International Journal of Education and Practice
2025 Vol. 13, No. 2, pp. 624-636
ISSN(e): 2310-3868
ISSN(p): 2311-6897
DOI: 10.18488/61.v13i2.4120

Optimizing learning achievements for Generation Z: The impact of video-based instruction in vocational education

Kinanti Wijaya[1+]
Baharuddin[2]
Sutrisno[3]
Ahmad Andi Solahuddin[4]
Nono Sebayang[5]

[1]*Building Engineering Education Study Program, Universitas Negeri Medan, Jl. Willem Iskandar Psr.V, 20221, North Sumatera, Indonesia.*
[1]*Email: kinanti.w@unimed.ac.id*
[2]*Electrical Engineering Education Study Program, Universitas Negeri Medan, Jl. Willem Iskandar Psr.V, 20221, North Sumatera, Indonesia.*
[2]*Email: baharuddin.bah@gmail.com*
[3,4]*Civil Engineering Study Program, Universitas Negeri Medan, Jl. Willem Iskandar Psr.V, 20221, North Sumatera, Indonesia.*
[3]*Email: trisno@unimed.ac.id*
[4]*Email: ahmad.andi@unimed.ac.id*
[5]*Buiding Engineering Study Program, Universitas Negeri Medan, Jl. Willem Iskandar Psr.V, 20221, North Sumatera, Indonesia.*
[5]*Email: nsby1960@gmail.com*

(+ Corresponding author)

Article History
Received: 30 August 2024
Revised: 28 January 2025
Accepted: 14 February 2025
Published: 5 March 2025

Keywords
Generation Z
Learning method
Material technology
Team-based project
Vocational.

ABSTRACT

This study investigates the effects of video-based learning on the academic performance of Generation Z students in vocational education. Generation Z is a technologically savvy population that relies on digital media in their daily activities. The study focused on 60 students participating in Universitas Negeri Medan's Material Technology practical course using the Instructional Development Institute (IDI) paradigm. As part of the development process, team-based project learning-specific video-based learning materials were defined, created and assessed. A quasi-experimental design was used with pre- and post-test data. Data were analyzed using SPSS to perform normality, homogeneity, and t-tests to evaluate learning results between groups using video-based learning material and those who did not. The results showed a significant improvement in learning outcomes for students who used video-based learning media with an average post-test score of 88.57 compared to the control group. The t-test results indicated $t_{calculated}$ (5.868) > t_{table} (2.00172) demonstrating that the video-based method considerably boosted student performance with an 88.57% effectiveness rate. Video-based instructional media was an effective technique for improving Generation Z students' learning outcomes in vocational education particularly practical courses. The findings imply that integrating video-based learning in vocational education courses can dramatically improve students' engagement and performance.

Contribution/Originality: This study integrates video-based learning tailored to Generation Z's digital preferences into vocational education and focuses on practical courses. It adopts a team-based project approach to enhance engagement and learning outcomes which has not been extensively applied in the educational context.

1. INTRODUCTION

Rapid developments in worldwide technological growth have heralded the society 5.0 age significantly altering the social landscape and educational demands of younger generations particularly Generation Z. Generation Z, born between 1997 and 2012 is a technologically savvy population that relies extensively on cell phones, internet connectivity, and digital media in their daily life. According to the 2020 census, Generation Z makes up 27.94% of

Indonesia's population (Rakhmah, 2021). While this technology transformation offers enormous promise for innovation, it has also posed problems to established educational systems, particularly student involvement and character development. Foreign cultural influences through social media and internet usage have begun to damage Indonesia's national identity and cultural values (Wijaya, 2023).

The younger generation tends to spend more time engaging in activities indoors beyond what is reasonable. This behavior can lead to criminality due to the lack of social interaction in their environment. In 2023, the number of violence cases in Indonesia reached 19,593 cases with 38% of victims aged 13-17 years. According to the Ministry of Women's Empowerment and Child Protection (Kemen-PPA), sexual violence, physical violence and psychological violence are the most common types of violence in Indonesia. In addition, according to Imawan, Pettalongi, and Nurdin (2023), Granito and Chernobilsky (2012) and Maritsa, Salsabila, Wafiq, Anindya, and Ma'shum (2021) young people's digital engagement often makes them less socially engaged which can lead to behaviors such as isolation and antisocial behavior. These behavioral changes are also exacerbated by decreased student concentration and increased social disengagement and mental health problems such as increased aggression in adolescents.

In Indonesia, the education system faces significant challenges in imparting academic and technological skills to Generation Z in addition to instilling morality and social responsibility. Teachers are responsible for encouraging their students to develop their full potential including spiritual, intellectual and personal abilities in accordance with Law No. 20/2003 on the National Education System. This requires creating engaging and innovative learning methods that cater to Generation Z's digital fluency while maintaining Indonesia's fundamental principles.

Nowadays, children are less receptive to traditional teaching methods that worked for earlier generations. In vocational education, particularly in practical courses such as material technology, student performance has declined. While students in the 2022/2023 academic year scored lower with ranges between 79-83, indicating that traditional methods are no longer sufficient, a product-oriented, team-based project learning approach proved effective in the 2021/2022 academic year (with the highest scores ranging between 84-87) (Wijaya, Siregar, Yuzni, Sari, & Idris, 2021) with an OBE (Outcome Based Education) learning design (Sutrisno et al., 2021). This has prompted educational institutions to adopt innovative ways that appeal to Generation Z's distinct learning preferences.

The purpose of this study is to investigate how well Generation Z students do academically in vocational education when they are exposed to video-based learning. Instructional approaches must be tailored to their tastes given this generation's high affinity for digital media. This study aims to provide insights that can assist vocational education institutions in designing more engaging and successful learning environments by evaluating the possibilities of video-based learning, particularly in practical courses. This outcome will stimulate broader discussions on the reconciliation of traditional educational methods and the digital habits of Generation Z. Ultimately, this will enhance academic success and character development.

2. LITERATURE REVIEW

2.1. The Nature of Learning and Instruction

Learning is an activity undertaken by individuals to acquire necessary skills and knowledge. The primary objective of the learning process is to improve individual talents. Learning is the process of integrating new information into an individual's memory. Learning involves understanding information through concentration on relevant details, cognitive organization and the creation of connections between new information and existing knowledge. According to De Houwer, Barnes-Holmes, and Moors (2013) learning is an activity that involves cognitive, emotional and psychomotor components and aims to acquire changes in behavior as a result of interactions with the environment. Another way to think about learning is as an internal process that modifies a

person's thoughts, attitudes, and behaviors (Kurniawati, 2021). Thus, learning can be characterized as an activity in which an individual responds to new knowledge by integrating it into memory for instructional purposes, resulting in changes in thinking processes, attitudes and actions.

In practice, teachers in the learning process aim to achieve desired outcomes through four principles: 1) Logic (thinking skills and logical thinking, practiced through various subjects). 2) Practice (practical matters that must be practiced). 3) Ethics (moral values, manners, local customs, and values, all of which can be trained through agreed-upon rules or guidelines). 4) Aesthetics (habitual attention to beauty, cleanliness, and neatness). 5) Habits of working together as a smart and cohesive team (Kim, Raza, & Seidman, 2019). Instruction can be understood as a process of adding knowledge and insights through learning experiences consciously undertaken by the individual with the aim of developing their competencies in a positive direction, ultimately leading to new skills and knowledge in cognitive, affective and psychomotor aspects (Wijaya et al., 2021). In the learning process, there is an interaction between the teaching activities of the teacher and the learning activities of the students, and it is this interaction that is often referred to as instructional interaction (Wagner, Göllner, Helmke, Trautwein, & Lüdtke, 2013).

2.2. Learning System Design

In general, a system always interacts with its environment. Additionally, a system carries out a process within itself. The system receives inputs from its environment and undergoes a process or transformation to convert these inputs into outputs. We can understand the learning process as something that needs to be designed systematically through a systems approach. The term "systems approach" can be defined as a logical and iterative process that can be used to improve and enhance the quality of learning programs (Dick, Carey, & Carey, 2005). Furthermore, the systems approach is a procedure used by instructional system designers to create effective and efficient learning. When using a systems approach, each step taken must receive input from the previous step. We can carry out steps or processes in a systematic manner by applying a systems approach.

2.3. The Role of Technology in Education

The presence of technology has undoubtedly made education much easier. Everyone can learn anything more easily without the barrier of distance. Schools and universities can easily access information from home reaching students in various regions who participate in online learning. Technology plays a crucial role in improving the quality of education by integrating interactive educational tools into the classroom. Technology is considered a valuable resource that facilitates the teaching and learning process. The graduate competency standards regulation provides details where the 13th principle of learning states "Utilization of information and communication technology to enhance the efficiency and effectiveness of learning" (Desniana, 2019).

Technology serves as a means of selecting learning strategies, materials and media tools to enhance the learning environment. The application of technology benefits education in several ways:

1. The emergence of mass media as sources of knowledge and educational centers, particularly electronic media. Examples include the internet network and computer labs.
2. The impact is that teachers are no longer the sole source of knowledge, so students are not solely focused on the teacher and the information provided by the teacher. They can also access learning materials through the internet. Teachers now play the role of instructors and guides, directing and monitoring students' learning processes to ensure they use information media correctly in their studies.
3. The introduction of new methods that can facilitate students' learning processes in school. Methods that capture students' attention and make it easier for them to understand the material are created with technology.

4. Learning can be conducted online, for example, using applications like Zoom, Google Meet, and even internet postal services.
5. The existence of data management systems for assessments that utilize technology. Before the advancement of technology, research and data analysis had to be done manually and in person, but now all tasks can be completed using technology, requiring less time and producing more accurate results. Examples of such technology include laptops or computers that can manage data using software available on the devices.
6. The rapid provision of educational facilities. For instance, when creating exam questions, it is necessary to produce enough copies for all students. With the development of technology, such tasks can be accomplished quickly using photocopy machines that can duplicate copies in a short amount of time. This technological advancement helps to significantly reduce the time needed for such tasks.

3. RESEARCH AND METHODOLOGY

3.1. Research Design

This study followed a research and development (R&D) approach specifically the Instructional Development Institute (IDI) paradigm. The University Consortium for Instructional Development and Technology (UCIDT) created the IDI paradigm divided into the following three main stages: define, develop, and assess. The purpose of this study was to develop and assess the effect of video-based learning media on the academic achievement of Generation Z students in vocational education. The video-based learning materials were developed to enhance the learning environment in the materials technology practicum course using a team-based project learning approach.

3.2. Population and Sample

The research population comprised students from Universitas Negeri Medan enrolled in the materials technology practicum course during the 2023-2024 academic year. The test sample comprised 60 students chosen according to the enrollment figures for this course. The students were partitioned into two groups. The control group employed conventional teaching techniques whereas the experimental group used video-based media.

3.3. Instrument

An initial test, a final test and a structured questionnaire were the instruments used in this study. The initial and final tests were designed to assess students' abilities before and after the use of video-based learning media. A questionnaire was used. In addition, an expert validation form was used to assess the relevance, content, and design of the video-based learning materials. The video-based learning materials cover various topics on materials technology practical courses, such as specialty basics, organic and silty content aggregates, aggregate gradation and analysis, volume, weight, airspace, heavy aggregate types and absorption capacity.

3.4. Validity and Reliability Tests

A series of tests were conducted to ensure the accuracy and reliability of the research tools and data. Expert validation was conducted to assess the validity of the video-based learning media content. Medan State University core material experts evaluated the teaching materials, quizzes and media language. They provided input on how well the information aligned with the learning objectives and competencies. The validation findings showed that the learning medium was quite practicable with the material aspect scoring 85.45%, quizzes 80% and language 60%. Using SPSS software, reliability tests were carried out to make sure the learning objectives were consistent. Cronbach's alpha was used to assess the internal consistency of the tests, and the t-test was utilized to examine the statistical significance of learning outcomes between the experimental and control groups.

Classical Assumption Tests: Normality and homogeneity tests were also carried out using SPSS to make sure the data satisfied the requirements for doing a parametric T-test. The data from both the experimental and control

groups were normally distributed with no significant variations in variance indicating that they were suitable for further investigation.

4. RESULTS

4.1. Characteristics of Students' Learning Styles Today

Students naturally have their learning styles which help them easily grasp the lessons they study. One of these is the kinesthetics learning style where students learn by interacting with or experiencing things around them and tend to understand something by directly engaging with it. Each medium used for learning has its characteristics and to utilize it effectively, it must be aligned with the dominant learning style of the students. A questionnaire was given to 60 students enrolled in the materials technology practical work course in the second semester of the 2023/2024 academic year. Based on previous research (see Table 1), of the three types of learning approaches, it is clear that students generally acquire knowledge through observation and hands-on experience (visual and kinesthetic learning styles).

Table 1. Learning style.

No	Learning style	%
1	Visual	55
2	Auditory	17
3	Kinesthetics	28

4.2. Analysis of Learning Styles

The survey data shows that students have different learning style preferences. Most students tend to learn by seeing and doing (visual and kinesthetics styles) as reflected in their responses to the use of modern measuring tools and experimental activities. However, some students also show a preference for auditory learning styles such as listening to the instructor's material introduction. This indicates the importance of variety in material delivery and diverse teaching methods. These results serve as a benchmark in developing learning methods or styles that combine visual and practical approaches enabling students to learn effectively and enjoyably through the development of a learning method that incorporates instructional videos.

4.3. Results of the Video-Based Learning Media Trial

4.3.1. Results of Expert Validation on Material

A subject matter expert validated the material contained in the interactive video-based learning media. The specialist teaches at Universitas Negeri Medan's Materials Technology Practical Work course. The goal was to evaluate the viability of the developed learning media as well as the correctness and calibre of the content offered as interactive, video-based learning materials. The material expert's tool made use of four elements, each of which evolved into several signs. Table 2 explains each material validation component.

According to Table 2, regarding the material aspects, it is evident that the indicator for alignment of material with objectives has a percentage value of 80%. For the indicator on the depth of material, it is deemed feasible for development. The indicator for systematic, coherent and clear logical flow has a percentage value of 80% for the items "material presented systematically," the "material presented clearly," and the "material presented in an engaging manner." Meanwhile, the items the "material presented is easy to understand," "video presented is engaging," " video presented is clear," and " video presented aligns with the learning objectives" have a feasibility of 100%. Overall, the feasibility level for the material aspect is 85.45% which is classified as highly feasible for development.

Table 2. Assessment of material aspects.

Indicators	Items	Σx	Σx_i	P (%)	Criteria
Alignment of material with objectives	Alignment of material with basic competencies.	4	5	80	Feasible
	Alignment of material with indicators.	4	5	80	Feasible
	Alignment of material with learning objectives.	4	5	80	Feasible
Depth of material	The material discussed in the media is comprehensive.	3	5	60	Feasible
Systematic, coherent and clear logical flow	The material presented is systematic.	4	5	80	Feasible
	The material presented is clear.	4	5	80	Feasible
	The material is packaged in an engaging manner.	4	5	80	Feasible
	The material presented is easy to understand.	5	5	100	Highly feasible
	The video presented is engaging.	5	5	100	Highly feasible
	The video presented is clear.	5	5	100	Highly feasible
	The video presented is aligned with the learning objectives.	5	5	100	Highly feasible

Table 3. Assessment of quiz aspects.

Indicator	Items	Σx	Σx_i	P (%)	Criteria
Clarity of question formulation	Questions are clearly formulated.	4	5	80	Feasible
Completeness of questions	Questions in the media are comprehensive.	4	5	80	Feasible
Correctness of question concepts	Questions are aligned with theory and concepts.	4	5	80	Feasible
	The answer key is consistent with the questions.	4	5	80	Feasible
Consistency of evaluation with learning objectives	Evaluation is consistent with the learning objectives.	4	5	80	Feasible

Based on Table 3, the aspect of questions or quizzes in the developed learning media as assessed by the subject matter expert is deemed feasible for development. The indicators for clarity of question formulation, completeness of questions, correctness of question concepts and consistency of evaluation with learning objectives are all considered feasible by the subject matter expert with a percentage value of 80% for each indicator. Therefore, overall, the aspect of questions/quizzes is considered feasible for development.

Table 4. Assessment of the implementation aspect and language aspect.

Indicators	Items	Σx	Σx_i	P (%)	Criteria
Providing learning motivation	The material presented can motivate students to learn.	4	5	80	Feasible
	Students become more active in engaging in learning activities.	4	5	80	Feasible
Communicativeness of language	The language used is communicative.	3	5	60	Feasible
	The terms and questions used are accurate and appropriate.	3	5	60	Feasible

Based on Table 4, the language aspect of the developed learning media is considered feasible with a percentage value of 60%. The language aspect of the developed learning media is considered feasible with a percentage value of 60%. The subject matter expert's assessment of the four aspects resulted in an average score of 76.36% which is

qualitatively categorized as feasible for development. The following table presents the subject matter expert's assessment results for the three aspects (see Table 5).

Table 5. Results of the subject matter expert's assessment on the four aspects.

Aspects	Score
Material aspect	85.45 %
Questions/quizzes	80 %
Language	60 %
Implementation	80 %
Overall average	76.36 %
Category	Feasible

Table 5 shows that the following four aspects were assessed in the subject matter expert's evaluation: the material aspect, the question/quiz aspect, the language aspect and the implementation aspect. With a score of 85.45%, the material aspect is ranked higher than the other three. A percentage score of 80% is assigned to the question/quiz and implementation aspects and a percentage score of 60% is assigned to the language component. Based on these percentage scores, the subject matter expert's overall assessment rates the learning media as "feasible" for development.

4.3.2. Results of the Media Expert's Validity Test

The media expert's assessment was conducted by a specialist in media development. This assessment was applied to the interactive video-based learning media. Based on the data obtained from the media expert (see Table 6), the software engineering aspect of the learning media has five indicators. The first indicator is "effective and efficient use of resources" which includes two items: the file size of the application is not large receiving a percentage score of 100%, meaning it is highly feasible for development and the application does not run slowly, also receiving a percentage score of 100% indicating it is feasible for development.

The "media reliability" indicator has the following two items: the video does not hang during operation, and the video does not cause an error on the phone both of which received a percentage score of 100%, meaning they are highly feasible for development.

Table 6. Video aspects.

Indicators	Items	Σx	Σx_i	P (%)	Criteria
Providing learning motivation	The material presented can motivate students to learn.	5	5	100	Highly feasible
	Students become more active engaging in learning activities.	5	5	100	Highly feasible
Media reliability	The video does not hang during operation.	5	5	100	Highly feasible
	The video does not cause an error on the phone.	5	5	100	Highly feasible
Media compatibility	The video can run on all types of operating media.	5	5	100	Highly feasible
	The video can run on various hardware specifications.	4	5	80	Highly feasible
Media usage	The video is easy to run.	5	5	100	Highly feasible
	The video has a clear usage flow.	5	5	100	Highly feasible
	The video's operation is simple.	4	5	80	Highly feasible
Communicativeness	Users easily understand the content of the video.	3	5	60	Feasible

The "media compatibility" indicator includes two items: the video can run on all types of operating systems which received a percentage score of 80% and the video can run on various hardware specifications receiving a percentage score of 100%, meaning this aspect is considered highly feasible for development. The "media usage" indicator includes the following three items: the video is easy to run which received a percentage score of 100%, it has a clear video usage flow with a percentage score of 100% and the video's operation is simple, receiving a percentage score of 80%. All three of these items are considered highly feasible for development. The "communicative" indicator has one item: users easily can understand the content of the video, with a percentage score of 60%. Overall, the media usage assessed the software engineering aspect with a score of 92% which means it is highly feasible for development.

Based on Table 7, the communication aspect has 3 indicators and 8 question items. Overall, this communication aspect has a percentage score of 90% indicating that this interactive learning media is highly feasible for development.

Table 7. Visual communication aspect.

Indicators	Items	P (%)	Criteria
Visual	The use of background sound is not distracting.	80	Highly feasible
	The background sound used is appropriate.	80	Highly feasible
	The visual design used in the application is appealing.	100	Highly feasible
	The text is easily readable.	100	Highly feasible
Animation	The animations used are engaging.	80	Highly feasible
	The animations used are not distracting.	100	Highly feasible
Navigation	The navigation is simple.	80	Highly feasible
	The navigation functions well.	100	Highly feasible

Table 8. Lecturer's assessment.

Aspects	Score
Video aspect	96 %
Learning design	95 %
Communication	90 %
Overall average	93.67
Category	Highly feasible

From Table 8, it is evident that the software engineering aspect assessed by the course instructor has a percentage score of 96%, the learning design aspect 95% and the communication aspect 90% indicating that this interactive learning media is considered highly feasible for development.

5. DISCUSSION

Based on the research results and data processing through testing and hypothesis calculation, it was discovered that the content, media, and teacher practitioner validations indicate that this video-based interactive learning media is suitable for usage. The outcomes of the material expert validation assessed in four aspects are as follows: (1) With an average score of 85.45%, the material aspect came in first followed by the question/quiz aspect (80%), the language aspect (65%), and the implementation aspect (80%). The overall average score is 76.36% which is considered practical. The material expert suggests that the developed product be revised to focus on value creation rather than value addition, to provide more operational examples relevant to current conditions, to clarify the difference between attitudes and behaviors, to include a glossary with more current examples, and to use appropriate language.

The media expert's validation results viewed from two perspectives are as follows: visual communication component with an average score of 66.67% and video aspect with an average score of 93%. With an overall average

score of 79.33%, it is considered practicable. The media expert suggests making the following changes: making follow-up content more systematic and clearer without requiring scrolling adding a "next" button for continued material; making sure content is succinct, clear, and to the point; making the best use of display space; changing text size and color to match background; and choosing higher-resolution icons or images. The teacher practitioner validation results, assessed from three perspectives are as follows: The three aspects that received the highest average scores were the video element (96%), learning design aspect (95%) and communication component (90%). With an overall average score of 93.67%, it is considered highly plausible.

Following an expert evaluation, a three-stage feasibility study was undertaken with students to evaluate responses and identify flaws in the generated learning medium. Three students participated in the first trial which was an individual one with one high achiever, one average student and one low achiever. Averaging a score of 97% for the software engineering aspect, 96% for the learning design component, and 94% for the visual communication aspect are the feedback obtained from this trial for the learning media presentation. With an overall average score of 96%, it is considered highly viable.

The second trial was a small group trial with nine students: three high achievers, three averages and three low achievers. The following is a summary of the trial's feedback regarding the learning media presentation: (1) Video aspect (average score of 94%). (2) Learning design aspect (average score of 93%). (3) Visual communication aspect (average score of 95%). With an overall average score of 94%, it is considered highly viable. In the second semester of the 2023–2024 academic year, 60 students enrolled in the materials technology practical work course participated in the third trial which was a field experiment.

An efficacy test was performed to determine the effectiveness of this learning media by comparing student learning results using video-based interactive learning media to those who did not use it. According to data analysis of 60 students from the materials technology practical work course in the second semester of the 2023/2024 academic year, the pretest average score was 75.37 which climbed to 88.57 after using the video-based interactive learning material. The enhancement in learning results resulted from the compelling design of the video-based learning medium which facilitated greater student participation in educational activities. A parametric statistical test (t-test) was employed to assess whether the experimental and control groups exhibited significant differences. Normality and homogeneity tests were conducted before data analysis to get t-test results. The pretest data for the experimental class exhibited a Kolmogorov-Smirnov (K-S) value of 0.175 and a significance value of 0.120, both exceeding 0.05 as per the normality test findings from SPSS data analysis. This conclusion verifies that the pretest outcomes for the experimental group are typical. The post-test findings of the experimental class indicated a significance value of 0.2 and a Kolmogorov-Smirnov (K-S) value of 0.99, both exceeding 0.05. This indicates that the post-test findings of the experimental group are representative. The pretest data for the control group indicated a significance value of 0.149 and a Kolmogorov-Smirnov (K-S) value of 0.138, both beyond 0.05. The pretest scores for the control class are representative.

The post-test results showed a significance value of 0.2 and a Kolmogorov-Smirnov (K-S) value of 0.111, each greater than 0.05. This indicates that the post-test data for the control class is normal. Next, the post-test data from the experimental and control groups were tested for homogeneity using the two variances equality test. The results showed equal variances, or homogeneity with a mean score of 0.254 ($p > 0.05$).

A t- test was then performed on the post-test data from the experimental and control groups revealing that $t_{calculated} > t_{table}$, or $5.868 > 2.00172$ indicating that H_0 is rejected and H_a is accepted. Consequently, it can be concluded that the learning results of the 60 students enrolled in the materials technology practical work course during the second semester of the 2023–2024 academic year were superior to those of the students who were not exposed to the video–based interactive learning medium with an 88.56% efficacy rate. This indicates that adopting video-based interactive learning media is more effective in improving the learning outcomes of the 60 students

enrolled in the materials technology practical work course during the second semester of the 2023-2024 academic year.

The following conclusions can be drawn based on the concept, objectives, findings and discussion of the video-based interactive learning media development research provided earlier: The material expert's overall assessment indicates that this learning media is "feasible" for development. The media expert's assessment of the visual communication element yielded a score of 79.3% indicating that the media expert considers video-based interactive learning media feasible for development. From the results, it can be seen that the software engineering aspect assessed by the course instructor received a percentage score of 96%, the learning design aspect 95%, and the communication aspect 90% indicating that this interactive learning media is considered highly viable for development. Based on the t-test calculation findings, it was discovered that $t_{calculated} > t_{table}$, or $5.868 > 2.00172$ indicating that H_0 is rejected and H_a is approved. With an efficacy rate of 88.5667%, it can be concluded that students who use video-based interactive learning materials achieve better learning outcomes than students who are taught without such materials.

The educational delivery system has a significant influence on how students acquire 21st-century abilities. Curriculum, assessments, school climate and policies, pedagogy and skill benchmarking are all important components in the development and management of 21st-century competencies. However, the classroom is the principal site where the previously mentioned components support learning and skill development. In addition, the classroom offers a setting where children can practice these abilities while seeing their teachers perform them. Consequently, training and preparing teachers for the acquisition and use of 21st-century abilities is equally important. Assessing the strategies and tactics teachers employ in the classroom is a crucial initial step in supporting and encouraging the development of 21st-century skills in students (Kim et al., 2019).

Technology has become an indispensable part of the educational process (Haleem, Javaid, Qadri, & Suman, 2022). Due to technology improvements, e-learning programs are growing in popularity among teachers and learners (Kolekar, Pai, & Manohara, 2018; Sloan & Lewis, 2014). The term "video-based learning" (VBL) describes the process of gaining knowledge or abilities through watching instructional videos. Using both audio and visual cues is one of the video's primary features. The educational materials have the content. The student will use this written material or instructor-facilitated activities to meet the learning objectives (Dick et al., 2005). Any resources that are being used in a lesson could fall under this category. Workbooks for students, activity guides, problem sets, resource lists, textbooks, and computer simulations are a few examples. It is essential to coordinate educational materials when choosing and creating them.

According to Giannakos, Chorianopoulos, Ronchetti, Szegedi, and Teasly (2014); Yoon, Lee, and Jo (2021) and Thomas, West, and Borup (2017) using videos in education allows for a wider exploration of digital worlds and overcomes practical limits in the actual world. Video is one of the most effective virtual learning media for capturing and distributing information while also offering a vibrant learning environment in which students can better absorb and remember material (Fern, Givan, & Siskind, 2002). Videos offer a comparable learning experience to traditional instructor-led courses (Stöhr, Stathakarou, Mueller, Nifakos, & McGrath, 2019). Video-based learning offers cost-effective and accessible alternatives to in-person or real-time training. Specifically, when real-time lectures cannot be implemented because of location-related issues like a lack of physical classrooms, using pre-recorded video lectures is more economical (Giannakos et al., 2014). Students can take advantage of video-based learning's greater accessibility by watching video lectures as many times as necessary to grasp the course material. Advanced capabilities in video players, such as bookmarking and annotations can also assist students actively in connecting with the main learning content. Furthermore, matching the modality to the subject maximizes the utility of video lessons. Teachers can increase the germane cognitive load of a learning experience by employing audio/verbal and visual/pictorial channels to deliver new knowledge, and by matching the sort of material to the most appropriate channel (Brame, 2016).

Analogous to Daniela, Kalniņa, and Strods's (2017) study, we discovered that surveys are typically employed to investigate the attitudes of particular respondents rather than to gauge academic performance or cognitive development. Furthermore, according to Siti, Yolanda, Ruri, and Nurismilda (2021) educational facilities can help students improve their intelligence which determines their academic accomplishment. In addition, when the instructor employs captivating PowerPoint presentations and instructive movies (video) to clarify lessons, students can behave responsibly since they can concentrate on the instructor and answer questions about the material being covered. In addition, the university's facilities facilitate students' ability to showcase their skills, encourage curiosity and drive for learning and relentlessly pursue excellence.

A multimodal educational communication reaches the learner's cognitive system through their eyes and hearing. Printed words and visuals are temporarily stored in visual sensory memory while spoken words are temporarily saved in auditory sensory memory. The student can focus on some of the content as these visuals fade, and it gets stored in working memory for later processing. The student may arrange verbal and visual information into verbal and visual models in working memory as well as integrate comparable verbal and visual representations with pertinent long-term memory information. The result is useful information that is kept in long-term memory and may be used in new situations (Mayer, 2024).

6. CONCLUSION

This study shows that video-based learning improves the learning results of Generation Z students in vocational education particularly in practical courses like material technology. Post-test scores improved and engagement increased when compared to traditional teaching techniques when video-based media was incorporated into the instructional design. In particular, the students who used video-based learning had an 88.56% effectiveness rate with an average post-test score of 88.57.

Expert validation results for the video-based learning media indicated that they are highly suitable for creation and use in educational settings. Media professionals and subject matter specialists gave positive reviews for the instructional content, quiz design and overall learning experience with feasibility ratings between 76.36% and 93.67%. T-test results confirmed the statistical significance of improved learning outcomes in the experimental group indicating that video-based teaching worked well for the student group. These results suggest that video-based learning materials can serve as a useful tool in professional education, fitting the digital lifestyle of Generation Z and encouraging character and academic development. It is expected that educational institutions start using video-based learning methods to align with the technological tendencies of today's students and improve their engagement and academic achievement.

Funding: This research is supported by PNBP (Non-Tax State Revenue) of Universitas Negeri Medan for the 2024 fiscal year in accordance with the rector's decree of Universitas Negeri Medan (grant number: 00299/UN33/KPT/2024).
Institutional Review Board Statement: The Ethical Committee of the Universitas Negeri Medan, Indonesia approved this study on 22 March 2024 (Ref No. 0071/UN33.8/PPKM/PPT/2024).
Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
Competing Interests: The authors declare that they have no competing interests.
Authors' Contributions: All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.

REFERENCES

Brame, C. J. (2016). Effective educational videos: Principles and guidelines for maximizing student learning from video content. *CBE—Life Sciences Education, 15*(4), es6. https://doi.org/10.1187/cbe.16-03-0125

Daniela, L., Kalniņa, D., & Strods, R. (2017). An overview on effectiveness of technology enhanced learning (TEL). *International Journal of Knowledge Society Research, 8*(1), 79-91. https://doi.org/10.4018/IJKSR.2017010105

De Houwer, J., Barnes-Holmes, D., & Moors, A. (2013). What is learning? On the nature and merits of a functional definition of learning. *Psychonomic Bulletin & Review*, *20*(4), 631-642. https://doi.org/10.3758/s13423-013-0386-3

Desniana. (2019). *The influence of android-based information technology (Smartphone) in industrial education*. Paper presented at the Proceeding Seminar Nasional Pendidikan Program Pasca Sarjana Universitas PGRI Palembang.

Dick, W., Carey, L., & Carey, J. O. (2005). *The systematic design of instruction*. Boston, MA: Pearson/ Allyn and Bacon.

Fern, A., Givan, R., & Siskind, J. M. (2002). Specific-to-general learning for temporal events with application to learning event definitions from video. *Journal of Artificial Intelligence Research*, *17*, 379-449. https://doi.org/10.1613/jair.1050

Giannakos, M. N., Chorianopoulos, K., Ronchetti, M., Szegedi, P., & Teasly, S. D. (2014). Video-based learning and open online courses. *IJET*, *9*(1), 4-7. https://doi.org/10.3991/ijet.v9i1.3354

Granito, M., & Chernobilsky, E. (2012). *The effect of technology on a student's motivation and knowledge retention*. Paper presented at the NERA Conferences Proceedings, 1-22. https://opencommons.uconn.edu/nera_2012/17?utm_source=opencommons.uconn.edu%Fnera_2012%2F17&utm_medium=PDF&utm_campaign=PDFCoverPages.

Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the role of digital technologies in education: A review. *Sustainable Operations and Computers*, *3*, 275-285.

Imawan, M., Pettalongi, A., & Nurdin. (2023). The influence of technology on character education of students in the society 5.0 era. *Proceeding Kajian Islam dan Integrasi Ilmu di Era Society*, *5*(5), 323-328.

Kim, S., Raza, M., & Seidman, E. (2019). Improving 21st-century teaching skills: The key to effective 21st-century learners. *Research in Comparative and International Education*, *14*(1), 99-117. https://doi.org/10.1177/1745499919829214

Kolekar, S. V., Pai, R. M., & Manohara, P. M. (2018). Adaptive user interface for moodle based E-learning system using learning styles. *Procedia Computer Science*, *135*, 606-615. https://doi.org/10.1016/j.procs.2018.08.226

Kurniawati, W. (2021). Learning planning design. *Jurnal An-Nur: Kajian Pendidikan dan Ilmu Keislaman*, *7*(1), 1-10.

Maritsa, A., Salsabila, U. H., Wafiq, M., Anindya, P. R., & Ma'shum, M. A. (2021). The influence of technology in the world of education. *Al-Mutharahah: Jurnal Penelitian Dan Kajian Sosial Keagamaan*, *18*(2), 91-100. https://doi.org/10.46781/al-mutharahah.v18i2.303

Mayer, R. E. (2024). The past, present, and future of the cognitive theory of multimedia learning. *Educational Psychology Review*, *36*(1), 1–18.

Rakhmah, D. N. (2021). *Gen Z dominant: What does it mean for our education? Center for education standards and policy, agency for curriculum standards and education assessment, ministry of education, culture, research and technology*. Retrieved from https://pskp.kemdikbud.go.id/produk/artikel/3133/gen-z-dominan-apa-makananya-bagi-pendidikan-kita

Siti, M., Yolanda, A., Ruri, A. S., & Nurismilda. (2021). The influence of learning facilities on student learning achievement in higher education. *Edu Cendikia: Jurnal Ilmuah Kependidikan*, *1*(2), 40-45.

Sloan, T. W., & Lewis, D. A. (2014). Lecture capture technology and student performance in an operations management course. *Decision Sciences Journal of Innovative Education*, *12*(4), 339-355. https://doi.org/10.1111/dsji.12041

Stöhr, C., Stathakarou, N., Mueller, F., Nifakos, S., & McGrath, C. (2019). Videos as learning objects in MOOCs: A study of specialist and non-specialist participants' video activity in MOOCs. *British Journal of Educational Technology*, *50*(1), 166-176. https://doi.org/10.1111/bjet.12623

Sutrisno, Y., Yuzni, S. Z., Sebayang, N., Lukman, M. F., Wijaya, K., Idris, I., & Yolanda, A. (2021). Design and validation of lesson plan development materials technology course with an outcome-based education approach. *Advances in Social Sciences, Education and Humanities Research: Proceeding Series*, 943-948. https://doi.org/10.2991/assehr.k.211110.210

Thomas, R. A., West, R. E., & Borup, J. (2017). An analysis of instructor social presence in online text and asynchronous video feedback comments. *The Internet and Higher Education*, *33*, 61-73. https://doi.org/10.1016/j.iheduc.2017.01.003

Wagner, W., Göllner, R., Helmke, A., Trautwein, U., & Lüdtke, O. (2013). Construct validity of student perceptions of instructional quality is high, but not perfect: Dimensionality and generalizability of domain-independent assessments. *Learning and Instruction*, *28*, 1-11.

Wijaya, J. H. (2023). *Lifestyle transformation in Indonesia: The impact of foreign cultures in the era of globalization*. Retrieved from https://ssrn.com/abstract=4511264

Wijaya, K., Siregar, S., Yuzni, S. Z., Sari, R. A., & Idris, I. (2021). The effectiveness of learning with the team-based project method in the decision-making technique course by using the product-oriented module. *JTP-Jurnal Teknologi Pendidikan*, *23*(3), 216-234.

Yoon, M., Lee, J., & Jo, I.-H. (2021). Video learning analytics: Investigating behavioral patterns and learner clusters in video-based online learning. *The Internet and Higher Education*, *50*, 100806.