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Development of Socio-Scientific Issue Learning Videos in Order to Support Education for Sustainable Development of Hydrocarbon and Petroleum Materials for High School Students Grade XI

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learning video, socio-scientific issues, education for sustainable development, hydrocarbons and petroleum

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Abstract
This study aimed to develop learning videos based on socio-scientific issues in order to support education for sustainable development of hydrocarbons and petroleum materials for class XI Senior High School students. The method of the study was sequential exploratory mixed methods through the qualitative data collection stage, data analysis, and questionnaires. The developed videos contained three issues from the primary material in hydrocarbons and petroleum relevant to daily life. The created instructional videos are accessible online through the YouTube platform or via USB/Bluetooth file transfer. Usability and readability tests were performed to determine the feasibility of the generated learning videos; while the resulting percentages for usability and readability. Based on the result, videos were declared feasible by chemistry teachers and students at grade XI Senior High School so that videos can be used as the source of information based on the socio-scientific issue in order to support education for sustainable development of hydrocarbons and petroleum materials with usability and readability percentages respectively of 83.73% and 79.59%.

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INTRODUCTION

Chemistry has always been seen as a complex scientific discipline to comprehend. This is because the majority of chemistry deals with abstract concepts, including stoichiometry, redox, electrolyte and non-electrolyte solutions, hydrocarbon compounds, and atomic structure and periodic systems (Dwiningsih, et al., 2018; Zephrinus, et al., 2015; Zoller, 2012). Students' challenges in chemistry learning can also be attributed to a deficiency in the effectiveness of learning tactics designed to inspire and stimulate students' interest in the subject (Arham & Dwiningsih, 2016). Consequently, teachers need to engage chemistry classes with enthusiasm in order to cultivate a favorable perception and learning environment among students, thereby fostering enhanced academic achievements (Silaban, et al., 2020).

In order to enhance student learning results, chemistry instruction should entail not only memorization and conceptual comprehension but also practical application, implementation, and problem-solving with real-world scenarios. How curriculum and learning materials are utilized has an impact on the depiction and elucidation of chemistry-related phenomena in the real world, such as the properties of matter, the processes by which substances combine or separate, form, and interact with one another, and so forth (Gulacar, et al., 2020; Oladejo, 2020; Stuckey, et al., 2013). Students' foundational understanding and scientific knowledge enable them to discern inquiries, obtain

novel insights, and formulate conclusions regarding scientific matters. Additionally, they comprehend the attributes that distinguish science as a mode of inquiry and human knowledge and develop an awareness of how science and technology influence the material and intellectual milieu, as well as culture. Moreover, they cultivate a disposition to actively participate in scientific discourse and embrace scientific concepts as conscientious citizens (Gustita'iroh, et al., 2019). This objective can be achieved by incorporating socio-scientific concerns into the study of chemistry.

Socio-scientific issues correspond to scientific subjects, including chemistry, that require students to engage in intentional communication, debate, and discussion (Zeidler & Nichols, 2009). Motivating students to learn chemistry can be achieved by actively contributing their perspectives to conversations about contentious subjects, drawing from their personal experiences (Lin & Mintzes, 2010). One practical approach to generating interest in socio-scientific topics is to establish a connection between the topic and sustainable development. This is because scientific and social components are intricately intertwined with economic, social, and environmental dimensions (Tolppanen, 2015). As a result of the direct association between socio-scientific challenges and knowledge of Education for Sustainable Development (ESD), curriculum content must incorporate education for sustainable development (Kanapathy, et al., 2019; Osborne & Dillon, 2008).

To prepare future generations with the knowledge and skills necessary to be responsible members of society, chemistry education incorporating educational principles for sustainable development must emphasize ecology, economy, and society (Burmeister, et al., 2012; Haan, 2006). Chemistry materials are extensively covered in high school curricula, encompassing socio-scientific concerns such as petroleum and hydrocarbons (Rahayu, 2019). Although this subject matter is highly relevant to daily life—specifically, global climate change and plastic usage—it is frequently abstract and challenging for students to observe immediately. Global climate change threatens human survival as a sort of environmental harm that affects nearly every aspect of existence (Rizky, et al., 2022). The rise in the quantity of single-use plastic garbage due to the proliferation of internet-based meal delivery companies is an additional contentious matter (Tapilatu & Kolibongso, 2021; VOA Indonesia, 2020). Knowledge of the commonplace applications of fuel oil does not inherently imply comprehension of the intricacies of molecular structures, chemical bonds, and reactions that transpire within hydrocarbon molecules. Learning media may assist students in overcoming their inability to comprehend and comprehensively understand chemical substances.

Learning videos can be utilized to bundle socio-scientific issues associated with education for sustainable development in chemistry. One notable benefit of utilizing learning videos is their capacity for perpetual and recurrent viewing (Pölloth, et al., 2020). An additional benefit of incorporating video media into educational settings is its ability to depict intangible concepts, such as material about carbon's properties and reactions or the invisible form perceived through the five senses. This not only boosts student motivation but also instills positive values that stimulate contemplation and discourse among students in groups but also exposes events to heterogeneous or large, small, or individual audiences (Sukiman, 2012; Tsaparlis & Zoller, 2003).

Hence, teachers may employ an educational approach to sustainable development, incorporating socio-scientific themes into learning videos to enhance student's interest and motivation toward chemistry study and better equip them for forthcoming difficulties. To generate learning videos that address socio-scientific issues by employing an educational methodology centered on sustainable development, this research aimed to provide solutions to emerging problems

RESEARCH METHOD

The study employed an exploratory sequential design, utilizing the sequential exploratory mixed methods approach that Creswell and Plano Clark had devised (2018). The processes performed by the researchers are illustrated in Figure 1.

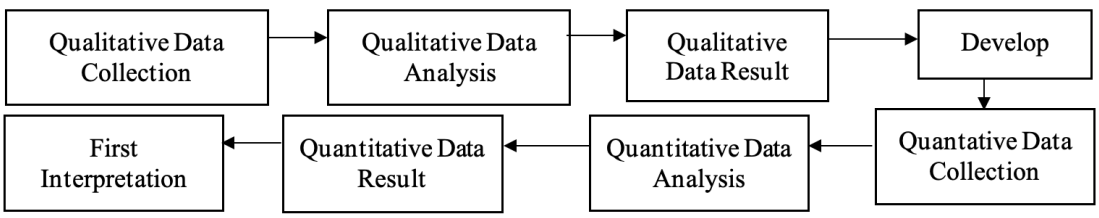

Figure 1. Sequential Exploratory Mixed Methods

First, Qualitative Data Collection included the needs analysis stage using the literature study method on sillaby, material coverage through the 2013 curriculum published by the Ministry of Education and Culture, and various references for developing learning videos. Another method used to conduct a needs analysis was to observe chemistry learning activities at school.

Second, Qualitative Data Analysis included activities to analyze data collected at the Qualitative Data Collection stage, obtained from the literature study and observation methods. The data analysis stages were carried out with the aim that the data obtained can draw conclusions regarding the problem and map the problem. Data analysis was carried out to obtain suitable problem-solving for related problems.

Third, Qualitative Data Result was a stage that presented the results of the analysis from the Qualitative Data Analysis stage. The result of the data analysis that had been carried out on problems during chemistry learning is that a learning video design based on socio-scientific issues was obtained in order to support education for sustainable development that will be created.

At the development stage, several steps must be carried out: looking for references related to material coverage, editing materials, creating designs and products, compiling instruments, carrying out feasibility, usability, and readability tests, and making product improvements according to test results. The instruments used were initial observation sheets, expert feasibility tests, teacher usability, and student readability responses.

Next, Quantitative Data Collection included collecting data from chemistry teachers' usability tests and students' readability tests. Students and teachers were asked to assess the development product using a rating scale at this stage.

The Quantitative Data Analysis included activities to analyze data collected at the Quantitative Data Collection stage, obtained from usability and readability tests. The data analysis stages were carried out with the aim that the data obtained could conclude from the test results so that improvements could be made to the development product.

The Quantitative Data Result was a stage that presented the analysis results from the Quantitative Data Analysis stage. The results of the data analysis that had been carried out on usability and readability test results are then used as a basis for improving product development so that learning videos based on socio-scientific issues are obtained in order to support education for sustainable development of hydrocarbon and petroleum materials for high school students grade XI.

Lastly, The First Interpretation stage was carried out by describing the final product of the learning video developed by the researcher. Two chemistry learning specialists, five chemistry teachers, and thirty-one students in high school students grade XI participated in the study by providing evaluations and feedback on the product. The gathered research data was qualitative in nature. Descriptive analysis approaches were employed to transform qualitative data into quantitative form through the utilization of descriptive statistics. The validation instruments completed by chemistry learning experts, chemistry teachers, and high school students grade XI is presented in Tables 1, 2, and 3.

Table 1. Learning Expert Validation Instrument

No.	Indicator	No. Items
1.	material	7
2.	appearance	5
3.	audio	5
4.	typography	4
5.	language	4
6.	programming	3

Table 2. Teachers' Usability Instrument

No.	Indicator	No. Item
1.	functions and benefits	3
2.	material	6
3.	appearance	2
4.	audio	3
5.	typography	2
6.	language	4
7.	programming	3

Table 3. Students' Readability Instrument

No.	Indicator	No. Item
1.	functions and benefits	2
2.	appearance	2
3.	audio	3
4.	typography	1
5.	language	2
6.	programming	1

The data in developing learning videos consisted of product improvement recommendations from learning experts, teachers, and students. It was included in product revisions following a descriptive analysis of the qualitative data.

After that, a quantitative descriptive analysis was conducted on the data obtained from the instructor usability and student readability questionnaires. This analysis aimed to ascertain the suitability of the learning videos and the students'

evaluations of the learning media. Data was obtained through a questionnaire with a Likert scale with 5 answer choices: Very Good (VG), Good (G), Moderate (M), Poor (P), and Very Poor (VP).

RESULT AND DISCUSSION

Literature Study Results

A literature study conducted on the 2013 curriculum found material coverage at basic competencies 3.1, 3.2, and 3.3 for hydrocarbon and petroleum materials. Socio-scientific issues that will be included in the material include the use of plastic, fossil fuels and electricity, as well as the use of biodiesel. These controversial issues are essential to discuss in chemistry learning because they have a solid connection to chemical material and will lead students to develop solutions for various aspects of life, including aspects of science, culture, morals, and other cases (Li & Guo, 2021).

Need Assessment Results

A needs assessment or preliminary needs analysis was performed at SMA Negeri 1 Bantul by distributing a needs analysis questionnaire to chemistry instructors and students in class XI. Based on the observations of three chemistry teachers and 62 high school students who had received material on petroleum and hydrocarbons, it can be concluded that the vast majority of students possess internet-connected smartphones and laptops that can be utilized and accessed throughout the learning process. Students may acquire the necessary knowledge through electronic devices during instruction and study (Ataş & Çelik, 2019). The majority of students experience joy and enthusiasm when studying chemistry.

Students sometimes encounter difficulties in memorizing details regarding the nomenclature, isomers, and chemical reactions that occur within hydrocarbon molecules in gas and petroleum courses. By employing apps and other pedagogical methods, teachers bypass this limitation and excite students' interest in chemistry. Beyond this, teachers and students must participate in dialogues concerning current issues and form associations with chemical substances because of the correlation between chemical substances and socio-scientific issues, such as the urgent issue of global warming. Considering students' deliberate sense of responsibility and interest in problem-solving, teachers should provide them with materials that can assist them in preventing, minimizing, and potentially resolving challenges. This aligns with the goal of chemistry education guided by the socio-scientific issues approach, which is to aid students in problem-solving and decision-making concerning everyday occurrences (Kinskey & Zeidler, 2021; Muhariyansah, et al., 2021; Saija, et al., 2022).

Learning Experts' Validity Results

Feasibility testing by learning experts was carried out to measure and assess the feasibility of learning videos both from the media aspect and the validity of the material and content of the learning videos being developed.

Overall, aspects of the material were declared suitable for use. Even so, it was necessary to add information and explanations to several concepts and examples of cases that have occurred. In terms of appearance, it was generally stated to be adequate with improvements such as adjusting the size of text and images, adjusting images to the material presented, and clarifying images. The audio aspect was declared adequate by learning experts, but improvements were still being made to pronunciation, volume, and sentences. The typography aspect was declared feasible with improvements in less than proportional writing size, and several words had to be replaced due to their inappropriate use, additional explanations of the chemical terms used were needed, and the writing of monomers needed to be more consistent. All input and suggestions from learning experts were analyzed and used as guidelines for product development improvements.

Usability Test Results

Usability tests were carried out by chemistry teachers on products that had been improved from the results of feasibility tests. Results were obtained based on usability tests by chemistry teachers, as in Figure 2.

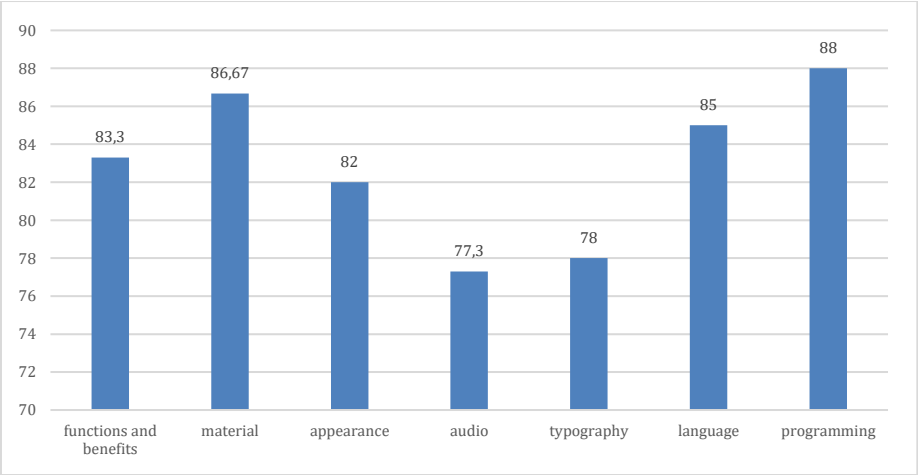

Figure 2. Usability Test Results

Qualitative data from comments and suggestions from chemistry teachers included that the voice should be improved with more interesting intonation so it does not feel like reading, and the background sound was louder than the reader's voice. The videos were very informative and in line with current problems. It would be more beneficial if a discussion space for students were created. A more narrow conclusion needed to be added (perhaps an opinion accompanied/supported by data from the manufacturer). In the first video, the polyethylene image size needed to be enlarged to make it more straightforward. In the second video, the background can be darkened to make the white writing more visible (for the beginning of the video). The third video is good. The recommendation was to pay more attention to the background images. It would be reasonable when talking about palm oil; the background also supports/images of palm oil.

Readability Test Results

After carrying out a usability test on chemistry teachers and the second stage of improvement, a readability test was conducted on 31 grade 11 students who had received material on hydrocarbons and petroleum. The data obtained is qualitative data converted into quantitative data for analysis and determining the product suitability category as a reference in improving the product at the final stage.

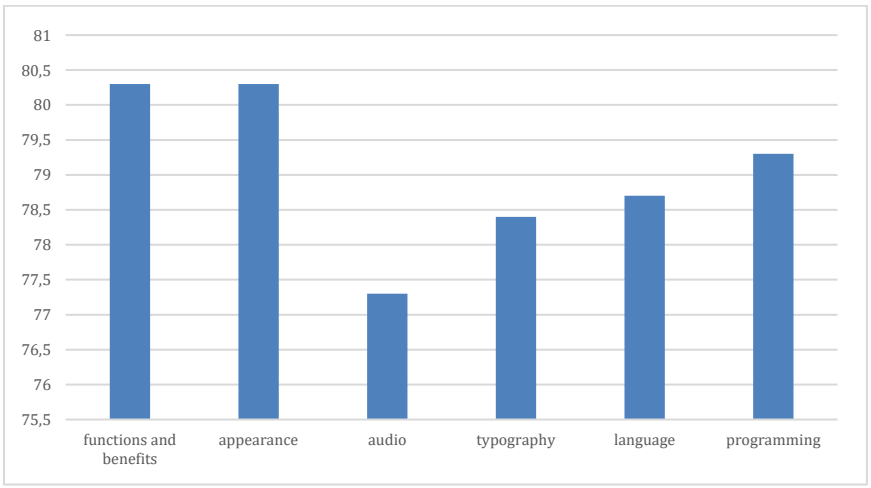

Figure 3. Readability Test Results

Some of the comments and suggestions given by class XI students stated that the learning videos were good. Videos really helped students understand better. It would be best to publish the video on various media such as Tiktok, Instagram, Facebook, and other social media. Overall, the videos were excellent in sound, animation, and accessibility. The videos were also easy to learn and understand. The video duration did not need to be too long because the average person nowadays gets

bored quickly when learning, especially just by watching videos on YouTube. Some parts needed improvements in intonation to emphasize the words needed to make the video more interesting. Apart from that, the video backgrounds needed to be brighter. The animations given were appropriate and quite interactive.

Certain remarks and recommendations put forth by students in class XI indicated that the learning videos were satisfactory. Videos significantly improved students' comprehension. It would be optimal to distribute the video over multiple social media platforms, including Tiktok, Instagram, and Facebook. The videos were outstanding in audio quality, visual appeal, and usability. Additionally, the videos were simple to learn and comprehend. The videos could be brief, given that the ordinary individual soon becomes bored if studying over time, particularly by viewing YouTube videos. Specific segments need intonation adjustments to emphasize the words necessary to make the videos more engaging. Aside from that, better brightness was required for the video backgrounds. The provided animations were suitable and highly interactive.

Integration of Socio-Scientific Issues and Education for Sustainable Development in Hydrocarbon and Petroleum Learning Videos

Integrating environmental issues into the learning process can be done by implementing socio-scientific issue-based learning through an educational approach for sustainable development. Hydrocarbon and petroleum materials were chosen because hydrocarbon compounds are abstract but often found in everyday life, for example, in petrol, plastic, charcoal, and gas (Kristin, et al., 2019). It is not unusual for commonplace hydrocarbon molecules to have adverse effects, particularly on health and the environment (Setiyana, 2020). The status of an environment is determined and influenced by the interplay between human activities and the environment; therefore, it is crucial to create an environmental consciousness in students from a young age through the integration of environmental issues into the curriculum (Afandi, 2013; Iswari, 2017; Setyobudi & Saliman, 2018).

The 2013 Curriculum delineates the role of education in promoting sustainable development by including core principles, issues, skills, perspectives, and attitudes about environmental, social, and economic dimensions of sustainable development (Hayudinna, 2018). Education oriented towards sustainable development requires a change in mindset by considering environmental conditions both now and in the future. By enhancing individuals' knowledge, skills, values, and consciousness regarding the significance of protecting and caring for the environment, educational goals that are aligned with sustainable development encompass fostering their capacity to implement actions that promote sustainable development, greening the economy, nature conservation, and the establishment of a just and equitable society (Nasibulina, 2015).

The effectiveness of socio-scientific issue-based learning videos in promoting sustainable development education among high school students grade XI regarding petroleum and hydrocarbons materials can serve as an indicator of whether the objective of integrating socio-scientific issues into an educational approach for sustainable development has been met. Achievements in motivating students may motivate them to create alternative solutions and cooperate as a conscientious society in order to resolve mundane challenges as a responsible society without sacrificing the abilities of the next generation. The sustainable development strategy utilizes natural resources and human resources, simultaneous and balanced the technology development and institutional transformation, and investment potential, as well as paying attention to current potential and future availability to fulfill the needs and interests of society (Fitriandari & Winata, 2021).

Development Product Characteristics

This research had resulted in the development learning videos that address socio-scientific issues. These videos aimed to assist high school students in pursuing sustainable development knowledge regarding hydrocarbon and petroleum materials. The prepared learning videos addressed three contentious points—concerns regarding the use of plastic, fossil fuel and electric vehicles, and biodiesel fuel.

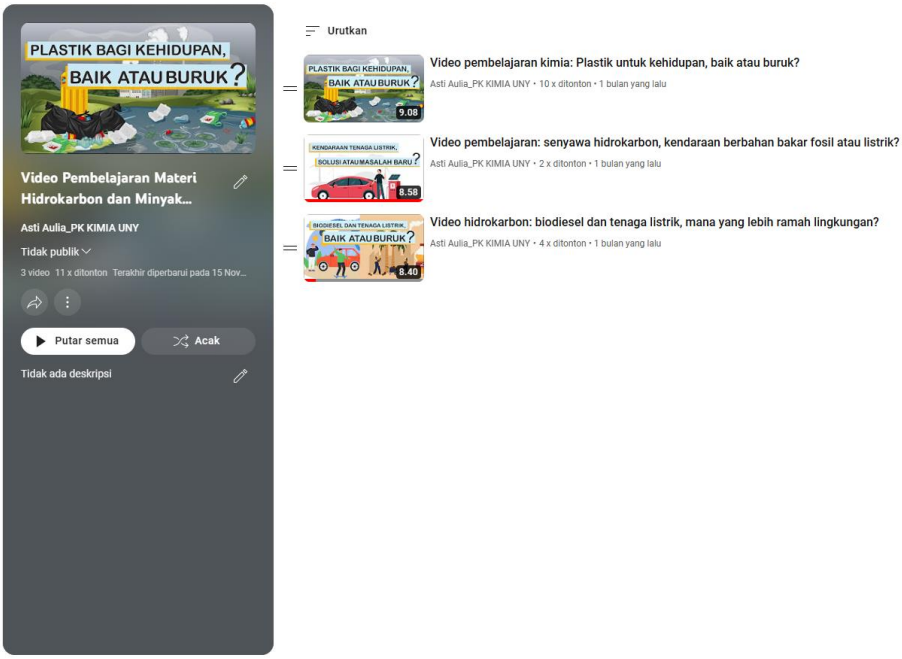

Figure 4. Youtube video list

The first characteristic discussed the scope of hydrocarbon and petroleum materials. The material presented in the learning video is guided by Minister of Education and Culture Regulation No. 37 of 2018 for basic competencies 3.1, 3.2, and 3.3.

The second characteristic showed the connection between socio-scientific issues, education for sustainable development, and the primary chemistry material discussed. High school chemistry material related to socio-scientific issues includes basic competencies 3.2 and 3.3 regarding petroleum discussion processes and chemical reactions. The dimensions related to this material are technological, environmental, social, and economic dimensions (Dishadewi, et al., 2020). These four dimensions are related to the goals achieved by education for sustainable development, including the economic, educational, sanitation, energy, industrial, innovation, infrastructure, environmental, and health aspects (World Health Organization, 2015).

The third characteristic discussed the platform used to access learning videos. The use of the YouTube platform as a medium for disseminating the learning videos developed is due to the function of social media, namely, to help individuals obtain and convey information. Using social media as teaching materials positively impacts the teaching and learning process both inside and outside the classroom. The use of social media cannot be separated from the daily lives of teenagers and can be an open medium for increasing students' interest in learning (Kamhar & Lestari, 2019).

Feasiblity Analysis

Product improvements were made based on suggestions and input provided by learning experts. These improvements involve clarifying scientific explanations of the issues raised, clarifying the learning objectives to be achieved, correcting writing and conceptual errors, and adjusting the size of text, images, hydrocarbon structures, and language use.

Usability and Readability Tests Analysis

Usability tests were carried out by chemistry teachers on products that had been improved from the results of feasibility tests. Seven aspects were tested, namely aspects of function and benefits, material, appearance, audio, typography, language, and programming. Each aspect tested and obtained results in qualitative data is converted into quantitative with descriptive statistics and then analyzed. Based on calculations and analysis of the usability test results carried out by the chemistry teacher, the ideal percentage of the product was obtained as in Figure 2.

The average ideal percentage of the product usability test was 82.9% and received a feasible category. The average ideal percentage is obtained by calculating the sum of the ideal percentages of seven aspects divided by seven (the number of aspects tested). The product feasibility percentage table can be seen in Table 4.

Table 4. Feasibility Score Range

Score Range	Category
76% - 100%	Highly Feasible
56% - 75%	Feasible
41% - 55%	Decent Enough
0% - 40%	Not enough

Qualitative data in the form of comments and suggestions from chemistry teachers was then used as a reference for improving the second stage.

Suggestions related to image backgrounds, including choosing colors and replacing them with palm oil images, should have been followed up, because the background chosen was aimed at giving students the impression that they were in the classroom. A dark green background was also chosen to match the colors of school classrooms, which are usually relatively light colors such as grey, light green, light blue, cream, and others. This aimed to ensure that when the video is played at the front of the class, the dark green color will be the center of students' focus and avoid mixing the color with the writing so that the writing can still be read by students even at the back of the class. Images of palm oil have been provided in the video content. Further recommendation was to incorporate a concluding statement towards the end of the videos. It was arguable because students are expected to be able to conduct discussions and express personal opinions without being limited in their thinking space.

A readability test was carried out after conducting a usability test on chemistry teachers and the second stage of improvement. The data obtained is qualitative data converted into quantitative data for analysis and determining the product suitability category as a reference in improving the product at the final stage. The ideal percentage for the student readability test can be seen in Figure 3.

The recommendations and comments of the students were subsequently utilized as a benchmark for enhancements in the third phase. Suggestions for publishing videos on other applications such as TikTok, Instagram, and Facebook should have been followed up. Suggestions related to shortening the video duration were not followed up because if they were compressed again, the information and material provided would not be optimal. If the explanatory voice is accelerated, it is feared that students will be unable to capture the information provided. The presentation of the material could have been more varied, and the intonation at several turns was improved.

The lowest percentage of ideality for usability and readability tests was in the audio aspect, with a percentage of 77.9%. Even though it had the lowest percentage of ideality, the audio aspect can still be categorized as feasible. The lowest assessment indicator is the background sound quality and voice-over. This was possible because the results of the voice-over recording were less than optimal, so further improvements were needed regarding the voice-over. Good audio quality is essential so students can hear the material delivered well and clearly (Taib & Mahmud, 2021).

Overall, the usability test results showed a feasible category for use. This showed that learning videos can be categorized as learning videos that can increase user motivation and effectiveness based on several characteristics. The characteristics of learning videos include being able to provide message clarity, being easy to use, being able to represent content, being able to be used classically and individually, using high-resolution quality, and being able to provide visualization with media such as text, animation, sound and video (Riyana, 2007). Using appropriate symbols and images was expected to increase student retention by focusing on students' ability to understand learning videos that rely on visual and auditory learning style tendencies (Robertson & Flowers, 2020)

The results of the readability test indicated that the function and benefit aspects and the appearance, each with an optimum percentage of 80.3%, were classified as highly feasible. In contrast, the rest aspects received the feasible category. The average percentage of ideality for the aspects tested was 79.05% and was included in the feasible category. This shows that the learning videos developed can arouse students' interest and motivation, make it easier for students to understand, attract their attention to learning about hydrocarbons and petroleum, and inspire them to care more about the environment, in line with research that states that learning videos can be exciting and increase students' motivation in learning chemistry. Increasing student interest can provide a sense of enjoyment so that it can influence student learning activities (Junaidi & Anwar, 2022). Learning media supports learning effectiveness so that learning objectives will be achieved (Pradilasari, et al., 2020).

CONCLUSION

Based on the conducted research, the socio-scientific issues-based learning videos intended to assist in the education of high school students grade XI regarding sustainable development in hydrocarbon and petroleum materials comprise three videos. These videos addressed three contentious issues brought by Minister of Education and Culture Regulation No. 37 of 2018 for basic competencies 3.1, 3.2, and 3.3. The created instructional videos are accessible online through the YouTube platform or via USB/Bluetooth file transfer. Usability and readability tests were performed to determine the feasibility of the generated learning videos; the resulting percentages for usability and readability were 83.73% and 79.59%, respectively.

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