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Physics Learning Media Based on Social Media: STEM-Based Videos on Renewable Energy through TikTok Application

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Abstract – *The integration of digital technology into senior high school physics teaching is becoming more urgent to support students' engagement and understanding of abstract concepts, especially in time-limited classroom settings. TikTok, as a short-form video platform with strong visual and audiovisual features, offers potential to deliver brief, interactive learning content aligned with students' digital habits. This study aimed to create STEM-based learning videos on renewable energy topics through TikTok and to evaluate their feasibility and appeal as teaching tools. The study used a Research and Development (R&D) approach, employing the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation), and was conducted at SMA Islam Elsyihab Bandar Lampung. Product feasibility was assessed by four validators two media experts and two content experts while user responses were gathered from a physics teacher and 37 students via questionnaires. The results show that the videos are highly feasible: media expert validation averaged 90%, and content expert validation averaged 84%, both classified as very feasible. User evaluations also demonstrated strong acceptance; the teacher rated the videos as 96% (very interesting), and student responses averaged 92% (very interesting), indicating high perceived attractiveness and educational support. The novelty of this study lies in combining a STEM instructional design with TikTok short videos on renewable energy physics, supported by a systematic ADDIE development process and tested by multiple stakeholders for feasibility and appeal. In conclusion, STEM-focused TikTok learning videos are feasible, engaging, and accessible digital resources that can supplement traditional instruction and promote student-centered learning in senior high school physics. This study advances physics education by offering a validated model for utilizing popular social media platforms to deliver structured STEM content and boost engagement through technology-rich learning environments.*

Keywords: *ADDIE model; digital learning; STEM education; renewable energy; TikTok education*

I. INTRODUCTION

In the 21st century, rapid advances in science and technology require human resources to adapt to increasingly dynamic social and professional demands. Improving the quality of human resources, therefore, depends on adequate facilities and infrastructure, particularly in education and educational technology (Agustina & Syarlisjiswan, 2023). Technology has become deeply embedded in everyday life and has enabled many activities to be performed more efficiently (Shanmugasundaram & Tamilarasu, 2023). In learning contexts, technology can empower students to develop innovation and creativity by providing tools to address authentic problems and improve performance across domains (Yuberti et al., 2023). Broadly, technology includes the methods, procedures, and processes used to apply scientific knowledge to meet human needs and improve the quality of life. Consequently, efforts to enhance educational quality increasingly emphasize the adoption of innovative learning methods that can be adjusted to the characteristics and conditions of each school (Smale-Jacobse et al., 2019). Schools and educators are expected to provide learning experiences that support students' development of concepts, principles, initiative, emotions, generalization abilities, and practical skills. To achieve these outcomes across cognitive, affective, and psychomotor domains, educators need learning media that are engaging and pedagogically appropriate (Suprapto et al., 2020).

Learning videos represent one form of instructional media that can strengthen students' attention, conceptual understanding, and skills during learning activities. Preliminary observations at SMA Islam Elsyihab Bandar Lampung indicated that the learning media used in physics classes were less engaging, and the integration of technology, particularly for renewable energy topics, had not been optimal. To address this gap, the present study develops STEM-based learning videos delivered via the TikTok application as an alternative learning medium. Implementation results indicate a substantial improvement in student engagement, increasing from 51% before the use of TikTok-based videos to 89% afterward. These findings suggest that TikTok-based learning videos can enhance students' attention and support skill development in physics.

The effectiveness of learning can be improved through well-designed learning media, as media selection influences students' understanding of the subject matter (Brame, 2016). Accordingly, learning media should be aligned with classroom conditions and instructional strategies implemented by educators (Lee & Kim, 2017). The integration of technology-based instructional media is also considered to improve the overall quality of the learning process (Handayani et al., 2021). Video is particularly relevant as an additional learning resource beyond student and teacher textbooks and can be engaging and effective within the Merdeka Curriculum context (Lin & Yu., 2024). Learning videos are recordings designed to convey instructional content and facilitate the achievement of learning objectives (Mayer, 2020). Moreover, because videos can present information in a structured manner, they may support students' comprehension of complex concepts. Learning videos can be distributed across multiple social media platforms, including Facebook, YouTube, Instagram, and TikTok (Bhaw et al., 2024).

One widely used technology, especially attractive to younger learners, is the TikTok social media application. With its visual and audiovisual features, TikTok serves not only as an entertainment platform but also as an interactive, easily accessible medium for learning. TikTok can support learning activities by leveraging contemporary technological trends and delivering content in engaging short-video formats (Abualrob, 2025). TikTok is a social networking and short-video platform originating from China and launched in 2016. Its growth has been rapid and, in some contexts, has exceeded the popularity of other platforms such as Instagram and WhatsApp. In Indonesia, TikTok has millions of active users, most of whom are school-aged learners from millennial and Generation Z groups (Kaye et al., 2021). The TikTok application enables users to access short-form videos on mobile devices anytime, making it a feasible learning medium (Conde-Caballero et al., 2024). In physics instruction, the use of innovative approaches is essential to improve learning quality; one promising approach is STEM-based learning (Ulu & Yerdelen-Damar, 2024). Therefore, examining TikTok user trends is relevant to justify the platform's potential as a learning channel.

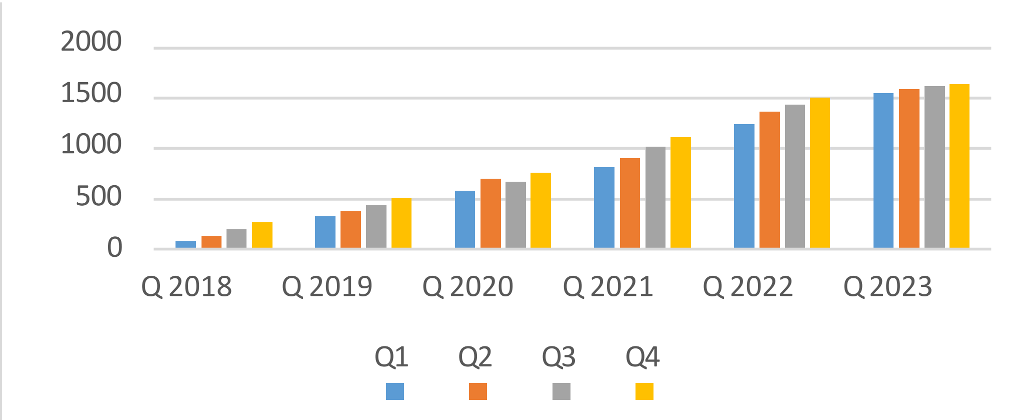

Figure 1. Global TikTok users 2018-2023

Figure 1 presents TikTok user growth from 2018 to 2023 based on quarterly data (Q1–Q4). The trend shows a consistent increase within each year and across years, indicating sustained platform expansion without a notable quarterly decline. This pattern underscores TikTok's strengthening position as a dominant digital platform among younger users and highlights its potential to deliver short, visual, and interactive STEM-based learning content aligned with students' digital habits. In a STEM learning context, TikTok videos can facilitate contextual and problem-based learning by enabling students to observe scientific phenomena, technological applications, simple engineering designs, and mathematical reasoning linked to everyday experiences. Moreover, TikTok integration may contribute to the development of 21st-century skills, including creativity through content production, critical thinking through problem analysis, collaboration via group digital projects, and communication through concise idea delivery.

The STEM approach integrates science, technology, engineering, and mathematics within instruction and emphasizes the development of 21st-century competencies, particularly the 4C skills: creativity, critical thinking, collaboration, and communication. Through STEM, students are encouraged to design innovative solutions to real-world problems and communicate ideas effectively and systematically (Hochberg et al., 2018). STEM learning also helps students connect classroom concepts to phenomena in their daily lives (Roehrig et al., 2021) and is believed to promote deeper thinking skills, enabling students to identify opportunities based on information gained through meaningful learning activities (Stehle & Peters-Burton, 2019).

Classroom observations further indicated that some students experienced difficulties in learning, particularly in the renewable energy content in physics. Renewable energy is important to younger generations because climate change and energy crises increasingly require innovative solutions (Resminingpuri et al., 2023). Renewable energy refers to energy derived from natural resources that can be replenished naturally within a relatively short period, such that availability does not diminish due to use (Samsudin et al., 2023). For these reasons, developing learning resources that improve students' conceptual understanding of renewable energy is essential.

The development of STEM-oriented instructional videos delivered through the TikTok application, therefore, represents a promising alternative learning medium, especially for renewable energy topics. Short-duration videos combined with dynamic visual presentation are expected to support students' understanding by presenting concepts concisely and engagingly. In addition, TikTok's wide reach and interactive affordances may encourage active student participation and make learning more enjoyable. Previous studies have reported that learning media can support instructional processes and improve student achievement, and that such media may be appropriate for independent learning. Building on this evidence, the present study focuses on developing TikTok-based learning videos specifically tailored to renewable energy materials. The product is expected to serve as an innovative model for technology-integrated science instruction and to enrich students' learning experiences in the digital era.

II. METHODS

This study employed a Research and Development (R&D) approach, which aims to develop educational products and systematically evaluate their feasibility and effectiveness (Jacobsen & McKenney, 2023). The study was conducted at SMA Islam Elsyihab Bandar Lampung. Participants in the validation stage included two media experts and two material experts, who served as validators. After the product was declared valid, field trials were conducted to obtain responses from one educator and 37 students toward the STEM-based learning videos developed using the TikTok application. The development procedure followed the ADDIE instructional design model, which includes five stages: Analysis, Design, Development, Implementation, and Evaluation (Sablić et al., 2021). The overall research steps are presented in Figure 1.

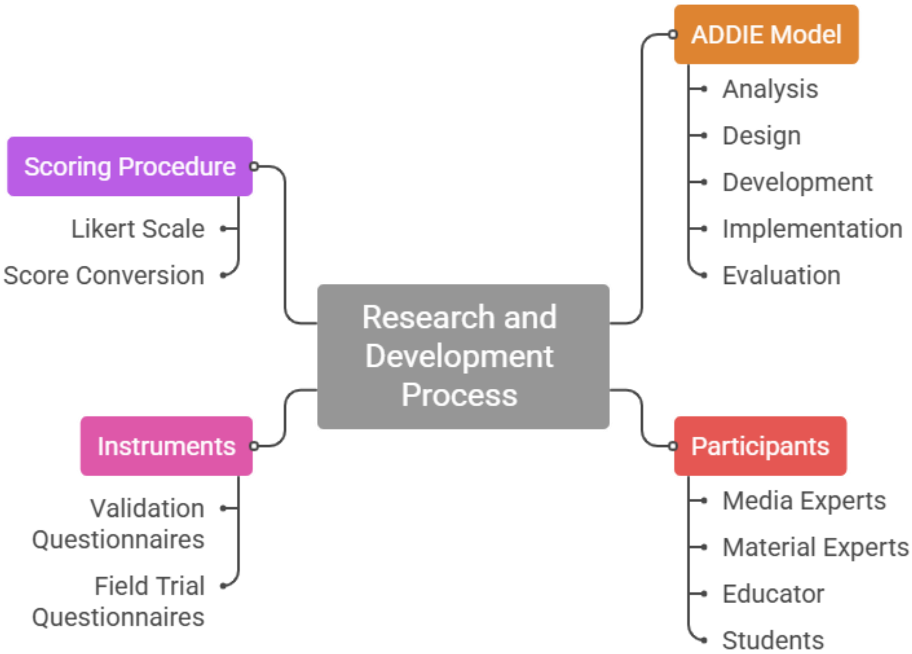

Figure 2. Research steps using the ADDIE model

Data were collected using questionnaires administered to material experts and media experts to obtain validation results. Additional questionnaires were distributed to educators and students during field trials to assess their responses to the developed videos. A five-point Likert scale was used in both the media expert and material expert validation instruments to assess product feasibility. For the media expert instrument, the assessed aspects included: (1) content quality, (2) creativity, (3) visual and audio quality, (4) delivery technique, and (5) TikTok video duration. For the material expert instrument, the assessed aspects comprised: (1) material completeness, (2) material up-to-dateness, (3) feasibility of presenting the material through

TikTok videos, (4) alignment with the curriculum, and (5) relevance of the content to STEM. After validation by media and material experts, field trials were conducted. The educator and student response questionnaires evaluated: (1) clarity of the material, (2) presentation, (3) language, (4) appearance, and (5) relevance of the video to STEM.

All questionnaire responses were converted into scores on a 1–5 scale, as shown in Table 1 (Baran et al., 2020).

Table 1. Product feasibility assessment scale

Criteria	Score
Very Worth It	5
Worthy	4
Quite Decent	3
Not feasible	2
Totally Unworthy	1

The validation and response data were analyzed using an average (mean) technique. Feasibility and response results were then converted into percentages using the following formula:

$$P = \frac{\sum x}{\sum x_i} \times 100\% \qquad 1)$$

where:

P= percentage score.

$\sum x$= total score given by validators/respondents.

$\sum x_i$= maximum possible total score.

100% = constant.

The feasibility criteria for media experts and material experts are presented in Table 2 (Yusoff, 2019).

Table 2. Eligibility criteria for media and material expert validation

Percentage	Criteria	Information
80%<×≤100%	Very worth it	Can be used without revision
60%<×≤80%	Worthy	Can be used with minor revisions
40%<×≤60%	Quite decent	Can be used with multiple revisions
20%<×≤40%	Not feasible	It is recommended not to use
0%<×≤20%	Totally unworthy	Not yet usable

After validation by media and material experts, field trials were conducted to determine educator and student responses to the developed product (Boateng et al., 2016). The response interpretation criteria are shown in Table 3.

Table 3. Educator and student response criteria

Percentage	Criteria	Information
80%<×≤100%	Very interesting	Can be used without revision
60%<×≤80%	Interesting	Can be used with minor revisions
40%<×≤60%	Quite interesting	Can be used with multiple revisions
20%<×≤40%	Not attractive	It is recommended not to use
0%<×≤20%	Very uninteresting	Not yet usable

III. RESULTS

This study produced STEM-based learning videos on renewable energy delivered through the TikTok application. TikTok was selected because it is widely used by students, supports short and engaging video formats, and can be accessed anytime and anywhere, thereby extending learning beyond classroom time. In addition, TikTok-based learning videos can serve as an alternative when instructional time is limited, as students can repeatedly access the content to meet their learning needs throughout the teaching–learning process.

1. Analysis stage

The analysis stage aimed to identify learning problems and determine the requirements for developing an appropriate solution. At this initial stage, observations were conducted at the school by distributing questionnaires. The purpose was to capture obstacles encountered in physics learning, particularly renewable energy topics, and to identify feasible solutions. Based on the problem and needs analysis at SMA Islam El Syihab Bandar Lampung, several issues were identified: (1) limited learning media and learning resources, (2) learning infrastructure that had not been optimally utilized, and (3) existing learning media that did not sufficiently support the learning process. In addition, students' use of digital applications such as TikTok tended to be unstructured, which contributed to an imbalance between time spent on non-educational entertainment and time devoted to improving knowledge and creativity. These findings indicate the need for structured, educational digital media that aligns with students' digital habits while supporting physics learning objectives.

2. Design stage

The design stage involved planning and structuring the product by developing an effective learning concept to support the instructional process (Hapsari et al., 2019). This stage included preparing video scripts, designing animations, and editing the videos using Canva and CapCut. The design output was required to be clear, detailed, and aligned with the planned learning elements to ensure the videos supported the intended instructional goals.

In this study, TikTok learning videos were designed in Canva for animated visual elements, then edited in CapCut for voice-over integration, background sound arrangement, and subtitle insertion. Canva is a web-based graphic design tool widely used for its accessibility and feature-richness (Syarlisjiswan et al., 2024). CapCut was used as the primary editing tool because it offers comprehensive features and is relatively easy to use, making it a popular choice among users (Wulan et al., 2024). After editing, the videos were uploaded to TikTok, accompanied by a description to contextualize the learning content.

The main procedures for video creation and editing were as follows:

a. Creating Canva, CapCut, and TikTok accounts

Accounts was carried out by registering with an email address or phone number and setting a password, after which users completed basic profile setup, verified the email/number when required, adjusted initial privacy and security settings, and finally accessed each platform either through the newly created credentials or by using linked accounts such as email or Facebook for faster login and synchronization across services.

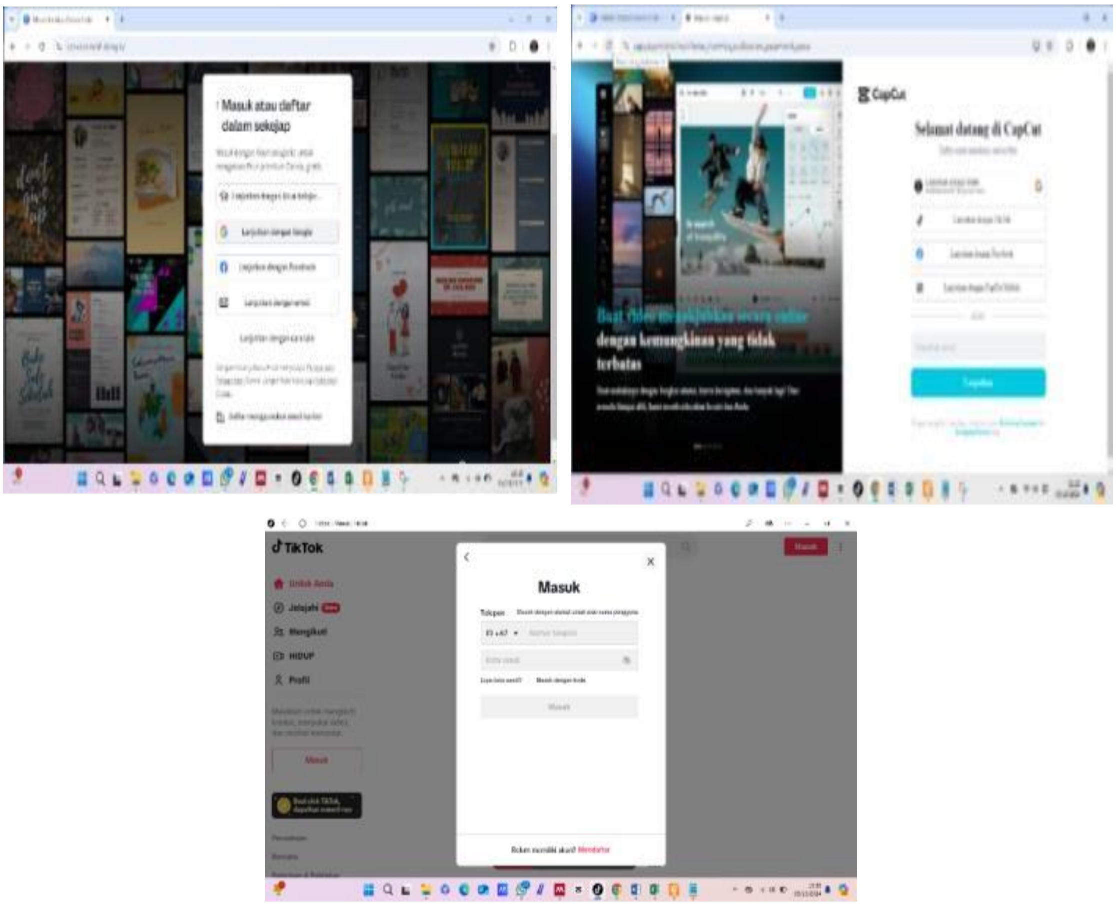

Figure 3. Initial view of Canva, CapCut, and TikTok application

b. Accessing the Canva homepage and developing animated elements

Accessing the Canva homepage and developing animated elements began with logging into Canva until the homepage interface loaded completely, selecting the Design feature to open a new workspace, choosing an appropriate template or custom canvas size aligned with the learning objectives, creating and arranging animated visual elements (icons, illustrations, text, and transitions) to support concept explanation, enhance attractiveness, and reduce student boredom, refining timing and motion effects to ensure clarity and smooth narration flow, and finally exporting the finished designs by downloading them from Canva in the required format for subsequent editing and integration into the short learning videos.

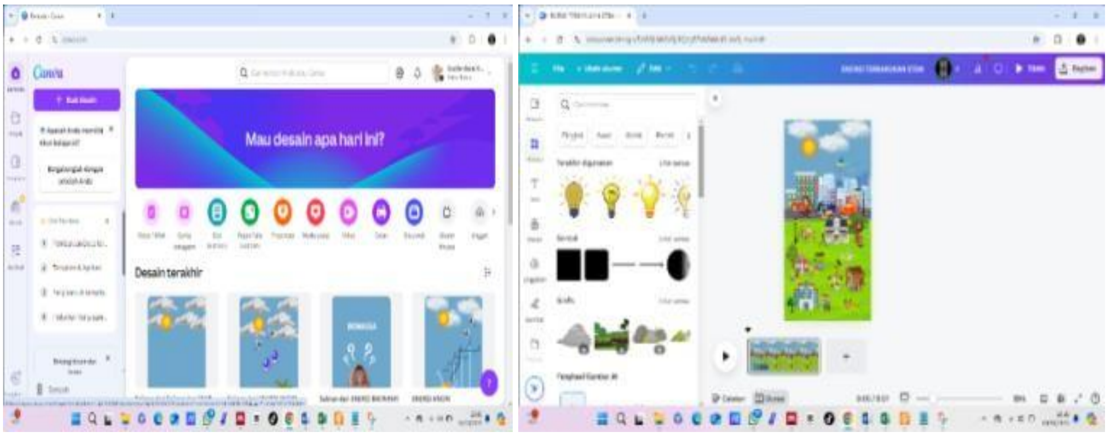

Figure 4. Initial view of Canva and element creation

3. Editing the video using CapCut

Editing the video with CapCut involved logging in and selecting the "Create a video" menu to open the editing workspace. I imported the animated elements previously designed in Canva and organized them on the timeline according to the theme and sequence of the learning material. I adjusted clip durations, positioning, and transitions to ensure visual coherence and pacing. I added text overlays or captions where necessary to emphasize key concepts, included audio components such as recorded narration and background sounds, and balanced volume levels to ensure narration clarity. Finally, I reviewed the entire draft to refine the synchronization between visuals and audio before saving the project for the next stage production.

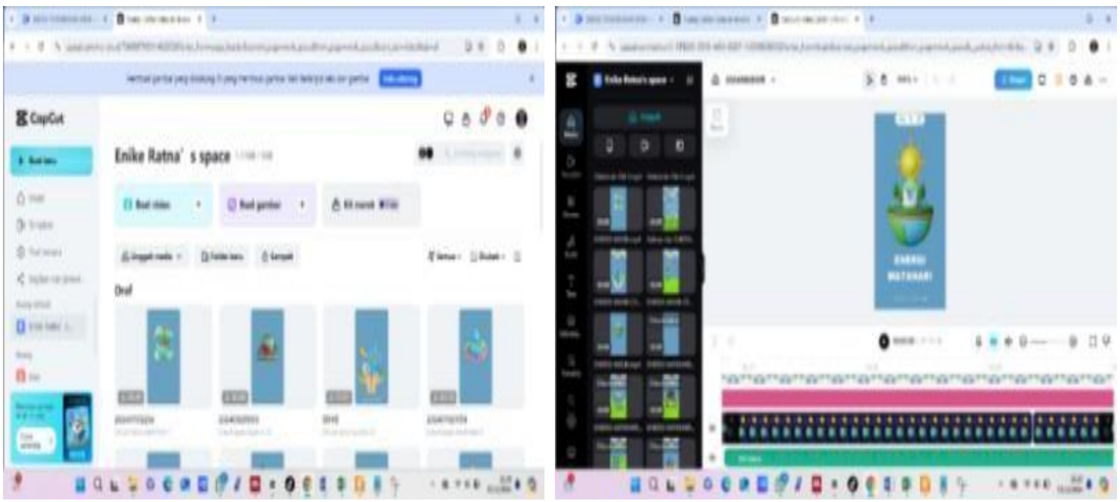

Figure 5. Editing workspace

d. Finalizing subtitles and exporting using CapCut Pro

Finalizing subtitles and exporting using CapCut Pro was done after completing the main editing by opening the project in CapCut Pro, adding accurate and well-timed subtitles to enhance message clarity and accessibility for diverse learners, adjusting subtitle font size, placement, and synchronization to match narration and on-screen visuals, reviewing the entire video to ensure consistent pacing, readability, and alignment between audio and text, applying final enhancements as needed (such as minor trimming, smooth transitions, and audio balancing), and exporting the video in the required resolution and format so it was ready for distribution on the intended platform.

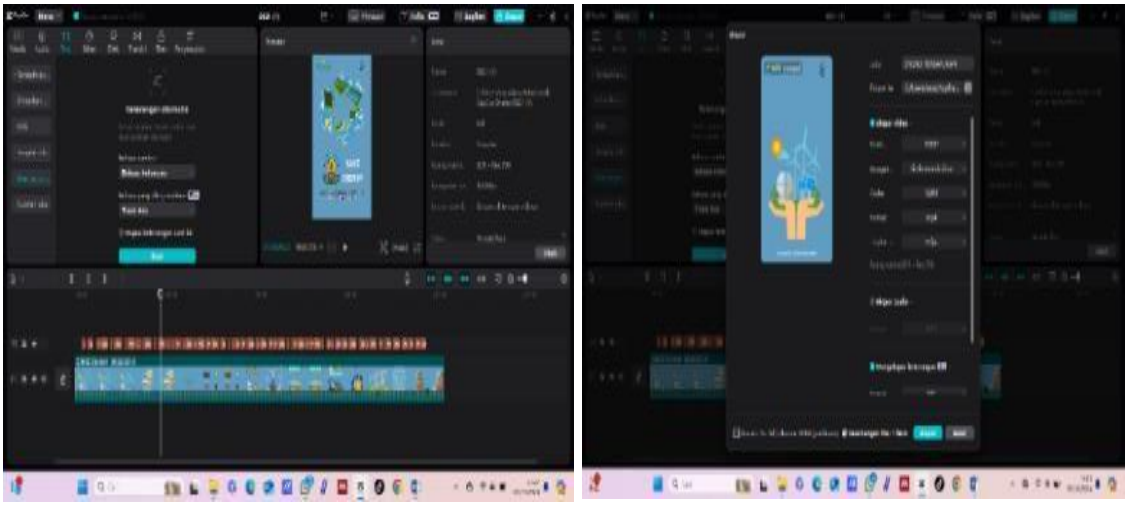

Figure 6. CapCut pro editing workspace

e. Uploading the video to TikTok

Uploading the video to TikTok involved logging into the TikTok account and opening the Upload feature from the main page, selecting the exported video file from device storage, and confirming it in the upload interface. Then, a clear title or caption aligned with the learning objectives was added, along with relevant keywords or hashtags to improve discoverability. The preview was reviewed to ensure audio, subtitles, and visuals displayed correctly. The appropriate visibility and interaction options (such as audience, comments, and sharing) were set according to classroom needs. Finally, the post was published so the learning video became accessible directly through the TikTok application for students to view anytime.

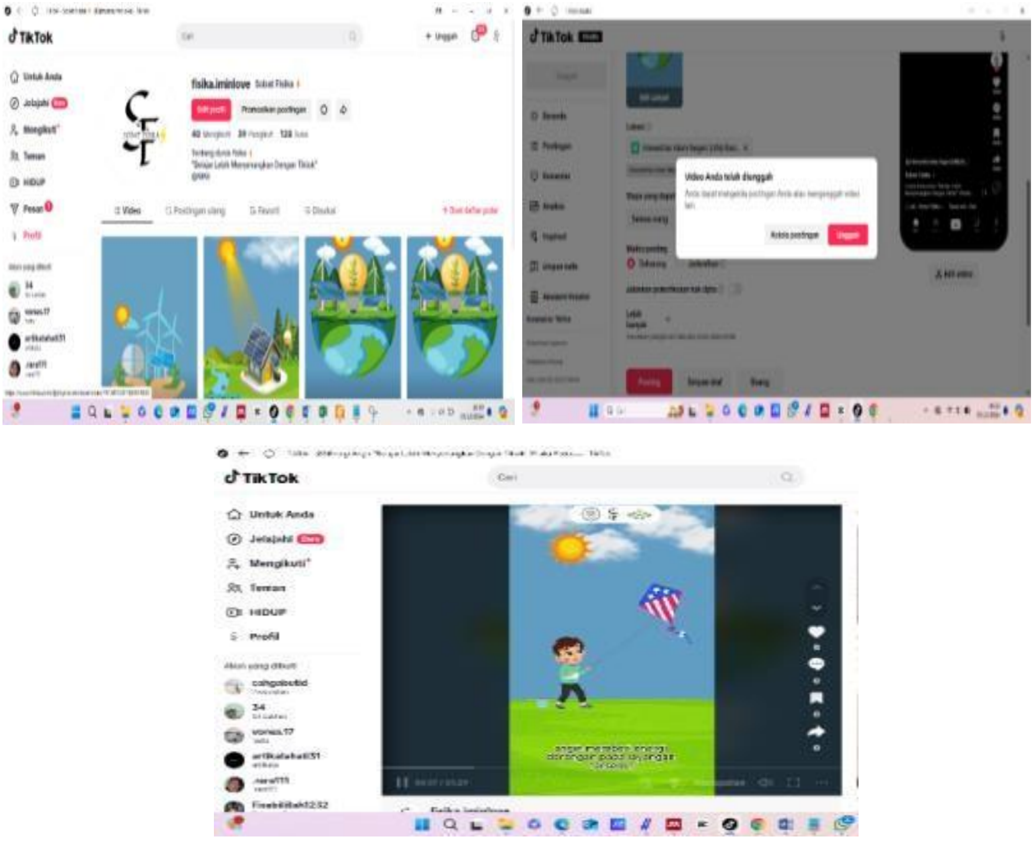

Figure 7. Upload a view in the TikTok application

3. Development stage

The development stage focused on producing the designed product into a tangible instructional medium (Yuberti et al., 2022). At this stage, the videos were created according to the predetermined concept and storyboard (Yuberti et al., 2021). Product development emphasized integrating STEM-oriented renewable energy content with attractive visuals, coherent narration, and concise sequencing, all suitable for TikTok's short-video format.

CapCut was used extensively at this stage to assemble visual assets, synchronize narration, manage transitions, add background audio, and produce a final video. CapCut is developed by ByteDance Ltd., which is also associated with TikTok, and it has become popular, particularly among Generation Z, due to its accessibility and ease of use (Farrokhnia, 2021). CapCut is also widely recognized for providing advanced editing features that can support the production of educational videos. Because TikTok provides an interface that enables users to easily create, edit, and share short-form audiovisual content, educational videos can be uploaded efficiently and accessed by students through the application (Bhandari & Bimo, 2022).

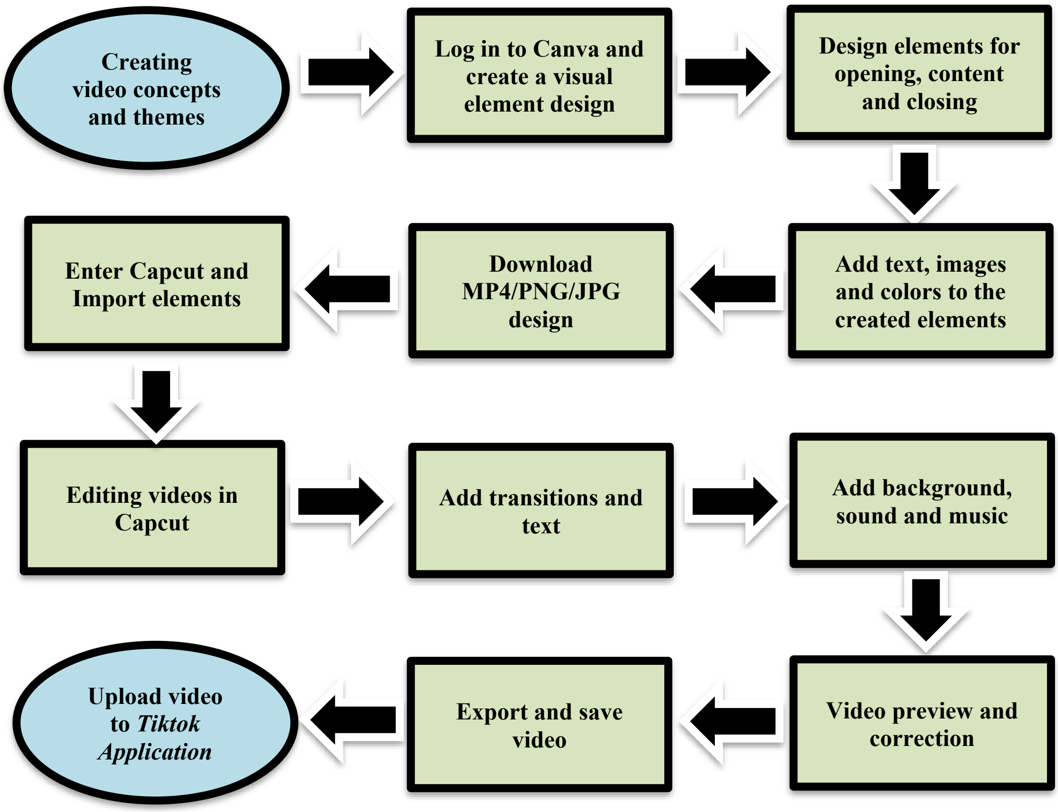

Figure 8. Media development flowchart

Media expert validation results are presented in Table 4. The assessment covered five aspects: content quality, creativity, visual and audio quality, delivery techniques, and TikTok video duration.

Table 4. Media expert assessment

Aspect	Percentage	Criteria
Content quality	89%	Very Worth It
Creativity	100%	Very Worth It
Visual and audio quality	90%	Very Worth It
Delivery techniques	87%	Very Worth It
TikTok video duration	100%	Very Worth It

As shown in Table 4, the media expert validation produced high scores across all aspects, ranging from 87% to 100%. The overall average score was 93%, placing the product in the Very Worth It category. These results indicate that the learning videos are highly feasible for use. A visual summary of the media expert validation is provided in Figure 9.

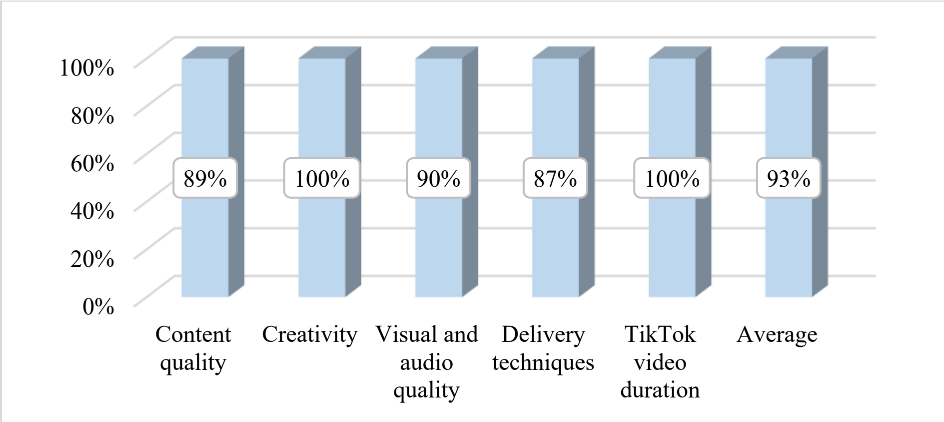

Figure 9. Media expert assessment

Although the product was rated as highly feasible, media experts offered several revision suggestions to enhance quality and consistency, including: adding a physics logo to the TikTok video, improving layout quality and consistency, adjusting narration and background music to prevent overlap, and adding subtitles to improve clarity and accessibility. Material expert validation results are shown in Table 5. Five aspects were evaluated: completeness of materials, currency of materials, suitability of material presentation in TikTok videos, alignment with the curriculum, and STEM relevance.

Table 5. Material expert assessment

Aspect	Percentage	Criteria
Completeness of materials in TikTok videos (MC)	89%	Very worth it
Updates on the material in the TikTok video (MU)	83%	Very worth it
Suitability of presentation of material in TikTok videos (PS)	87%	Very worth it
Alignment of material with curriculum (CA)	80%	Very worth it
STEM video relevance (SR)	80%	Very worth it
Average	**84%**	**Very worth it**

Table 5 shows that all assessed aspects achieved scores between 80% and 89%. The overall average was 84%, indicating that the learning videos are Very Worth It and feasible for implementation. The material feasibility assessment was conducted by two lecturer validators, and the results confirm that the content is appropriate for use. The material expert validation diagram is shown in Figure 10.

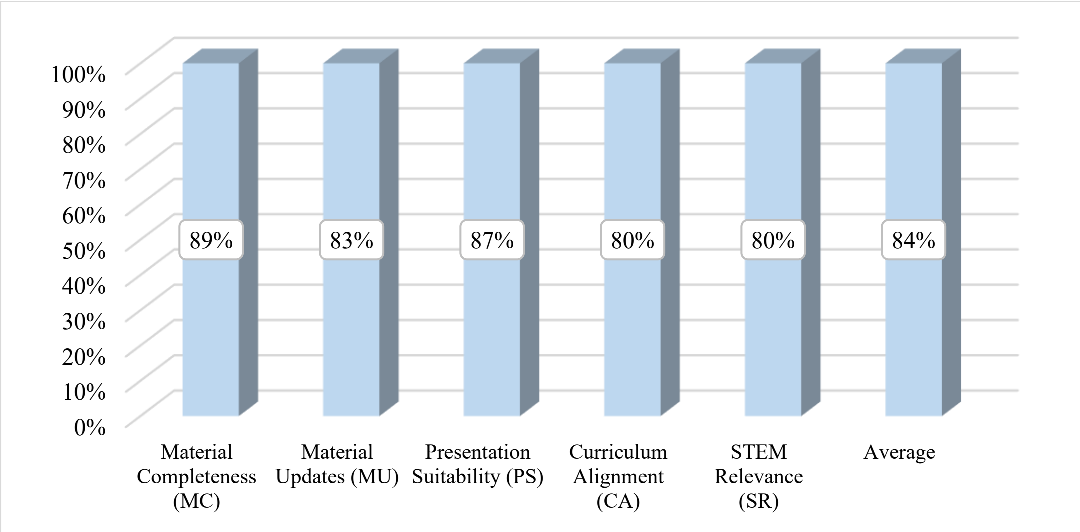

Figure 10. Material expert assessment

4. Implementation Stage

The implementation stage aimed to examine the feasibility and attractiveness of the STEM-based learning videos uploaded to the TikTok application for physics learning on renewable energy. At this stage, the product was trialed with an educator and students to collect data on usability and attractiveness. Educator response results are presented in Table 6 across five aspects: clarity of material, presentation, linguistics, appearance, and relevance to STEM.

Table 6. Educator response assessment

Aspect	Percentage	Criteria
Clarity of material	95%	Very interesting
Presentation	100%	Very interesting
Linguistics	100%	Very interesting
Appearance	93%	Very interesting
Relevance to STEM videos	93%	Very interesting
Average	**97%**	**Very interesting**

Based on Table 6, educator responses were consistently high (93%–100%), with an overall average of 97%, categorizing the product as Very interesting. These results indicate that the TikTok-based STEM learning videos are highly suitable for use in physics learning without revision. A diagram of the educator response results is presented in Figure 11.

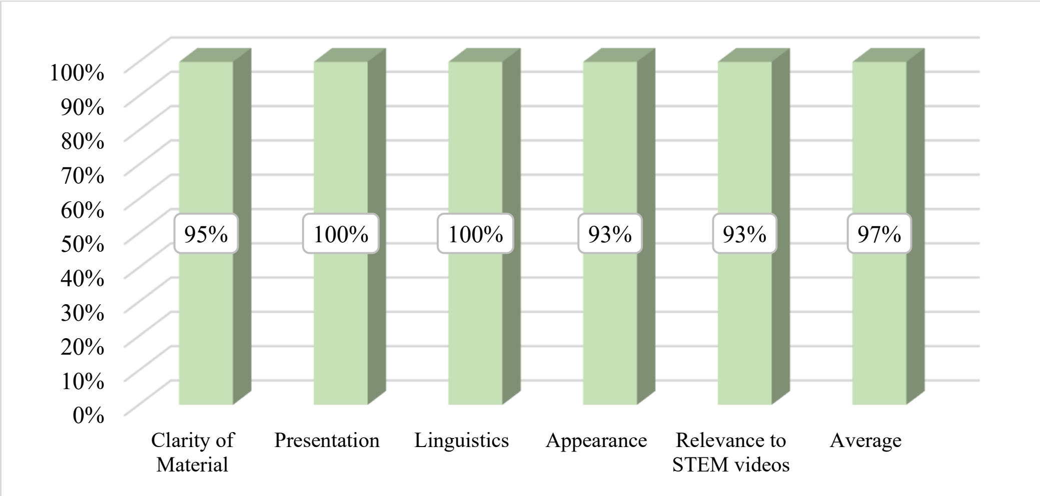

Figure 11. Educator response assessment

After completing the educator assessment, student responses were collected to evaluate attractiveness and perceived usefulness. The results from 37 students are summarized in Table 7.

Table 7. Student response assessment

Aspect	Percentage	Criteria
Clarity of material	90%	Very interesting
Presentation	90%	Very interesting
Linguistics	91%	Very interesting
Benefit	98%	Very interesting
Average	**92%**	**Very interesting**

Table 7 indicates that students rated the videos positively across all aspects. Scores ranged from 90% to 98%, with an overall average of 92%, placing it in the Very interesting category. These findings suggest that the TikTok-based learning videos are attractive to students and can be accessed flexibly anytime and anywhere, supporting their use as a complementary learning tool in physics instruction. The student response diagram is provided in Figure 12.

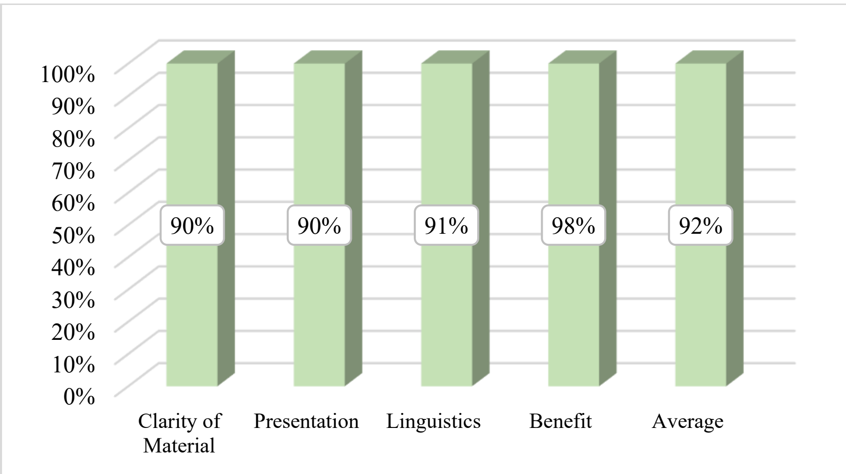

Figure 12. Student response assessment

5. Evaluation stage

The evaluation stage served as the final stage to determine whether the developed learning video product met initial expectations and quality targets (Moreira-Mora & Espinoza-Guzmán, 2016). Evaluation results were used to guide improvements throughout the development process, including refinement of the initial needs analysis, enhancement of video design to increase attractiveness, confirmation of feasibility through expert validation, and assessment of student interest based on field responses.

During product development, several limitations were identified. First, technical or hardware constraints may affect visual quality and the interactivity of animated videos. Second, regarding design and content, the variety and complexity of the materials should continue to be developed to accommodate differences in student understanding levels. Third, sustainability is a key consideration: periodic maintenance and content updating are required to ensure that the learning videos remain relevant and aligned with curriculum development and evolving learning technologies.

IV. DISCUSSION

The evaluation results show that the developed learning videos meet the expected quality standards and receive positive student responses, particularly regarding their attractiveness and perceived support for learning. This finding is consistent with previous studies reporting that video-based and interactive learning media can increase student engagement and support conceptual understanding in physics learning (Safira et al., 2021). Instructional videos that provide clear visualizations, structured explanations, and relevant animations can facilitate students' comprehension of abstract physics concepts by transforming them into more concrete representations. Nevertheless, as reported in related research, this study also identified technical limitations and design constraints that may influence video quality and interactivity, indicating that digital learning media development requires continuous refinement and systematic evaluation.

In addition, the need to adjust content complexity and ensure sustainability through periodic updates aligns with research emphasizing that technology-based learning media should be adaptive to varying student abilities and evolving curriculum demands (Irawan et al., 2025). Learning videos should therefore be treated not as static products but as dynamic instructional resources. Continuous improvement is needed in both pedagogical components (e.g., sequencing, conceptual depth, and learning objectives) and technological components (e.g., audiovisual quality, layout consistency, and platform compatibility). The consistency of the present findings with prior literature reinforces the importance of iterative development cycles supported by formative evaluation to maintain long-term effectiveness.

The implications of this study for physics education extend beyond feasibility and attractiveness. The findings highlight the pedagogical potential of short-form, STEM-oriented digital videos to support conceptual visualization, contextual learning, and student-centered instruction. TikTok-based videos can help represent physics phenomena, particularly those that are abstract or difficult to observe directly, in more observable and relatable forms, thereby reducing cognitive barriers and supporting gradual concept construction. Moreover, the concise format and visual emphasis can sustain attention and strengthen learning motivation when the content aligns with clear instructional goals. From an instructional perspective, integrating structured, visually optimized, and concept-focused videos into classroom practice may enrich learning experiences and complement conventional explanations, especially when class time is limited.

However, effective implementation requires careful pedagogical planning and sustained content management. Educators need to ensure that videos remain aligned with curriculum objectives, that STEM elements are explicitly connected to learning tasks, and that the level of conceptual complexity is appropriate for students' prior knowledge. Similarly, maintaining relevance over time demands periodic updates in response to curriculum changes, technological developments, and user feedback. Therefore, when supported by appropriate instructional design, technological accessibility, and sustainable content development, TikTok-based STEM learning videos can serve as effective digital resources to improve the quality of senior high school physics instruction.

V. CONCLUSION AND SUGGESTION

The present study developed STEM-based learning videos delivered through the TikTok account *Sobat Fisika* to support instruction on renewable energy for senior high school students. The videos can be accessed online via smartphones and computers, enabling flexible use across learning contexts. Feasibility results indicate that the product is suitable for implementation: media expert validation averaged 90% (highly feasible), and material expert validation averaged 84% (highly feasible). User responses further confirmed positive acceptance, with educator responses averaging 96% (very interesting) and student responses averaging 92% (very interesting), reflecting strong engagement and perceived usefulness in supporting physics learning.

Despite these positive findings, this study has several limitations. The product's effectiveness may be affected by technical constraints such as device capabilities, audio–visual quality, and internet access. Additionally, the content scope is limited to renewable energy topics in a short-form video format, which may restrict coverage of more complex subtopics. The trial involved only a single school setting and a small sample size, which may limit how applicable the results are to other contexts. Future research should aim to (1) expand the content to include more physics topics and varying levels of conceptual difficulty, (2) test implementation in a wider range of school environments with larger and more diverse samples, and (3) assess learning outcomes more comprehensively, including conceptual understanding and long-term retention, along with engagement metrics. Overall, this study adds to physics education by showing that TikTok-based, STEM-focused short videos can be practical, engaging, and accessible digital tools that supplement classroom teaching and promote student-centered learning in technology-rich settings.

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