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ORIGINAL RESEARCH ARTICLE

Increasing the attention, relevance, confidence and satisfaction (ARCS) of students through interactive science learning multimedia

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The use of interactive multimedia has the potential to create a high-quality learning environment. The key elements of various media, user control over information delivery and interactivity can be used to improve the learning process by creating an integrated learning environment. This study aims to determine the increase in students' attention, relevance, confidence and satisfaction (ARCS) before and after using interactive science learning multimedia. This study collected data from 30 students aged 12–13 years from a junior high school in Yogyakarta City, Indonesia. Data collection was done using learning motivation questionnaires. Data analysis techniques used paired sample *t*-test. The results of this study are that the learning motivation aspects of ARCS after using interactive science learning multimedia have increased significantly. However, the relevance aspect of students' learning motivation did not increase significantly.

Keywords: attention; confidence; relevance; satisfaction; interactive science learning multimedia

Introduction

Information and communication technology (ICT) continues to experience new developments routinely (Qurat-ul-Ain *et al.* 2019). The development of ICT is expected to be utilised by teachers in the learning process. Based on Ghavifekr and Rosdy's (2016) research, it is shown that teacher's preparation that is assisted with ICT equipment and facilities is one of the main factors in the success of technology-based teaching and learning. Computer-based learning has a broad potential to increase motivation and instructional design (Barger and Byrd 2011). Interactive multimedia technology in the learning process can improve interactions between teachers and students (Rajendra and Sudana 2018). Learning that utilises technology can engage students with the learning process and provide benefits in making it easier to obtain knowledge because of the flexibility of learning (Alexander *et al.* 2019). Students increasingly demand engaging, customised multimedia content (Liu and Elms 2019). Through interactive science learning multimedia is expected to be more effective, improve student and teacher interactions and make students more motivated.

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The use of interactive multimedia in learning will increase efficiency, motivation and student-centred learning (Wiana, Barliana, and Riyanto 2018). Meanwhile, Nusir *et al.* (2011) revealed that multimedia could create a high-quality learning environment. The key elements of various media, user control over information delivery and interactivity can be used to improve the learning process by creating an integrated learning environment (Cairncross and Mannion 2001). Interactivity in the context of computer-based multimedia learning can be interpreted as a reciprocal activity between learners and multimedia learning systems; besides, the learner's actions depend on the reaction of the system and vice versa (Domagk, Schwartz, and Plass 2010).

Nowadays, many schools in Indonesia have computer facilities utilised in the learning process as the learning media. This learning media will facilitate students in learning the material, especially for abstract material in science learning. One of the science materials that require learning media is the material of the solar system, as this material is difficult to observe directly in the classroom. Based on the results of interviews with junior high school science teachers at the research location during the needs analysis, it is known that the learning media that is usually used to teach the material of the solar system is PowerPoint slides. The other learning media available in the school teaches aids in the solar system, but the conditions are not right.

One of the disadvantages of using PowerPoint is that the operation of the media is entirely in the hands of the teacher, not the students. Lambert and Cuper (2008) state that linear multimedia tools generally develop from one screen to the next and are generally used by instructors (teachers) in addition to teaching aids. This multimedia form tends to limit the potential for learning as it does not require active participation. Therefore, interactive multimedia is considered necessary to facilitate students to be more active in the learning process.

Based on interviews with junior high school science teachers at the research location when conducting needs analysis, it is known that student motivation is not optimal to affect student learning outcomes. Other information from interviews with junior high school science teachers when conducting a needs analysis found that usually only as much as 50% of all students in the school achieved the minimum completeness criteria at the end of the semester assessment. Moreover, Taurina (2015) states that student motivation is a significant factor in achieving learning outcomes. Therefore, there is a need to increase students' learning motivation, so that the learning outcomes are also more maximised.

Motivation is a process that stimulates people's behaviour or arouses them to take action. It makes people do what they do (Arends 2012). According to Keller (2010), operational learning motivation is determined by four aspects, that is, attention, relevance, confidence and satisfaction (ARCS). The ARCS model is a commonly used motivational design model (Li and Keller 2018). The ARCS motivation model, which is uniquely based on teaching design, has a significant role in increasing the effectiveness of the teaching environment (Ozdamli 2018). The ARCS motivation model was developed in response to a desire to find more effective ways to understand the main influences on learning motivation and identify problems related to learning motivation (Keller 1987). Numerous reports and studies have described and confirmed the validity of this model (e.g. Means, Jonassen, and Dwyer 1997; Small and Gluck 1994; Visser and Keller 1990).

Attention is a motivation variable to stimulate and maintain the curiosity and interest of students (Keller 2010). The second aspect is relevance, in which students must believe their learning experience is personally relevant. Confidence generally

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refers to someone's expectations for success in various parts of their lives (Keller 2010). Furthermore, to make students have a continuing desire to learn, they must feel satisfied with the learning experience results (Keller 2010). According to Zheng *et al.* (2014), the use of interactive science software positively impacts students' motivation in science and their interests related to science. Therefore, the use of interactive multimedia in science learning becomes essential to increase student motivation.

Student interaction with interactive multimedia is different from PowerPoint presentations, where when using interactive multimedia, students can use multimedia directly and control the pace of learning. Conversely, when using PowerPoint media, the teacher will use the media, and students cannot control learning speed. According to De Sousa, Richter, and Nel (2017), students who are given access to multimedia devices can manage their learning, build knowledge with speed and in the direction that suits their needs and desires. An example of a science learning process that uses interactive multimedia is shown in Figure 1.

The examples of the display of interactive science learning multimedia are shown in Figure 2. Interactive multimedia products used in this research have been through research and development using the 4-D model, namely, define, design, develop and disseminate (Thiagarajan, Semmel, and Semmel 1974). However, at the time of this research, the steps taken were define, design and develop (product validation stage). The interactive multimedia validation process is carried out by two experts (lecturers) from internal universities. Permission from the faculty is also required to carry out this validation process. The results of interactive multimedia validation are shown in Table 1.

Figure 1. Science learning using interactive multimedia.

Figure 2. Examples of interactive science learning multimedia display.

Table 1. The results of interactive science learning multimedia validation.

Aspect	Score			Category
	Expert 1	Expert 2	Average	
Content eligibility	4.00	4.00	4.00	Very good
Graphics	4.00	3.80	3.90	Very good
Technical quality and usage	3.20	3.80	3.50	Very good
Instructional quality	3.50	3.50	3.50	Very good
Language	4.00	4.00	4.00	Very good

Based on the results of experts' validation, all aspects of the interactive science learning multimedia developed have had the feasibility to be used with a very good category. Based on the description explained previously, the researcher aims to observe the increase in students' learning motivation after using interactive science learning multimedia from four aspects of motivation that comprise ARCS.

Method

Participants

The sample of this study was 30 students in the seventh-grade class of junior high school on science subjects. The research subjects were selected by random cluster sampling. The location of this study is in one of the state junior high schools in the city of Yogyakarta, Indonesia, in semester 2 of 2017. This study has received permission from the school. Based on information from science teachers, a study on the use of interactive multimedia in science learning is first conducted at this school.

Measures

The participants were asked to complete a survey on their motivation for using 'interactive science learning multimedia' according to a 4-point Likert scale, which corresponded to strongly disagree, disagree, agree and strongly agree. The students' learning motivation that consists of four aspects, that is, ARCS, was measured using a questionnaire. Two expert lecturers (internal institutions) validated the questionnaire by providing valid or invalid statements and suggestions to improve the questionnaire. The questionnaire for student motivation consists of 26 items in the form of positive and negative statements. The statement criteria on the questionnaire are related to motivation: ARCS (Table 2).

Procedure

This study is a pre-experimental design. Questionnaires were given before and after using interactive science learning multimedia. The difference between the motivation questionnaire before and after using interactive science learning multimedia is found in the statement sentences used. Before data collection, a PowerPoint slide detailing the research objectives and how to fill out the questionnaire is presented to students. The questionnaire used in this study was not given an identity to maintain student

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Table 2. Motivational aspects and criteria were modified from Keller (2010).

Aspects	Criteria
Attention	a. The attraction of learning activities b. The attraction of material c. The attraction of learning resources/learning media used d. Can focus on material e. Have curiosity
Relevance	a. Having a feeling of wanting to succeed in learning b. Feel that the material is filled as needed
Confidence	a. The feeling can learn the contents of the material b. Have an easy feeling of remembering the material/content of the lesson c. Having feelings will succeed in the test
Satisfaction	a. Have a feeling of being happy about the lesson b. Having a feeling of being satisfied with the results achieved c. Feel good about learning design

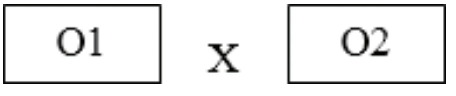

Figure 3. Experimental design.

privacy. The experimental design is described, as shown in Figure 3 – notes: O1 the motivation before and O2 the motivation after using interactive science learning multimedia.

Learning science using interactive multimedia is done as many as three sessions because the interactive multimedia product developed only contains three sessions and limited time for research at school. The total time spent in three sessions is 320 min with the following details: 120, 80 and 120 min according to the schedule at school. During the study, the students were asked to independently use the interactive science learning multimedia under the guidance of their teacher. The interactive science learning multimedia was installed on each computer in the school computer laboratory. In the first meeting, before students used interactive science learning multimedia, they were asked to fill out a learning motivation questionnaire consisting of four aspects, that is, ARCS. In the initial motivation questionnaire (before using interactive science learning multimedia), the statement in the questionnaire contains the learning process experienced by the students previously, that is, when they are studying in the classroom as usual. At the end of learning at each meeting (when the students learned by using interactive science learning multimedia), the students were also asked to fill out a learning motivation questionnaire.

Data analysis

The data analysis technique used is (1) paired sample *t*-test and (2) converting the qualitative value to quantitative value and then calculating the percentage and converting it into five categories. The conversion of the qualitative value to the quantitative value in the learning motivation questionnaire was done based on Riduwan

(2014) technique with the provision, as shown in Table 3. The reference for converting a percentage into five categories also relied on Riduwan (2014), which is also shown in Figure 4.

Results

Data on learning motivation for each aspect are shown in Tables 4 and 5. Furthermore, based on Table 4, the percentage of students' learning motivation for each aspect and each session can also be presented in the form of a diagram, as shown in Figure 5.

A significance test using paired sample *t*-test needs to be done to prove whether the increase in learning motivation in each aspect increased significantly. The significance test for each aspect of students' learning motivation can be seen in Table 6.

Discussion

Based on the motivation questionnaire data that the students had filled out, the data were then processed and converted to a percentage. Before using interactive science

Table 3. Conversion of learning motivation questionnaire to scale four.

Positive statement		Negative statement	
Answer	Score	Answer	Score
Strongly agree	4	Strongly agree	1
Agree	3	Agree	2
Disagree	2	Disagree	3
Strongly disagree	1	Strongly disagree	4

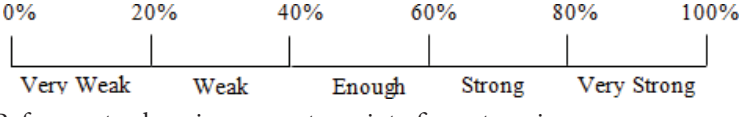

Figure 4. Reference to changing percentages into five categories.

Table 4. Data on the results of student learning motivation.

Motivation aspects	Motivation before using multimedia (%)	Motivation to learn during using multimedia (%)			
		The first session	Second session	Third session	Average
Attention	73.08 (strong)	84.58 (very strong)	84.41 (very strong)	82.75 (very strong)	83.91 (very strong)
Relevance	83.54 (very strong)	85.20 (very strong)	85.41 (very strong)	84.37 (very strong)	84.99 (very strong)
Confidence	66.80 (strong)	80.41 (very strong)	79.16 (strong)	80.55 (very strong)	80.40 (very strong)
Satisfaction	73.05 (strong)	83.47 (very strong)	83.19 (very strong)	80.97 (very strong)	82.54 (very strong)

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Table 5. Data on the results of increasing student motivation.

Motivation aspects	Percentage of motivation		
	Motivation before using multimedia (%)	Motivation after using multimedia (%)	Increased motivation (%)
Attention	73.08 (strong)	83.91 (very strong)	10.83
Relevance	83.54 (very strong)	84.99 (very strong)	1.45
Confidence	66.80 (strong)	80.40 (very strong)	13.60
Satisfaction	73.0 (strong)	82.54 (very strong)	9.54
Average of all aspects	74.105	82.960	8.855

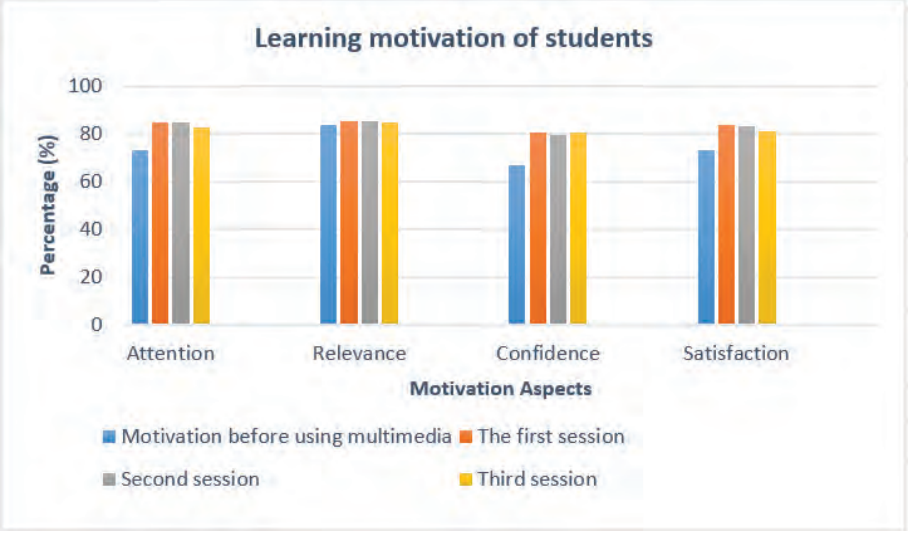

Figure 5. The results of students' learning motivation in each aspect.

Table 6. Test results for the significance of the paired sample *t*-test.

Decision criteria	Motivation aspects	Sig value. (two tailed)	Decision	Conclusion
H0 is rejected if sig. (two tailed <0.025)	Attention	0.000	H0 is rejected	There is a significant difference between attention before and after using multimedia
	Relevance	0.224	H0 is accepted	There is no significant difference between relevance before and after using multimedia.
	Confidence	0.000	H0 is rejected	There is a significant difference between confidence before and after using multimedia.
	Satisfaction	0.000	H0 is rejected	There is a significant difference between satisfaction before and after using multimedia.

learning multimedia (initial), the percentage of attention is 73.08, with a strong category. Then, at sessions 1, 2 and 3, after students used the interactive science learning multimedia, the percentage of attention aspects became 84.58, 84.41 and 82.75, with a very strong category. After the students used the interactive science learning multimedia, the average attention aspect percentage is equal to 83.91. Therefore, the attention aspect of the students increases from 73.08% to 83.91%, with an increase of 10.83%. When observed, the percentage of attention aspect from meeting 1–3 experienced a slight decrease. The highest percentage of the attention aspect of the students' learning motivation is in the first session. The use of interactive multimedia in science learning for students is the first experience; therefore, in the first session, they have more attention than in the next session.

Getting attention in the learning process is essential because it initiates motivation for learners. Once students are attracted to a topic, they are willing to invest their time, pay attention and find out more. One way to get the students' attention is by asking questions that make them do critical thinking (Malik 2014). In this study's interactive science learning multimedia, several questions are featured and will automatically appear on every page. After the students choose the questions, the feedback will appear in the form of an answer key, and what steps should be taken if the answer is wrong. According to Annamalai (2016), to get students' attention in multimedia, it should be designed with narration, visuals, animation and video.

Meanwhile, Keller (2010) states that one way to get the students' attention in the multimedia display is to provide blank space on the screen to separate blocks of information (text) with illustrations. This method was also applied by the researchers in designing the display of interactive multimedia science learning. Based on the results of research conducted by Aris *et al.* (2006), it is known that the presentation of exciting information and taking into account the readability of the text and the presence of text, images, graphics and videos in interactive multimedia can attract students' attention and stimulate memory. Another study conducted by Nusir *et al.* (2013) also shows that interactive multimedia is effective in getting the students' attention. The research undertaken by Ismail and Basri (2012) shows that students' attention increases when using interactive multimedia. Based on the research, it was observed that students' attention when using interactive multimedia reached 95.7%. In the study conducted by Ismail, however, the percentage of the increase in the attention aspect of students' learning motivation is not stated.

The motivation aspect of relevance is the relationship shown between the learning material, the needs and the conditions of the students. The initial (before using multimedia) relevance aspect is 83.54%, with a very strong category. After the students used the interactive science learning multimedia at meeting 1, 2 and 3, the percentage calculated is 85.20, 85.41 and 84.37, respectively, and it is classified in a very strong category. The students' average motivation aspect of relevance after using the interactive science learning multimedia is equal to 84.99%, with a very strong category. Thus, it can be inferred that the relevance aspect only increased by 1.45%.

One way to improve the relevance aspect of students' learning motivation, according to Malik (2014), is that the educator (teacher) must explain the learning objectives. Moreover, another way is to give examples of what benefits can be obtained after learning the material. Faryadi (2012) also states that to get the relevant aspect of students' learning motivation, designing interactive multimedia must include learning objectives, and the content in the interactive multimedia must be relevant. This study's interactive science learning multimedia also lists learning objectives and provides

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examples of benefits after studying solar material, displayed on the 'science info' page. Meanwhile, Netis (2001) states that increasing the relevance aspect of students' learning motivation can be done by giving feedback on the wrong answers, which is also applied in this interactive science learning multimedia. It had been considered that in interactive science learning multimedia developed by the researchers, each wrong answer would be given feedback in the form of an explanation of the correct answer.

Furthermore, the research conducted by Ismail and Basri (2012) shows that the relevance aspect of students' learning motivation increases when using interactive multimedia. Based on the research, it is found that the relevance aspect of students' learning motivation when using interactive multimedia is equal to 99.3%. In the study conducted by Ismail, however, the increase in the relevance aspect of students' learning motivation is not stated.

The confidence aspect generally refers to someone's expectation for success. Compared to the other aspects of motivation, the percentage of confidence aspect before using the interactive science learning multimedia was the lowest percentage amongst the different aspects, that is, 66.80. The confidence aspect of students' learning motivation at meeting 1, 2 and 3 became 80.41%, 79.16% and 80.55%, respectively, with a very strong category. The average percentage of the confidence aspect of students' learning motivation is 80.04. The confidence aspect experienced an increase of 13.60%, from 66.80% before to 80.40% after using the interactive science learning multimedia. The confidence aspect experienced the most significant improvement compared to the other aspects. Meanwhile, the highest percentage of the confidence aspect of students' learning motivation is at the third meeting. The highest confidence in the last session is rational because students have completed all the material to be tested.

The way to build students' confidence is by having full control over multimedia, interest and navigating all lessons. Besides, the enrichment activities (quiz) and direct feedback for each question can also increase students' self-confidence (Annamalai 2016). Interactive science learning multimedia also has controls in the form of menu and navigation. Besides, several quizzes and evaluation questions accompanied by values obtained by students are equipped in this interactive science learning multimedia. According to Keller (2010), to improve confidence in a technology-based instructional material application, students should be given control over the lesson and the time required to complete lessons.

Netis (2001) states that students need to be given a reasonable opportunity to answer quizzes (practice questions) in interactive multimedia to build confidence. Researchers also provide students with opportunities to answer quizzes on interactive multimedia by considering the level of difficulty of the questions. The questions referred to the predetermined learning objectives. Ismail and Basri (2012) show that students' confidence increases when using interactive multimedia. Based on this research, it is known that students' confidence when using interactive multimedia is equal to 100%. In the study conducted by Ismail and Basri (2012), however, the percentage of the increase in the confidence aspect of students' learning motivation is not stated. Moreover, Faryadi (2012) also shows that using interactive multimedia in learning will make the students more confident. According to Fahmi, Priwantoro, and Cahdriyana (2018), students learn by using interactive multimedia and experiencing self-confidence changes. These changes include aspects of students who feel they can get good grades when studying with computers. Students feel very confident when they start learning with computers, and students feel confident learning with computers.

The satisfaction aspect is related to the feeling of satisfaction with the process or result of learning experiences. The initial percentage of satisfaction aspect is 73.05, with a strong category. After the students use interactive science learning multimedia at meeting 1, 2 and 3, the percentage increases to 83.47, 83.19 and 80.97, respectively, with a very strong category, and the average percentage is 82.54. The satisfaction aspect of students' learning motivation increased by 9.54%, from 73.05% to 82.54%.

According to Netis (2001), to make the students get satisfaction with the learning process, they must use what they have learned. Satisfaction can be accommodated by using scores on how well they progress. The interactive science learning multimedia developed by the researchers has also fulfilled this element by having a score when students finish working on evaluation questions at each meeting. Interactive science learning multimedia gives immediate feedback for every question. In this case, the students can determine the score they get when the problem has been completed. Evaluation questions in the interactive science learning multimedia developed by researchers are in the form of multiple choices. If students succeed in answering questions in a multimedia quiz, congratulatory words will appear on the computer screen. Meanwhile, if they are wrong in answering questions in the quiz, motivational words will appear on the computer screen.

Zhang (2005) shows that the satisfaction level of students is higher when using interactive multimedia than in traditional classes. In line with that, the research conducted by Ismail and Basri (2012) shows that students' satisfaction increases when using interactive multimedia. Based on this research, it is found that the satisfaction level of students when using interactive science learning multimedia is equal to 94.9%. In the study conducted by Ismail and Basri (2012), however, the percentage of the increase in the satisfaction aspect of students' learning motivation is not stated. Also, Faryadi (2012) also shows that using interactive multimedia in learning will make the students feel more satisfied than not using multimedia. The satisfaction aspect can be obtained through direct feedback for each question from the quiz (Ismail and Basri 2012). Respondents were satisfied with multimedia and design elements in multimedia because they helped discuss topics better than conventional teaching and learning methods (Khedif, Engkamat, and Jack 2014). All aspects of learning motivation, that is, ARCS, have increased with different percentages. The attention aspect experienced the highest increase, equal to 10.83%, and the relevance aspect experienced the smallest increase only by 1.45%.

Based on the significance test result with paired sample *t*-test, students' learning motivation aspects of attention, confidence and satisfaction show a significant difference between before and after using the interactive science learning multimedia. In contrast, the relevance aspect did not show a significant difference. When referring to the students' initial learning motivation before using interactive science learning multimedia, the relevance aspect is already in a very strong category, with a percentage of 83.54. The aspect of relevance is already very strong before using interactive multimedia because science material taught by the teacher when not using interactive multimedia (before treatment) is already as expected by students. Thus, the increase is not too high, which is only 1.45%. Besides, the relevance aspect did not increase significantly, which only increased by 1.45% because the relevance criteria used in the questionnaire were only two items, even though, based on the theory, there were nine criteria. The questionnaire only contained two criteria on the aspects of relevance to reducing the number of items of statements that were too many but affected the results obtained. This is one of the limitations of this study. As a result, only aspects of relevance did not increase significantly. This causes the significance test results for

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the relevance aspect to show that there is no significant difference. In general, if the students' learning motivation is seen as a whole by combining all of the aspects, then the students' learning motivation increased significantly after using interactive science learning multimedia with an increase of 8.855%. These results are obtained based on the difference between initial motivation (74.105%) and final motivation (82.960%).

A limitation of this study is that it does not use a control class and a small sample size (30). This study only uses questionnaires to collect data, so that it becomes a limitation of this study. Another limitation is that the questionnaire only contains two criteria on the motivational aspects of relevance to affect the results.

Conclusion

Interactive science learning multimedia is one form of utilisation of technology in learning, which can be operated directly by students through a computer or laptop, so that students can manage their learning speed and can increase their involvement in the learning process. Through interactive science learning multimedia, science materials such as the solar system can be presented in the media of text, images, animations and videos to increase student motivation. Interactive science learning multimedia can significantly improve students' learning motivation, particularly attention, confidence and satisfaction. However, the relevance aspect of students' learning motivation did not increase significantly. The existence of animations, images, text, music, videos and quizzes accompanied by feedback on interactive multimedia can keep students' attention. The relevance can be obtained through interactive multimedia by including a list of learning objectives and providing examples of benefits after studying the material. Student confidence when using interactive multimedia can be achieved with full control over multimedia by students through the navigation features and the existence of the quiz. Student satisfaction when using interactive multimedia can be obtained through direct feedback for each question, congratulatory words when they succeed in answering questions and providing motivational words if they are wrong in answering questions whilst working on the quiz.

Future studies will use control and experimental classes and increase the number of students involved. Opportunities for meaningful learning through the use of interactive multimedia are exciting; there are motivational aspects that need to be explored more in-depth. In the future, this research will explore deeper about students' learning outcomes and critical thinking skills when using interactive multimedia.

Recommendations

Other researchers can develop interactive multimedia for learning science in other materials and explore more deeply student motivation. Interview and observation techniques need to be done as a complement to student motivation data. Teachers can use interactive multimedia in science learning as an alternative to teaching abstract material such as the material of the solar system.

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