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DEVELOPMENT OF TIKTOK-BASED VIRTUAL LABORATORY FOR PRACTICUM BASIC CHEMISTRY 1 COURSE TO ENHANCE CRITICAL THINKING SKILLS AND SCIENTIFIC PROCESS

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Abstract: The objective of the research that has been conducted is the development of a learning media in the form of a virtual laboratory using the TikTok application. The virtual laboratory that has been created is intended for the Practicum Basic Chemistry 1 course. This media was developed to enhance students' critical thinking skills and scientific process skills. In this research, the research approach utilized the ADDIE model. Validation was done through validation by content experts and media experts. Each validator consisted of 2 (two) experts. The average validation score from content experts was 4.68, and for media validation, it was 4.40. This indicates that the learning media in the form of a TikTok-based virtual laboratory is highly feasible for use as a learning resource. The next step involved testing practicality and effectiveness on first-semester students in the chemistry education program, specifically in classes A and B. Data was collected using observation instruments, interviews, and questionnaires. Subsequently, data analysis was done using descriptive statistical methods. Based on the developmental research conducted, it is concluded that the TikTok-based virtual laboratory is highly feasible, practical, and effective for use in Basic Chemistry 1 learning, with an effectiveness percentage of 89.7%. This indicates that the created product can enhance students' scientific process skills and critical thinking.

Keywords: development, virtual laboratory, TikTok, critical thinking, scientific process

INTRODUCTION

The role of education is crucial for the progress of a nation. Education plays a key role in preparing human resources. Therefore, the quality of education can be considered as the key to the quality of human resources and the progress of the times. In education, knowledge, attitudes, and skills are developed and taught in individuals[1]. The quality of education needs to be improved, one of which is by enhancing the quality of learning. During the learning activities, there is interaction between learners and learning resources. In this regard, educators, such as professors or lecturers, must have pedagogical competence, including the ability to design and implement teaching and learning. In addition to mastering the subject matter, educators are also required to be proficient in using learning resources and media[2].

The era of globalization has led to rapid advancements in science and technology, affecting various other aspects of life. Numerous sectors have experienced significant development, propelling Indonesia into a swiftly evolving era of globalization. The accessibility of the internet has facilitated society in accessing and disseminating information[3]. The rapid development of information and communication technology also has an impact on the field of education in Indonesia. These changes include creating various electronic devices and accelerating the pace of progress in the education sector[4]. The rapid development of technology has an impact on the advancement of computer and internet-based learning media. Another term for learning media in this context is multimedia learning. Elements of multimedia learning consist of at least two components, such as text, graphics, audio, and video, integrated together[5].

The development of learners can be achieved through the teaching and learning process. One way is by utilizing educational media and methods that support learning. Educational media, facilities, and infrastructure can help enhance the potential and boost learners' motivation due to intensive interaction during the teaching and learning process, making classroom learning more effective. Additionally, alternative teaching models, such as the laboratory approach, are also necessary, especially in the fields of engineering and natural sciences. Laboratory learning provides testing against theories, allowing students to discover and reinforce the concepts they acquire. Currently, various media have been developed to enhance the teaching and learning process, encompassing both theoretical and laboratory aspects, such as digital experiments [6].

The creativity of lecturers is highly needed to generate curiosity and students' enthusiasm for learning, particularly through practicum activities. Currently, students belong to Generation Z, which requires lecturers to enhance their creativity. The characteristics of today's students include being

accustomed to and skilled in using information and communication technology. Therefore, the role of digital technology is crucial in teaching activities. The goal is to motivate students, stimulate their curiosity, and engage in virtual learning activities such as discussions and presentations. In addition, students are already get used to innovative and creative ideas and products; therefore, the learning process must adapt accordingly. The teaching and learning process should stimulate students to think creatively and motivate them to solve problems[7].

Chemistry is considered important as it is related to everyday life. Our lives are never separated from an understanding of chemical concepts. However, chemical materials in teaching and learning activities are often regarded as not easy. The field of chemistry studies things that are abstract and symbolic microscopic concepts[8]. Chemistry is considered a challenging subject, requiring educators to have skills and creativity in the teaching and learning process. Educational activities within the school and university environment, in addition to involving understanding and learning in the classroom, also encompass the development of skills and the discovery of knowledge by the students themselves. One example is laboratory practicum work[9].

The essence of learning natural sciences lies in gaining scientific concepts, honing process skills, and cultivating a scientific attitude in students. The meaning of learning is achieved when students can independently discover the scientific concepts of natural sciences. Scientific process skills are crucial as they are required to uncover the concepts of natural sciences themselves. Scientific skills involve doing, observing, analyzing, and evaluating concepts based on acquired facts, which is achieved through experimentation. Students will create their understanding of scientific concepts through this method[13].

Critical thinking skills are essential abilities that students must have[11]. Critical thinking skills mean an individual's ability to analyze and judge using logic and evaluate a problem using their scientific insights[12]. The goal is to facilitate students in solving problems, both within academic coursework and in daily life. These skills enable students to develop high-quality thinking methods, making the learning experience more meaningful[11].

In chemistry learning, laboratory practicum activities play a crucial role. Through laboratory learning, students can have direct experiences to connect scientific phenomena with learning materials. Through this learning model, students are expected to gain firsthand experience, strengthening their understanding of the subject matter. In addition to developing students' conceptual abilities, laboratory learning also supports the enhancement of skills, stimulates interest, curiosity, creativity, and problem-solving activities by students. Therefore, the laboratory approach is crucial in chemistry education[9].

In reality, the implementation of laboratory experiments often faces challenges related to equipment and materials availability, with limited available resources. Issues in laboratory learning include inadequate availability of chemical equipment and materials, the absence of individuals tasked with assisting laboratory activities or laboratory assistants, and risks during experimentation. Hence, there is a need for experience and understanding related to laboratory safety procedures before engaging in laboratory practical activities. Laboratory learning allows students to enhance practical skills by illustrating scientific methods in practical activities, enabling them to discover knowledge concepts independently. The laboratory is one of the supporting facilities for learning. In addition to physical laboratories, there is also the concept of a laboratory with application programs known as a virtual laboratory. A virtual laboratory contains videos or animations related to the practicum process, including equipment, materials, work procedures, and experimental results. Virtual laboratories enable students to conduct experiments whenever they like by observing each procedure in the provided videos, allowing them to remain actively engaged in the experiment. Moreover, virtual laboratories also offer safety benefits compared to physical laboratories for students[10].

The fundamental concept of a virtual laboratory is a laboratory that utilizes technology in its design and utilization. Its goal is similar to that of a physical laboratory, aiming to train and enhance students' skills. A virtual laboratory serves as a simulator of laboratory activities designed with the assistance of information and communication technology to train students' skills or provide laboratory work experience. Its purpose is to reduce the risk of laboratory accidents and provide an understanding of concepts related to a particular subject matter[14]. In this study, a TikTok-based virtual laboratory was developed for the Practicum Basic Chemistry 1 course. In developing this TikTok-based virtual laboratory, transformations of laboratory tools and their usage were digitally designed. The goal of developing this TikTok-based virtual laboratory is to enhance students' scientific process skills and critical thinking. It is expected that students will be able to construct their knowledge, enabling them to discover concepts related to the material being studied. Additionally, students are anticipated to improve their skills and learn independently using the gadgets they possess.

RESEARCH METHOD

In this study, the development of a virtual Basic Chemistry 1 laboratory was carried out using the TikTok social media platform. The creation of this virtual laboratory falls under educational

development research. The ADDIE model (analysis, design, development, implementation, and evaluation) was used [14].The sample in this study consisted of first-semester students in the chemistry education classes A and B at the Faculty of Mathematics, Natural Sciences, and Earth Sciences, Universitas Negeri Manado. Data collection techniques included observation sheets, interviews, discussions, expert validation questionnaires for both content and media and documentation. Preliminary analysis and needs assessment in this research were conducted using observational techniques. The interview technique used a structured interview format, where questions were organized and prepared in advance. Documentation took place during the creation of practicum video sessions and during laboratory testing with students.

The validation process for feasibility testing was conducted in the development phase using questionnaires for media experts and subject matter experts. The questionnaire data used a Likert scale ranging from 1-5, which was then adjusted according to the validity level intervals in Table 1 below [15].

Table 1. Interval of Validity Level Determination

Interval	Description
$1 \leq Va < 2$	Not valid
$2 \leq Va < 3$	Less valid
$3 \leq Va < 4$	Moderately valid
$4 \leq Va < 5$	Valid
$Va = 5$	Very valid

The analysis of practicality and effectiveness was conducted during the implementation and evaluation phases. The practicality analysis of the TikTok-based virtual laboratory media was carried out on students using a questionnaire. Student responses were analyzed using a calculation formula for the average percentage of each statement component found in the response questionnaire. The results were then converted using the practicality categorization according to [16] as presented in Table 2:

Table 2. Practicality Categorization

Score	Category
$80\% \leq \bar{R} \leq 100\%$	Very practical
$60\% \leq \bar{R} < 80\%$	Practical
$40\% \leq \bar{R} < 60\%$	Moderately practical
$20\% \leq \bar{R} < 40\%$	Less practical
$0\% \leq \bar{R} < 20\%$	Not practical

Finally, effectiveness testing is based on observations and student reports, which are part of the final assessment to determine the completeness of student learning outcomes. The completeness of student learning is based on the qualification criteria set by the university, where students are considered to pass the course if they obtain a minimum grade of C or an equivalent quality value of 2.00 – 2.75.

RESULTS AND DISCUSSION

1. Analysis Phase

In the first phase, the analysis phase, initial analysis was conducted on samples of first-semester chemistry education students in classes A and B. In this stage, observations were made on first-semester chemistry education students in classes A and B regarding the learning support infrastructure. Observations were carried out during the Basic Chemistry 1 theory class. The results of the observation of the learning support facilities owned by the students are presented in Table 3 below:

Table 3. Learning Facilities Owned by Students

Facilities	Ownership Percentage
Handphone	100%
Laptops	87%
Internet access	100%

Next, an analysis of the learning process was conducted. The aim was to identify the facilities and infrastructure supporting the learning process. Additionally, it was also to determine the approaches used during the learning process. This stage was done through observations and questionnaires given to the lecturers teaching the course in the chemistry education program. The results of the observation are presented in Table 4 below:

Table 4. Facilities and Infrastructure Supporting the Teaching-Learning Process

Facilities and Infrastructure	Status
Chemistry Laboratory	Available
Internet access	Available
Library	Available

Table 5. Teaching-Learning Process

Item	Description
Learning Media	PowerPoint
Teaching Methods	Lecture and discussion/presentation
Assignments	Assignments, papers/presentation
Extracurricular Activities	Case studies and projects (infrequent)
Laboratory Learning	Infrequent

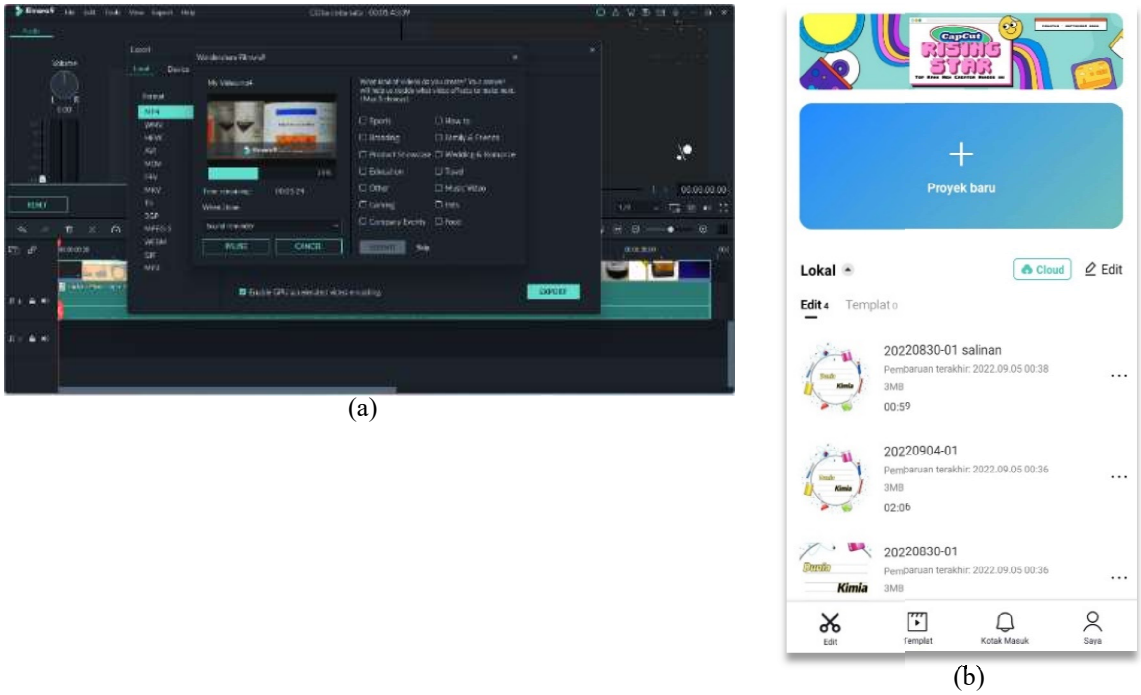
The next step is analyzing the need to create instructional media by examining learning documents such as the curriculum, Semester Lesson Plan (RPS), and graduate competencies. Based on the analysis results of the Chemistry Education Study Program, it can be concluded that the program can prepare skilled chemistry teachers both in the classroom and the laboratory. To achieve this goal, strategies are needed to equip students with relevant skills, particularly laboratory skills. Additionally, it is also important to provide training in scientific process skills.

2. Planning Phase

The second phase is the design phase. First, the goals to be achieved in creating this virtual laboratory are determined so that the design process can proceed smoothly. This phase begins with creating a flowchart and developing questionnaire instruments for content expert validation and media expert validation. Furthermore, questionnaire instruments for practicality and effectiveness testing for large groups are also created.

3. Results of the Development Phase

The third phase is the development phase of instructional media. This stage begins with designing laboratory experiments according to the existing practicum module. Subsequently, practicum sessions are conducted in the laboratory. The results of the practicum sessions are then transformed into a virtual laboratory format using the TikTok social media platform. In this stage, after the virtual laboratory media has been processed, the next step is to conduct expert validation and content expert validation to assess the feasibility of the created media. Subsequently, revisions to the TikTok virtual laboratory media are made if the validation results require them. Below are the results of the virtual laboratory on the TikTok social media application, as shown in Figure 1.



(a) (b)

Figure 1. (a, b). Screenshots of the process of creating practicum videos using the CapCut application

The results of the virtual laboratory on the TikTok social media application are shown in Figure 2 below:

(a)

(b)

Figure 2. (a, b). Screenshots of the TikTok virtual laboratory for Basic Chemistry 1

Validation by content experts and media experts was conducted with two lecturers each, according to their respective expertise. This validation aims to assess the level of validity of the media, considering content accuracy, concept, completeness, material accuracy, creativity, and attractiveness of the created media. The results of the product feasibility test are presented in Figure 3 below:

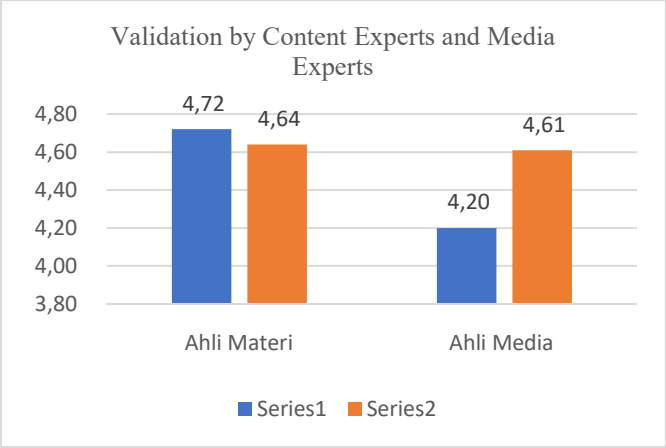


Figure 3. Results of the product feasibility test

The validation results from content experts and media experts show that the evaluation from content expert 1 scored 4.72, and content expert 2 scored 4.64, resulting in an average assessment of 4.68. Subsequently, for media expert validation, Expert One and Expert Two achieved scores of 4.20 and 4.61, with an overall average of 4.40. This indicates that the TikTok-based virtual laboratory is highly valid.This result isappropriate with research conducted by Bogar, Y. D. (2023) regarding virtual laboratories for physics subjects using PhET software which shows the highly valid of the learning media created[17].

4. **Implementation Phase**

The fourth phase is the implementation stage. In this stage, a trial of the created media is conducted, namely the TikTok-based virtual laboratory for Basic Chemistry 1. The respondents for this trial are 14 students from the first semester of the Chemistry Education study program, from classes A and B.

5. **Results of the Evaluation Phase**

The final stage is the evaluation phase, which is still part of the implementation stage.

The implementation and evaluation stages are carried out to test the practicality and effectiveness of the TikTok-based virtual laboratory for Basic Chemistry 1 that has been developed. This test is used to observe and assess the practicality, effectiveness, and whether the TikTok-based virtual laboratory media is acceptable to students or not. The testing is conducted on the topic of solution preparation. The process of media testing and the results are shown in Figure 4 and Figure 5 below:

Figure 4. Product Testing Process with Students

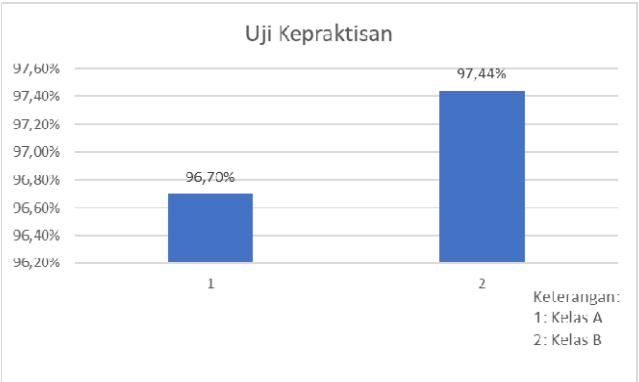


Figure 5. Results of Product Testing with Students from Classes A and B

The conclusion from this implementation and evaluation stage is that students are interested in using the virtual laboratory and are motivated by the short, simple, and easily understandable TikTok video content. Additionally, they will enhance their problem-solving skills and develop the acquired knowledge concepts. There are no obstacles at all in its utilization because students are already accustomed to using gadgets and the TikTok social media platform.

The effectiveness test is observed by students during the practicum activities. Throughout the practicum activities, observations were made on the effectiveness of using the TikTok-based virtual laboratory, and subsequently, students submitted practicum reports. Based on the students' practicum results, a score of 89.7% was obtained, indicating that the TikTok-based virtual laboratory created is highly effective as a learning media for students.

This research is in line with a study conducted by Elisa, E. (2020) on the development of a Virtual Chemical Engineering Laboratory using videos, which received a rating of 94%, indicating it is highly feasible and excellent[14]. Similar research was conducted by Alhimni Rusdi, M. (2021) on the development of a Virtual Lab for Acid-Base Titration, which obtained effectiveness scores based on students' understanding of chemical concepts and process skills. The results were 71%, 80%, and 90%. Furthermore, the posttest analysis showed an N-Gain value of 0.71, indicating high effectiveness. Finally, the practicality test using a questionnaire resulted in a score of 3.04, indicating a well-made product [18].

CONCLUSION

Based on the stages of the research results that have been conducted, namely the development of a virtual practicum basic chemistry 1 based on TikTok,

it can be concluded that the development of a virtual laboratory using the ADDIE model. The effectiveness and practicality assessment of the media resulted in a score of 89.7%.

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