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PAPER

Effectiveness of Question-Based Instructional Video (QBIV) for an Automotive Engineering Study Program

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ABSTRACT

The advancement of information and communication technology allows for online learning through a variety of media platforms all over the world, one of which is video, which is available online. Video has become an important aspect of education and can be used to convey learning content in class, through blended learning, or through online programs. The goal of this study is to develop a QBIV and evaluate its effectiveness in learning. The learning QBIV was field tested on prospective vocational teachers. The effectiveness of QBIV was evaluated utilizing a posttest-only control group design on automotive vocational teacher candidates. The experimental group included 39 students, while the control group included 42 potential automotive engineering teacher students. The t-test was used to examine the significance of differences in student learning achievement between the experimental and control classes. The analytical results demonstrate that there is a significant difference in learning outcomes between the experimental and control classes. The experimental class outperformed the control class in terms of learning outcomes. As a result, using QBIV for learning is effective.

KEYWORDS

instructional video, vocational education, vocational teacher, automotive education, vocational learning

1 INTRODUCTION

The advancement of information and communication technology enables online learning via numerous media platforms around the world, one of which is video, which can be accessible online. Video has become an important aspect of education and can be used to convey learning content in class, through blended learning, or through online programs. Effective video use as a learning tool can improve learning outcomes by taking three factors into account: how to manage the cognitive load

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of the video, how to increase student engagement with videos, and how to promote active learning from videos [1].

Videos have become an essential component of education. It can be combined with traditional learning methods. Video can also be used as a primary information delivery technique in online learning and as an important component of blended learning. Several meta-analyses have demonstrated that technology can improve learning [2, 3], and numerous research have demonstrated that video can be an extremely effective learning tool [4, 5, 6]. Learning videos have distinct advantages for students' classroom preparation; they are more fascinating [7, 8, 9], and videos are also appropriate for presenting abstract concepts through visualization, making them easier to understand. Videos can help you understand something that is tough to understand.

When it comes to vocational education in the automotive field, one of the courses that potential vocational education students find difficult is automotive electricity since the material is abstract or cannot be seen [10]. Students also experience difficulties in acquiring automotive electrical reading material that is easy for them to study or understand [11]. These difficulties are the result of a lack of knowledge about vehicle electrical problems. Automotive electrical learning media is one thing that is desperately needed for automobile electrical learning challenges [12]. Existing learning medium cannot match the demand for in-depth study of automotive electricity [13]. No one has used the question-based instructional video (QBIV) idea to develop analytical skills connected to automotive electrical material in particular for online learning.

Based on the research, it is vital to create instructional videos that leverage the QBIV principle to help students improve their skills. As a result, the following problem formulations will be addressed in this study: How effective is QBIV in improving analytical capabilities for vehicle electrical material?

2 LITERATURE REVIEW

2.1 Instructional video

Videos are an effective method for teaching in an online setting. However, passively watching videos is neither fascinating nor cognitively challenging, and as a result, most videos fail to effectively teach students the information. The addition of interactive elements transforms online videos from passive to active learning material [14]. Students can obtain knowledge and participate in video-directed activities by including interactive components in their videos. This will enlighten students and keep them from becoming bored too quickly [15]. This interactive feature is a crucial part of the learning process. Students are unlikely to learn if they are not engaged [16].

Today, video is becoming the dominant information delivery technology in the classroom and plays an essential role in education in terms of its integration into the traditional classroom. Video is a crucial component of blended learning programs, particularly in online learning. As a result, education must transition from traditional learning methodologies to video-based learning (VBL) [17]. According to active learning theory, students achieve superior learning outcomes when they actively participate in the learning process [18]. Active learning can occur when learning exercises are accompanied by learning videos. Several studies have found that videos can be a useful educational tool [19, 20].

2.2 Characteristics of instructional videos

The primary feature of the video is the employment of visual symbols in conjunction with an auditory system. The audio system deciphers information, while the visual system is the primary source of information [21]. There has been a lot of research done on the VBL method. As a result, this form of learning has gained popularity both within and outside the classroom. Many educational institutions give movies in classrooms as a learning tool or for independent learning in order to better the learning process. Videos can be utilized to teach in a variety of ways, and students can study at their own pace [22, 23].

Learning videos can help with problem solving and thinking by presenting creative material that communicates learning material through graphics and music. Students can learn problem-solving and cooperation skills by watching instructional video. In some circumstances, learning videos can serve as instructors by interactively transmitting procedures or data to aid in the mastery of the learning material. Students can see complex procedures as many times as they need to. Furthermore, current online-based media players with interactive capabilities can be used to improve students' active learning ways [17].

2.3 Video-Based Learning (VBL)

In addition to teaching specific practical skills, the VBL approach outperforms text-based learning. As a result, if educational designers wish to engage students in learning in an effective and engaging fashion, a video-based approach is one strategy that can be used [24]. Because of the extensive use of portable devices, the growing number of internet users, and online learning, technological developments allow the use of video in education are occurring at a rapid pace. Students and teachers are increasingly accepting of online learning videos. Video-based learning has proven to be an effective reflection tool for teachers in addition to boosting students' learning [25]. PBV provides video-based information or skills, with the key features being auditory and visual. The visual aspect is the primary source of information, and audio is employed to supplement it [26]. VBL has distinct characteristics that make it an effective learning strategy capable of improving learning results and student satisfaction [27].

2.4 Designing instructional videos

Educators can create videos that are tailored to the lesson topic. Cognitive aspects, noncognitive components that influence engagement, and features that enable active learning are three crucial variables to improve the learning experience through video. Learning movies created with these three components can be an excellent learning tool [28]. Aside from that, there are several guidelines to follow when creating learning videos, including: (a) Explicit goals: To create a video, you must first establish a clear aim in order for the video to be more effective, the learning process to be more comfortable, and students to complete their learning more rapidly [29]. (b) Simple and brief: The video should be brief in order to avoid boredom among students and keep them interested in the film. Video material employs an equal mix of graphics and text [30]. (c) Text: Some video content includes text to describe some specific content, and text drawings can add value. (d) Graphics: Videos and

photos can be merged to provide an appropriate visual background [6]. (e) Captions: Captions are particularly useful, especially when students have hearing impairments and cannot readily understand the video content, thus making captions in text form important [31]. (f) Sound: Sound is a crucial consideration when developing educational films since it can boost student engagement. The video's images and text must be accompanied by audio so that students may listen to the audio as well as the text and visuals [32]. (g) Screen recording: When plain text or audio cannot be displayed, screen recording approaches can be useful. For example, if you wish to show pupils how to save documents in Excel [33]. (h) Animated characters: Using real people throughout an instructional film can bore pupils. We can utilize animated characters of the persons involved to produce compelling videos [29].

2.5 Concept of question-based instructional video

Questions can be an effective way to aid the learning process. Educators can draw students' attention to the content being studied by asking them questions. Then, educators give students opportunity to complete the method and substance of the task on their own [34]. It is critical to ask questions during learning. Good questions can focus students' attention and passion for finding answers through contemplation and experimentation [35]. As part of the preparation, questions might be written before the lesson. Educators can also add questions "on-the-fly" during class, although two to five questions for a 45-minute course is usually sufficient. There are numerous question types that can be employed. One of them is a diagnostic evaluation question used to determine students' grasp of lecture material, define learning directions, and test students' understanding of previous lecture material. Question-based learning techniques have been shown to improve student learning outcomes [36].

Based on the findings of the preceding investigations, the concepts of question-based learning offered by Pedrosa et al. [34], Gariddo [35], and Jackowska et al. [36] were used to develop the concept of question-based instructional videos (QBIV). The distinction between this research and prior research is that previous research used the question-based learning concept for classroom learning, whereas this research used question-based learning videos. Figure 1 depicts the notion of question-based instructional video in this study.

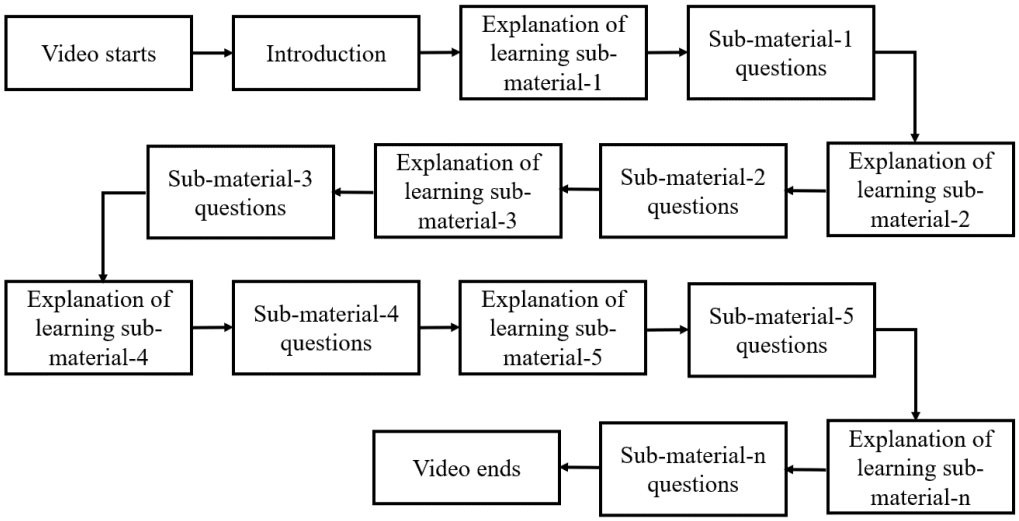

Fig. 1. Concept of question-based instructional video

According to Figure 1, each learning sub-material is explained in stages and systematically, from simple to sophisticated. Following the explanation of each sub-material in the video, students are presented with a series of questions linked to the sub-material that has been explained. Students must explicitly answer the questions for each sub-material before proceeding to the explanation in the next sub-material and so on, until students have studied all of the sub-materials in the movie and have followed the explanation of each sub-material and answered all of the questions in each sub-material.

3 METHOD

The learning video was tested in the field on potential vocational teacher students enrolled in the Automotive Engineering Education Study Program at Semarang State University's Mechanical Engineering Department, Faculty of Engineering. The experimental group had 39 students (5 females and 34 males), while the control group included 42 students (1 female and 41 males). The participants ranged in age from 19 to 21 years. The student is a third-semester student studying automotive electricity and electronics. All students are accustomed to utilizing electronic devices and connecting to the internet. The effectiveness of QBIV was evaluated utilizing a posttest-only control group design on automotive vocational teacher candidates.

This study went through several steps, which are as follows: First meeting: (1) learning about general resistor material was done in class using the lecture method, both experimental and control classes; (2) continuing independent online learning as a follow-up to classroom learning via the Learning Management System (LMS) and uploading QBOLV videos on YouTube with a link to the LMS; (3) each student can only enter the experimental or control class based on the account they were given; (4) The experimental class has material presented in learning video about basic automotive electricity and electronics with the main topic "resistors" (QBIV video); (5) The control class has material presented in learning video with the same subject matter "resistors" (non-QBIV video); and (6) Independent learning is carried out after class while still using the LMS. Next week's meeting: assessments are conducted in the experimental and control courses to assess learning results or comprehension of resistive information presented at the previous meeting.

Students watch the video and listen to each sub-material that is explained. After finishing sub-material 1 in the video, students are presented with a series of linked questions. Students must explicitly answer the questions for each sub-material before proceeding to the explanation for the next sub-material in the video and so on, until students have studied all of the sub-materials in the movie and have followed the explanation of each sub-material and answered all of the questions in each sub-material. Students in the control class, which does not use QBIV, directly follow the explanation via video from sub-material 1 to the last, with no questions in the video that must be answered.

The data acquired in this study are student learning outcomes for the experimental class after using QBIV in learning and student learning outcomes for the control class after using non- QBIV in learning. Test questions are used to assess mastery of learning material in accordance with the content of the subject in QBIV. The video content is based on one of the primary materials in the fundamental automotive electricity and electronics course. The primary topic is resistors. The video covers the definition of resistors, specifications, color codes, calculating resistor values based on color codes, series circuit analysis on resistors, and parallel circuit

analysis on resistors. The contents of the learning outcomes test instrument correspond to the learning objectives that must be met, which are determining resistor values based on color codes, analyzing series circuits on resistors, and analyzing parallel circuits on resistors.

The *t*-test was used to examine the significance of difference in student learning achievement between the experimental and control classes. If there is a significant difference in learning accomplishment between control and experimental class, and if the experimental class outperforms the control class, then QBIV is being used efficiently in learning.

4 RESULTS

The concept of question-based instructional videos was developed using the question-based learning concept described by Pedrosa et al. [34], Gariddo [35], and Jackowska et al. [36]. The question-based learning idea is typically used in classroom settings, but in this study, it was applied to question-based learning videos. Figure 1 depicts the QBIV idea. The videos created and used in this study fall into two categories: (1) QBIV video, which includes questions that the user must answer (these questions are posed in the context of explanations of each sub-material); and (2) non-QBIV video, which solely explains each sub-material. The results of field trials for the control (non-QBIV) and experimental (QBIV) classes are shown in Table 1.

Table 1. Learning achievement of experimental and control groups

Group Statistics					
	Class	N	Mean	Std. Deviation	Std. Error Mean
Achievement	Experimental	39	56.92	24.619	3.942
	Control	42	42.62	22.313	3.443

According to the data in Table 1, the QBIV appears to generate a difference in the average value of the experimental group's learning outcomes of 56.92, which is greater than the average value of the control group's learning outcomes of 42.62. The experimental class's learning outcomes were approximately 36% greater than the control class's. Table 2 shows the normality test findings for experimental and control class learning outcomes data using Shapiro Wilk.

Table 2. Shapiro wilk normality test result

	Class	Statistic	df	Sig.
Achievement	Experimental	.924	39	.091
	Control	.992	42	.182

According to Table 2, the Shapiro Wilk statistical value for the experimental class is 0.924, while sig = 0.091 > 0.05, indicating that the experimental class data is normally distributed. The Shapiro Wilk statistical value for the control class is 0.992, while sig = 0.182 > 0.05, indicating that the control class data is likewise normally distributed. Lavene Statistics was used to perform the data homogeneity test, and the results are shown in Table 3.

Table 3. Lavene statistic homogeneity test result

Levene Statistic			df1	df2	Sig.
Achievement	Based on Mean	.603	1	79	.440
	Based on Median	.598	1	79	.442
	Based on Median and with adjusted df	.598	1	78.176	.442
	Based on trimmed mean	.616	1	79	.435

According to Table 3, the based on mean value is 0.603 and the sig. is 0.440 > 0.05, the based on median value is 0.598 and the sig. is 0.442 > 0.05, and the value is based on the median and with adjusted df = 0.598 and sig. = 0.442 > 0.05, and based on the trimmed mean = 0.616 and sig. = 0.435 > 0.05, all sig values are more than 0.05, indicating that the data is homogeneous. Data analysis was performed using the independent sample *t*-test to assess differences in learning outcomes between the experimental and control groups, the results of which are provided in Table 4.

Table 4. Independent sample *t*-test result

		t	df	Sig. (2-Tailed)
Achievement	Equal variances assumed	2.743	79	.008
	Equal variances not assumed	2.733	76.713	.008

According to Table 4, $t = 2.743$ and Sig. (2-tailed) = 0.008 < 0.05. According to the findings of this study, the learning outcomes of the experimental and control groups were significantly different. As a result, QBIV is effectively used in education.

5 DISCUSSION

QBIV is effectively used in learning based on the findings of the data analysis that has been performed. The significant difference in learning results between the experimental and control classes demonstrates this. The efficiency of learning using QBIV can be attributed to this video's importance as a medium for delivering learning materials. By placing questions between the information presented in the video, students are required to be able to answer these questions. To be able to answer these questions, the supplied material must be taken seriously. This may result in more active, independent learning using QBIV. The answer to each question becomes one of the exercises or activities that students must complete. These findings are consistent with previous research, which indicates that using video in learning can lead to active learning. Video as a learning medium can be an excellent educational tool [19, 20]. The inclusion of visual and aural components in video media can enhance the information provided. The aural symbol system describes information, while the visual symbol system is the primary source of information [21, 26]. Students can use movies to learn independently, depending on their circumstances. Students can examine the learning material at their own pace before delving deeper into the intricacies in class [22, 23].

The combination of multiple questions in QBIV might push students to think critically and learn to solve problems through innovative presentation of learning content using graphics and sound. Learning videos, according to Beheshti et al. [17],

enable students to: (1) acquire skills and knowledge for problem solving and collaboration; (2) help mastery of learning material; (3) use them as instructors in representing procedures or facts interactively to help mastery of learning material; (4) view complex procedures as many times as necessary with interactive features; and (5) increase active learning.

QBIV, which students can access online, can be studied at any time and in any location. As a result of the increased use of portable devices and the large internet network, online learning is becoming more open and widespread. This is also consistent with what Sabli et al. [25] mentioned, that online learning videos are increasingly welcomed by students and educators due to their numerous benefits. Aside from assisting students in their learning, films have proven to be an effective reflection tool. QBIV are created in accordance with the learning material. QBIV contains three key components: cognitive aspects, non-cognitive factors that influence interaction (affective participation domain), and features that enable active learning. Learning movies created with these three features have the potential to be a successful teaching tool [28].

QBIV emphasizes users' ability to answer questions, enabling pupils to study independently based on the main subject that must be studied. The requirement to solve the issues offered in the film attracts students' attention to the key material. This is consistent with Pedrosa et al. [34], who state that educators can control learning by asking students questions. Then, instructors provide students with opportunity to finish the process and work independently. This approach is incorporated into QBIV, which can help improve pupils' ability to think and solve problems. Question-based learning techniques have been shown to improve student learning outcomes [36]. Similarly, question-based learning using learning videos can boost learning outcomes.

6 CONCLUSION

Because students must answer many questions in each sub-material, the QBIV video pushes students to pay close attention to each sub-material explained in the movie. Active exercises guided by QBIV result in directed learning experiences that improve learning achievement. The research revealed that there were substantial differences between the experimental and control groups. All assessments also revealed that the experimental class outperformed the control class in terms of learning outcomes. As a result, the usage of QBIV in learning is effective. Effective video use as a learning aid can improve learning outcomes by taking three factors into account: how to control video cognitive load, how to increase student engagement with the video, and how to promote active learning from videos.

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