. The realization of this media can provide independent learning access through TikTok as an alternative learning media for students by displaying illustrations of various materials. This can be an engaging presentation supporting student literacy in active, independent, and easy-to-understand learning materials. Thus, this learning media has the potential to be an effective means of disseminating information in an interesting and easily accessible way for students.

Based on this, the product developed is a TikTok-based biology learning media with socio-scientific forest conversion issues in the Indonesian Capital City to support the environmental literacy of high school students. The development of this media is adjusted to the characteristics of students, such as the millennial generation, who follow trends and can easily operate TikTok social media, which can be accessed using only a smartphone. TikTok social media can be designed as a learning media to motivate students to participate actively in environmental conservation and sustainable development. By presenting learning materials in the form of interesting content, this media is expected to be an alternative learning media that can support students' digital and environmental literacy about the environment.

METHOD

This research is a research and development (Research and Development) with a 4D model (define, design, development, disseminate). This research was conducted at SMA N 1 Godean in October 2024. The subjects of this research were material experts, media experts, biology teachers, and 36 students of SMA N 1 Godean. The object of this research trial was to use TikTok-based learning media with socio-scientific forest conversion issues in the Indonesian capital city to support the environmental literacy of high school students. The types

of research data are qualitative data and quantitative data.

The data collection instruments for this study used a material expert validation sheet, a media expert validation sheet, a biology teacher assessment sheet using a Likert scale assessment guideline with four alternative answers, namely Very Good, Good, Not Good, and Very Not Good, a student readability sheet using a Guttman scale assessment guideline with alternative answers "Yes" with a score of 1 and "No" with a score of 0, as well as pre-test and post-test questions to determine the effectiveness of the media in supporting students' environmental literacy. The instruments that had been prepared were first validated by consulting with the supervising lecturer as an expert (expert judgment) to receive suggestions and input regarding the truth and components that should be measured so that the instrument could be considered valid. The validation results were used to determine the basis for the instrument's collection of research data.

The data analysis technique for validation results by material experts, media experts, biology teachers, and students using the following formula:

$$P = \frac{\sum x}{\sum xi} \times 100\%$$

Information:

P	=	Percentage of assessment validity
$\sum x$	=	Total assessment validity score obtained
$\sum x\,i$	=	Total maximum assessment validity score
100%	=	Constant

Then, the calculation results are grouped into categories according to the score interpretation criteria on the Likert scale so that conclusions can be obtained about the feasibility of the media. The reference score calculation criteria to determine the validity category of feasibility, practicality, and readability can be shown in Table 1 (Sudaryono et al., 2013).

Table 1. Criteria for Interpretation of Media Eligibility, Practicality and Readability

No.	Valuation	Interpretation Criteria
1	81%-100%	Very Feasible/Very Practical/Very Good
2	61%-80%	Feasible/Practical/Good
3	41%-60%	Quite Feasible/Quite Practical/Quite Good
4	21%-40%	Not Feasible/Impractical/Not Good
5	<21%	Very Unfeasible/Very Impractical/Very Unkind

The value of feasibility, practicality, and readability is determined by the minimum value of the interpretation criteria, which is quite feasible. The product is considered feasible if the assessment of experts and biology teachers gives the final value.

Analysis of pre-test and post-test values was carried out on data obtained from the pre-test and post-test results related to the results of environmental literacy by students. The N-Gain Test is a method for analyzing the pre-test and post-test results as a representation of the improvement in students' test results related to environmental literacy. The results of the pre-test and post-test obtained are calculated using the following formula:

$$Indeks\ Gain = \frac{Posttest\ score - Pretest\ score}{Maximum\ score - Pretest\ score}$$

The developed learning media can support students' environmental literacy if the N-Gain test results reach the moderate category (Sukarelawa et al., 2024). The following are the N-Gain Score and effectiveness interpretation categories (Table 2 and 3).

Based on the calculation of environmental literacy score results, the criteria for environmental literacy levels based on the total results obtained by each student can be categorized according to Table 4 (Aini et al., 2021).

Table 2. N-Gain Value Categories

Gain Index	Criterion
$0{,}70 \leq g \leq 1{,}00$	Tall
$0{,}30 \leq g < 0{,}70$	Keep
$0{,}00 \leq g < 0{,}30$	Low

Table 3. Categories Interpretation of N-Gain Effectiveness

Persentase *N-Gain Score*	Category
≥ 76	Effective
$56 - 75$	Quite Effective
$40 - 55$	Less Effective
< 40	Ineffective

Table 4. Environmental Literacy Level Category

No.	Percentage (%)	Criterion
1	$90 - 100$	Excellent
2	$80 - 89$	Good
3	$70 - 79$	Enough
4	$0 - 69$	Not Good

RESULTS AND DISCUSSION

Results

Define phase

The definition stage in developing learning media involves needs analysis with several aspects. The first is an initial analysis through interviews with SMA N 1 Godean biology teachers and obtaining information that the independent curriculum is used for grades X and XI. In contrast, grade XII still uses the 2013 curriculum. The learning methods include discussions and presentations using the problem-based learning (PBL) and project-based learning (PjBL) models. TikTok application-based learning media has not been used, even though textbooks' teaching materials for environmental change are still limited. Integrating socio-scientific issues such as the conversion of IKN forests is considered relevant. As an Adiwiyata school, all students must implement and own environmental literacy.

The second is the analysis of students, in which, in learning, the media used so far are PowerPoint presentations and electronic modules. The school has allowed smartphones and provided wifi, but smartphones have not been utilized optimally for learning. The third is the analysis of tasks by considering the learning achievements contained in the independent curriculum in grade X phase E, emphasizing the ability of students to be responsive to global issues, with a focus on environmental pollution, alternative energy, and the use of technology. Students are expected to be able to conduct research and communicate solutions scientifically and creatively when facing the challenges of environmental problems. The fourth is the concept analysis, in which the central concept of environmental change learning is analyzed systematically, with socio-scientific issues related to converting IKN forests into TikTok-based learning media. Finally, the specification of learning objectives is formulated so that students can identify environmental issues, analyze the causes and impacts of environmental change, and provide solutions related to the conversion of IKN forests. The development of

EnvironByTikTok media is expected to be relevant to the needs of biology learning and support environmental literacy.

Design phase

The design stage in developing the EnvironByTikTok learning media includes several steps. The first is the selection of media, where, based on interviews, the existing textbooks are inadequate, so additional teaching materials that are integrated with social and environmental issues are needed. This result supports the selection of TikTok-based media, making it an alternative teaching material because of its easy accessibility and use for more engaging learning. Content design is carried out using the Canva application so that it can be created so that the content of the material presented is attractive and motivates students to learn. The second is selecting a format for presenting material content arranged with a balanced proportion between text, images, and supporting videos and concisely displaying important information.

This media is designed to be easily accessible via smartphones, laptops, or computers, possibly using QR codes or links to access additional materials. The third is the product's initial design, which is the layout of the learning media according to the storyboard as a design guideline to ensure alignment with the material. The material is designed according to the Merdeka Curriculum and includes 15 contents uploaded to TikTok. The content includes an introduction to media, learning achievements, discussions on the issue of converting IKN forests, material on environmental change and preservation, self-reflection, and environmental literacy. The last is the preparation of research instruments used to assess the media's feasibility, practicality, readability, and potential through expert validation questionnaires, teacher validation, student readability, and environmental literacy pre-test and post-test. This development aims to support more interactive and relevant biology learning with environmental issues.

Development phase

The development stage is where the initial product (prototype) that is developed will go through various revisions and trials to produce a feasible final product. This stage is carried out by two activities, namely:

Expert Validation

Expert validation and assessment are intended to obtain input and suggestions on the media being developed. This activity can be called expert appraisal, which is an activity to validate or assess the feasibility of a product design by experts in their fields as assessors who provide suggestions and input to researchers to improve the product design that has been prepared. The results of the media feasibility assessment by material experts can be presented in Table 5.

Table 5. Results of Media Eligibility Assessment by Material Experts

No	Aspects Assessed	Scores Obtained	Maximum Score	Percentage	Criterion
1	Material	23	24	96%	Very Eligible
2	Penyajian	32	32	100%	Very Eligible
3	Language	20	20	100%	Very Eligible
4	Display	21	24	88%	Very Eligible
Total Score			: 96		
Maximum Total Score			: 100		
Overall Percentage			: 96%		
Overall Criteria			: Very Worthy		

Based on the validation results by material experts on the feasibility of the developed learning media, the average percentage of the assessment was 96%, which is included in the category of very feasible to be used as a learning media. In addition, material experts also provided several suggestions and input for improvement or revision of the media. Then, the results of the media feasibility assessment by media experts can be presented in Table 6.

Table 6. Media Eligibility Assessment Results by Media Members

No.	Aspects Assessed	Scores Obtained	Maximum Score	Percentage	Criterion
1	Display	28	28	100%	Very Eligible
2	Language	19	20	95%	Very Eligible
3	Ease of Use	13	20	65%	Very Eligible
4	Quality of Illustrations	14	16	88%	Very Eligible
Total Score			: 74		
Maximum Total Score			: 84		
Percentage			: 88%		
Criterion			: Very Worthy		

Based on the validation results by media experts on the feasibility of the developed learning media, the average assessment percentage was 88%, which is included in the category of very feasible to be used as learning media. In addition, media experts also provided several suggestions and input for improving or revising the media.

Limited Trial

Limited trials are intended to obtain feedback from media users on the practicality and readability of the developed media. This activity can be called development testing, namely testing activities for both practicality tests from biology teachers and limited trials of the initial product design (prototype) on targets, namely students, to obtain an assessment related to readability based on student responses. Students are asked to access the developed media and complete a readability questionnaire in this limited trial. The results of the limited trial are used to improve the product according to the responses and assessments obtained to follow the eligibility category. After improvements are made, the final product is produced. The results of biology teachers' assessment of media practicality can be presented in Table 7.

Table 7. Results of Media Practicality Assessment by Biology Teachers

No	Aspects Assessed	Scores Obtained	Maximum Score	Percentage	Criterion
1	Material Suitability	36	36	100%	Very Eligible
2	Language	16	16	100%	Very Eligible
3	Effectiveness	20	20	100%	Very Eligible
4	Display	24	24	100%	Very Eligible
Total Score			: 96		
Maximum Total Score			: 96		
Percentage			: 100%		
Criterion			: Very Worthy		

Based on the validation results by biology teachers on the practicality of the developed learning media, the average percentage of the assessment was 100%, which is included in the category of very practical to be used as a learning medium. In addition, biology teachers also provided some suggestions and input for improving or revising the media. The results of the media readability assessment by students can be presented in Table 8.

Based on the results of student assessments of the readability of the developed learning media, the average percentage of the assessment was 97.9%, which is included in the very good category for use as learning media. In addition, students provided several suggestions and input

for improving or revising the media. The development trial was conducted with practicality and user-friendly tests. However, the effectiveness of the developed learning media in supporting students' environmental literacy was also tested with pre-tests and post-tests.

Table 8. Results of Readability Assessment by Students

No	Aspects Assessed	"Yes" Score Obtained	Maximum "Yes" Score	Percentage	Criterion
1	Ease of Use	282	288	97,9%	Excellent
2	Content Eligibility	213	216	98,6%	Excellent
3	Display	209	216	96,8%	Excellent
4	Language	142	144	98,6%	Excellent
Total number of "Yes" Scores obtained		: 846			
Maximum Total "Yes" Score		: 864			
Percentage		: 97,9%			
Criterion		: Excellent			

Based on the results of a limited trial of 36 SMA N 1 Godean students, the pre-test and post-test results were obtained, which were then analyzed. Increasing environmental literacy as an indicator of EnvironByTikTok media can support the environmental literacy of high school students. Then, the pre-test and post-test results were analyzed using the N-Gain Score to determine the effectiveness of using learning media in supporting students' environmental literacy. The N-Gain Score describes the category of support for environmental literacy of high school students after the learning process using the EnvironByTikTok media. The calculation of the N-Gain Score from the pre-test and post-test results can be seen in the Appendix. The results of the N-Gain values obtained can be presented in Table 9.

Table 9. N-Gain Results from Pre-test and Post-test

N-Gain Pre-test and *Post-test*				
Mean of *pre-test*	85.18519	Value Results		Category
Post-test *installment*	95.18519	*N-Gain Score*	0,675	Moderate
Maximum score	100	*N-Gain Percent*	67,5%	Quite Effective

Based on the table above, it is known that the average pre-test score is 85.18519, and the average post-test score is 95.18519. The maximum value of each is 100. From the calculation results, the N-Gain Score is 0.675, and the N-Gain Percent is 67.5%. According to Sukarelawa et al. (2024), from the N-Gain Score value, it can be concluded that there is an increase in the pre-test score to the post-test score with a moderate category and the N-Gain Percent with a reasonably effective interpretation category so that the use of EnvironByTikTok learning media in learning is quite effective to support students' environmental literacy with effectiveness included in the moderate category.

Disseminate phase

In this stage, the product of the development that has been improved according to the consideration of suggestions obtained from the results of expert appraisal and developmental testing is then disseminated to users more widely, namely by providing the development product to biology teachers at the research location to be used in future learning. The research results are also published in scientific journals as material to be developed better in the future.

Discussion

This research was conducted with the type of Research and Development (R&D) that focuses on the development of digital learning media based on TikTok and websites involving the topic of socio-scientific issues (SSI) of forest conversion in the Indonesian Capital City and

its relationship to environmental change material. The focus of this research is based on the need for learning media that can act as a guide for students to understand the material independently and support students' environmental literacy. This role is needed as a companion to the adaptation of the implementation of the independent curriculum in schools that prioritize the concept of student-centered learning (SCL) and raise topics or cases that exist in the surrounding environment to provide experience in applying the material that has been obtained.

Based on these considerations, the learning media developed in this study can act as an accommodation for students to understand environmental concerns and support students' environmental literacy. The SSI context integrated as learning material in learning media can be a guide for students to train their environmental literacy skills in applying learning materials to solve existing SSI issues and be able to provide solutions to their resolution.

According to Subiantoro et al. (2021), the SSI approach can develop students' thinking skills because SSI learning integrates scientific concepts that impact people's lives. This statement supports the research on the development of this learning media in order to meet the needs of learning media that can play a role in supporting students' environmental literacy so that later students, as the younger generation, will be able to respond to issues in society and are expected to be able to participate in social life, culture, and daily economic growth. This result is in line with the research of Handayani and Hastuti (2018), which supports using the SSI approach to support students' environmental literacy.

In general, the development of EnvironByTikTok media is also based on the SSI learning syntax, which can support students' knowledge and understanding of the environment, solutions to environmental problems, participate in solving environmental problems, and evaluate and plan environmental problem-solving. According to Nurrita (2018), engaging learning media following student characteristics can help students concentrate on learning and motivate them to pay focused attention to learning materials and understand the material more easily. The content of the material presented in the media is arranged using Canva to ensure that the presentation of the appearance and format produced provides interesting results for students.

In its development, learning media that already contains material content then goes through stages of feasibility assessment using assessment instruments that have been validated by the supervising lecturer to be assessed by experts. According to Arsyad (2022), learning media is feasible if it meets the requirements related to the validity of feasibility, practicality, readability, and effectiveness. Validity, in this case, is related to the extent to which the media can accurately describe and represent the material being taught so that it can be trusted and relevant to learning objectives. Practicality refers to the ease of use of the media by educators and students, which includes technical aspects in the form of ease of access, navigation, and interaction, where good media does not burden users with complicated processes but supports a good and enjoyable learning experience.

Effectiveness is related to the criteria for assessing how much the media can support student learning regarding knowledge, skills, and attitudes. Effective learning media can significantly impact learning outcomes by helping students understand the material in depth and apply it in relevant contexts. The stages of assessing the validity of the feasibility of learning media are carried out by material experts and media experts, followed by an assessment of practicality by biology teachers and an assessment of readability by students. An analysis of the results of media effectiveness is carried out.

Validity of EnvironByTikTok Learning Media

Validation by Material Experts

The feasibility was validated with the subjects, namely lecturers who are material experts at Yogyakarta State University. Validation was carried out by asking for an assessment

from the material experts through a questionnaire consisting of several statements covering four aspects, namely: (1) Suitability of Material, (2) Presentation, (3) Language, and (4) Appearance contained in the media being developed. According to Sadikin et al. (2020), the development of learning media needs to consider the suitability of the material so that the competencies possessed by students can increase and the learning media can support the achievement of learning objectives. The results of this study, followed by Ulfa and Rozalina (2019), state that the feasibility of learning media can be known and determined

Validation by Media Experts

Validation of eligibility was carried out by media expert lecturers at Yogyakarta State University. Validation was carried out by asking media experts for an assessment through a questionnaire consisting of several statements covering four aspects, namely: (1) Appearance, (2) Language, (3) Ease of Use, and (4) Quality of Illustrations contained in the media developed. In line with Panjaitan et al. (2021), using appropriate language can make it easier for readers to learn and understand information, thereby preventing double interpretation. However, there are suggestions given by media experts regarding ease of use, namely improving the instructions to make them more operational so that students can be directed to access content sequentially from beginning to end. This result is also supported by Amir (2014), who that the use of learning media will be effective if the media contains clear instructions for use that are easy for users to use so that the suitability of the instructions for use provided can make it easier for students to operate the learning media.

Practicality and Readability of EnvironByTikTok Learning Media

Practicality Assessment by Biology Teachers

The assessment of the practicality of the media was aimed at biology teachers at SMA N 1 Godean. This assessment was carried out by asking biology teachers to fill out a questionnaire consisting of several statements covering four aspects, namely: (1) Suitability of Material, (2) Language, (3) Effectiveness, and (4) Appearance contained in the media developed. The assessment of biology teachers is needed to meet their responses to the EnvironByTikTok learning media as educational practitioners at the high school level. This result is supported by Bulkani et al. (2022), who stated that the practicality of learning media requires assessment by teachers as practitioners, including aspects of material, media, and its implementation in line with learning conditions at school.

The results of this stage support that the design of the media is attractive and consistent, the selection of font types and sizes is appropriate, the selection of illustrations is appropriate, and the color composition and the integration of interesting and creative elements are appropriate. This result is supported by Arsyad (2013), who stated that good learning media must pay attention to consistency, format, organization of content, font size, and attractiveness so that it can make it easier for users to obtain information, motivate, and increase reading activities when using the media. According to Musliadi & Daud (2022), learning media is considered practical if it can be applied in the learning process properly without providing obstacles that interfere with the learning process and make it easier for users. Positive comments on the media were also expressed by biology teachers regarding the learning media that was developed that could be applied in learning, and there were suggestions given regarding numbering in the material content that could be combined between points, numbers, or letters because students tend to learn by paying attention to these points.

Student Readability Assessment

The readability assessment was carried out with subjects, namely SMA N 1 Godean students who had used the EnvironByTikTok media in a limited trial. The number of students

in this case was 36 students. Students were asked to fill out a readability questionnaire consisting of several statements covering four aspects, namely: (1) Ease of Use, (2) Content Suitability, (3) Appearance, and (4) Language contained in the media developed. According to Rahima et al. (2020), the readability test that obtained very good criteria indicated that the media developed was suitable for teaching materials. This result is supported by Munawaroh & Indah (2022), where one aspect of a good appearance, namely the type of font or size used, must provide comfort, ease of reading, and a perception of user interest in the material presented.

Fatmawati et al. (2019) stated that the preparation of learning media pays attention to the material's content and other aspects that attract users, namely, the composition of colors, fonts, layout, and display design must be attractive. Based on the comments and responses given by students to the EnvironByTikTok media, the majority gave positive responses such as (1) I think biology learning through TikTok media is interesting and easy to understand because the content is presented sequentially and displays cool visuals, (2) This learning media makes it easy for me to learn anywhere and anytime, (3) Learning to use this media increases my knowledge of social media, it turns out that knowledge is not only obtained from books.

Effectiveness of EnvironByTikTok Learning Media in Supporting Environmental Literacy

In order to determine the effectiveness of the EnvironByTikTok learning media in supporting environmental literacy, an analysis of the pre-test and post-test results generated from a limited trial was conducted. Based on a limited trial conducted on 36 students of SMAN 1 Godean, the pre-test and post-test data were analyzed using the N-Gain Score to measure the support or increase in students' environmental literacy after using the EnvironByTikTok learning media. The results of the study showed that there was an increase in students' science literacy after learning with the EnvironByTikTok learning media. The results of this study are supported by research conducted by Mufidah & Mufidah (2021), which states that the TikTok application can be an effective learning medium because it meets the learning needs of today's students.

TikTok attracts students' attention thanks to its interesting and innovative nature and its ability to present content close to the digital world, which is relevant to the characteristics of millennial generation students. TikTok has various features that can be implemented in learning and can be a dynamic medium for presenting educational content, including biology learning. Then also supported by Daniah et al. (2024) stated that TikTok as a learning medium meets the criteria for good media because it is interesting, easy to access, and relevant to student characteristics. TikTok can be processed into an interesting and innovative learning medium for students. This application is not only used for entertainment but is also implemented as a medium of learning thanks to its ability to present information dynamically. Various features on TikTok, such as short video content and photo slides, provide flexibility for teachers and students to design educational content that is interesting and easy to understand.

In addition, the EnvironByTikTok learning media also provides LKPD packaged in the form of a website page that is linked via a link on the Reference Link so that students can access it to work on the assignments given by referring to support the environmental literacy domain, namely competence/skills. However, the presentation of the discussion page and independent activities is arranged based on Hollweg et al. (2011), which is intended to allow the media to support environmental literacy in the competence or skills domain. Learning Discussion is intended so that students can actively discuss in groups with their deskmates how to evaluate information, use analytical skills, conclude, and solve problems together when working on the assignments given. In this case, a group consisting of two students will discuss and actively work together to complete the assignments given with the realization of the work according to the agreement of both parties through a job description; one student records the results of the

joint discussion on one paper by the other student, which will then be submitted on the collection page provided by the other students.

Structured discussion activities can support students in solving problems actively by discussing and working together so that these activities can support students' environmental literacy activities (van Velzen, 2017). This result is supported by the opinion of Nugraheni et al. (2022), which states that group discussions are one of the activities that can be carried out to find or improve students' knowledge, skills, and attitudes or abilities which are carried out logically and systematically so that learning can take place effectively. In this case, it can show the effectiveness of the media in supporting students' environmental literacy, which will impact increasing students' knowledge, skills, and attitudes towards the environment. Then, the Learning activity is intended so that students can complete the assignments given independently and individually based on the learning gained through group discussion experiences that have been carried out so that students can apply their respective knowledge, skills, and attitudes to the assignment materials provided on the website.

EnvironByTikTok media is developed based on social science issues by integrating the socio-scientific issues approach into the composition of the material content. SSI-based learning can present a meaningful learning process by accommodating students to mobilize theoretical knowledge from school in dealing with problems through socio-cultural experiences (Subiantoro & Ariyanti, 2013). In addition, the SSI approach can also be a new pattern in developing teaching materials or learning media (Sofiana & Wibowo, 2019). Thus, the content of the material presented in the media is based on contextual problems that stimulate students to learn. The problems presented will stimulate students to build meaningful student knowledge and produce actions to address existing problems to present learning by analyzing an environmental problem.

The results of the problem stimulation are shown by compiling questions in the formulation of the problem related to what problems occur, what causes them, what will happen if these problems continue to occur, what impacts they have on the environment and humans in the long term, and how to prevent and overcome them by considering aspects of sustainability for the future. The stages of SSI-based learning, according to Subiantoro et al. (2021), include orientation and analysis of issues, clarification of the scientific background of biology related to the issue, socio-scientific studies, discussions, reflections related to confirmation and reflection of aspects of social biology and decisions, and evaluation of student achievement after the learning process. Through these learning steps, it is hoped that they can direct and help students to think more broadly and not only limited to scientific concepts but also connect relevant and contextual socio-science problems with the concepts of the material being studied.

These stages align with the expected outcomes of students' environmental literacy, which include knowledge, competencies or skills, and attitudes. Using TikTok to present socio-scientific issues, such as converting Indonesian New Capital forests, allows students to understand the relationship between science and environmental sustainability challenges more comprehensively. Thus, integrating TikTok in biology learning based on socio-scientific issues increases students' motivation and understanding and encourages environmental literacy and real action. Students who are more aware of the importance of maintaining forest ecosystems will be encouraged to participate in pro-environmental activities and promote sustainability through community projects and digital campaigns.

CONCLUSION

Based on the results and discussions in the development research that has been carried out, it can be concluded that the EnvironByTikTok media, based on the assessment by material experts, obtained the results of the feasibility of learning media included in the very feasible

category and based on the assessment by media experts obtained the results of the feasibility of learning media included in the very feasible category. The EnvironByTikTok media, based on the assessment of biology teachers, obtained the results of the practicality of learning media included in the very practical category and, based on student responses, obtained the results of the readability of learning media included in the very good category. Then, the EnvironByTikTok media, based on limited trials, obtained the results of the N-Gain Score, which indicated that the learning media was quite effective in supporting the environmental literacy of high school students with a moderate level of effectiveness. Some suggestions for the utilization and development of further products that are needed include further development of TikTok-based media so that the material is not limited to learning achievements in environmental change. The final results of the media product can still be more complex and interesting. Therefore, modifications can be made according to other biology materials for further development.

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