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Improving Students' Higher Order Thinking Skills in Learning Health Systems Using Mobile-Based Instructional Approach

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ABSTRACT

Aims Learning health systems are healthcare systems in which awareness formation processes are inserted into daily practice to provide constant development in care. Many students have difficulty completing the health systems courses due to a lack of Higher-Order Thinking Skills (HOTS). Therefore, this study aims to improve students' HOTS using a mobile-based instructional approach.

Materials & Methods The enhanced HOTS is measured using indicators of critical and creative thinking processes known as Bloom's taxonomy concept. Furthermore, this is experimental research with a pre-test-post-test random control group pattern and ADDIE technique to develop the mobile-based instructional Approach. The study involved 120 students who were evenly divided into the experimental class and the control class. Respondents were selected from 650 SMK students in Central Java using the random cluster sampling method.

Findings Based on the results, this is evidenced by the ability to answer challenging questions associated with critical and creative reasons.

Conclusion Therefore, using a mobile-based instructional Approach supports independent learning.

Keywords Mobile Learning; health systems Using; Skills; Critical, Creative; CNC Programming

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[1] Children and youth services review vocational education in Indonesia ... [2] Improving employment outcomes of career and technical ... [3] Android-assisted physics mobile learning to improve senior high school students' divergent thinking skills and ... [4] E-learning development in improving ... [5] Improved learning design for pre-service teacher in a character ... [6] Students' use of information and communication technologies in the classroom: Uses, restriction ... [7] Teachers' self-directed learning and teaching ... [8] An analysis on the implementation of professional learning communities ... [9] Relationship between headmasters' leadership, task load on special education integration programme ... [10] Potret implementasi pembelajaran berbasis high order ... [11] A systematic review of m-learning in formal ... [12] Trajectory smoothing method using reinforcement ... [13] "Iedutech" mobile application development for information technology subjects in education among TVET ... [14] Use of mobile applications in collocation ... [15] Application of innovative technologies and computer ... [16] A new way of teaching business ethics: The evaluation ... [17] Taxonomy for learning, teaching, and assessing: a revision of ... [18] Distance learning hybrid format for university students ... [19] Unobtrusive observation of team ... [20] Developing an online pre-service student teaching ... [21] Development of product based learning-teaching ... [22] Developing an electronic module of local wisdom based ... [23] Developing mathematics learning media ... [24] "SolveMe" website development using ... [25] Development of Nahwu learning ... [26] Android-assisted mobile physics learning ... [27] A teaching based technology in ... [28] Learning science in immersive ... [29] Teachers and students poised ...

Introduction

In Indonesia, vocational high schools experience various problems such as incompetent teachers, lack of infrastructure, and inadequate learning innovation [1]. Consequently, these factors affect the students' abilities to develop higher-order thinking skills (HOTS) which is extremely relevant in the 21st century. The main indicator of HOTS is the ability to develop critical and creative thinking. Mechanical Engineering strongly relies on this field; however, graduates have been criticized for incompetency [2]. Computer Numerical Control (CNC) is a major mechanical engineering vocational education. Its competency is a relevant indicator of the manufacturing sector [3]. Therefore, to master programming competency in CNC PROGRAMMING, students are expected to be skilled in critical and creative thinking. Unfortunately, the majority have difficulties developing their reasoning skills [4].

Data obtained through classroom learning observations shows that the teacher-centered Approach to learning is still being adopted [5]. This follows the formative evaluation of the learning media used, which are less challenging. Therefore, teachers need to develop innovative learning, particularly critical and creative thinking skills, to teach CNC programming efficiently. Teachers make use of the teacher-centered learning approach [6]. However, this method has been widely criticized in several studies for not stimulating students to think creatively.

Innovation, educator development, and teaching experiences significantly affect students' learning processes and outcomes [7]. Industrial revolution 4.0 resulted in basic competencies considering contextual learning with the help of models, strategies, methods, and techniques. Effective and innovative learning practices emphasize the distinctive features of digital competencies that focus on individual creativity and performance, meta-learning strategies, and problem-solving [8]. Furthermore, certain misconceptions are encountered during the implementation of various teachers' knowledge processes. Globally, science education reforms are based on the constructivist views of teaching and learning [9]. The teaching strategy was changed from a traditional textbook-based and rote-based learning approach to an exploration and inquiry-based learning. Teachers need to adopt a comprehensive learning model related to higher-order thinking skills and activity-based [10].

A critical aspect of learning innovation is choosing appropriate strategies such as technological enhancement to produce competent graduates. Moreover, it serves as an alternative for educators [11]. Technology is also used as a learning instruction tool that improves students' learning achievement of CNC programming. However, currently, many teachers still doubt its positive impact. This is inseparable from the inability to integrate technology into the learning process. Mobile learning is a form of applying for technological advances. Its role is to connect the natural learning environments using mobile devices. Mobile learning is a strategic medium in vocational education to support and facilitate learning [12]. The questions related to the background of this research are the first question how the influence of the mobile-based learning approach designed for learning CNC programming and the second question how the students' HOTS results after taking the mobile-based learning approach. These questions are based on the argument that HOTS includes three domains: fundamental, development, and applied studies. Fundamental research attempts to define HOTS, thereby establishing its criteria and conceptions. The developmental aspect focuses on three aspects: teaching strategy (methods, models, lesson design), supporting Approach (media, modules), and assessment. Meanwhile, applied research concentrates on adopting fixed methods, models, and assessments. All these, including HOTS development, are focused on supporting teaching materials.

Mobile devices are one way of learning the suitable needs of present-day educational requirements [13]. Therefore, this process has been popularly used at all education levels. Technology-based learning is influenced by ownership of mobile phones and portable and wireless devices that are easily accessible [14]. Mobile-based learning has increased students' learning independence. The development of technology has become a bridge for students to acquire knowledge. Therefore, it motivates them to become active to realize satisfactory learning outcomes [15]. Furthermore, the educators' inability to adopt this learning pattern effectively hinders mobile technology in the classroom.

CNC programming is extremely relevant in Vocational High School. The essential competencies include algorithmic subjects, language, and program code [12]. Students are required to have high reasoning skills and a good understanding of programming languages. CNC machine learning is developed with the help of program simulation and virtual reality [16]. Classroom learning should provide a real picture of CNC work and create a sense of fun and enthusiasm for students.

Higher Order Thinking Skills (HOTS) is a reasoning process at an elevated level. The popular cognitive process or thinking skills categorization is derived from a book entitled "Taxonomy of Educational Objectives, Handbook I: The Cognitive Domain". The book was revised to become "A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy Educational Objectives". Students revise, remember, understand, apply, analyze, and evaluate. Students are known for codes C1 to C6. Based on the level of intellectual ability, C4 (Analyze), C5 (Evaluate), to C6 (Create) are HOTS. Meanwhile, C1 to C3 are classified as low-level thinking or LOTS [17].

Higher-order thinking occurs when a person acquires new information and relates it to previous knowledge, combines knowledge to achieve certain goals, and finds solutions to problems. Problem-solving is deciding what information to do, generating ideas, making predictions, and solving non-routine problems. Higher-order thinking is expected to make individuals interpret, analyze and manipulate information. Higher thinking skills assist individuals in using newly acquired information to elicit responses to new situations or circumstances. Ideas from higher-order thinking are obtained through the application of knowledge from activities of daily life [18].

Cognitive thinking skills are divided into two parts, namely, lower and higher-order thinking skills. HOTS comprises four components: reasoning, problem-solving, critical, and creative thinking [19]. LOTS includes remembering, understanding, and applying, while HOTS comprises analyzing, evaluating, and creating. The main characteristics of HOTS are critical and creative thinking. Developing students' cognitive domain is a learning process that boosts their Low Order Thinking Skills. HOTS-based learning is important and needs to be applied in class because it equips students and causes them to carry out specific tasks or experiments. In addition, it helps students to skillfully seek knowledge through inductive and deductive reasoning or identify and scientifically explore existing facts. Furthermore, the application of HOTS needs repeated thinking activities.

Materials and Methods

The ADDIE model has a systematic and flexible nature to assess technological developments during learning [20]. The second research question tested the increase in the number of students who have HOTS after participating in mobile-based learning. Following Anderson's concept, HOTS can evaluate questions using the cognitive domain from C4 to C6. The research data were obtained using the following steps. Develop a HOTS-based evaluation instrument in the form of argumentative questions, test the validity and reliability of the evaluation instrument, collect data, analyze and interpret and Draw a conclusion

The research respondents include 120 students equally divided into the experimental and control classes. The respondents were selected from 650 vocational school students in Central Java using the random cluster sampling method. Data were collected during the COVID-19 Pandemic through observation, interviews, and written test documentation. The Observations and interviews were used to obtain data on the development and application of mobile learning. Meanwhile, the written test, which was in argumentative multiple-choice questions, was used to determine learning outcomes after utilizing a mobile application. Scoring was based on the number of accurate answers due to the available rubric.

The research data were collected during the COVID-19 pandemic. Data were analyzed using descriptive statistics and an independent sample T-test with SPSS 20 software. Descriptive statistical techniques were used to analyze the effectiveness of the applied media. In contrast, the independent T-test was used to determine the difference in values obtained from the control and experimental classes [21].

Findings

Analysis

This stage adopted the interview method with mostly students, teachers, and graduates [22, 23]—the interview aimed at acquiring information related to CNC programming learning (Table 1).

Table 1) Information on the results of the analysis stage

Respondent	Results
Teachers	Teachers find it difficult to teach due to limited facilities. The poor skills and creativity of teachers in developing instructional media. The teachers adopted the teacher-centered Approach to learning.
Students	Students find it difficult to understand the learning subjects. Students are unable to illustrate the manner the compiled CNC Turning program functions. Students find it difficult to learn independently. Poor student motivation and learning achievement
Alumni	Low competency of CNC Turning graduates Difficult to compete in the world of work Lack of confidence in facing challenges

Design

Content design in mobile-based learning is based on vocational high schools' basic competencies and learning objectives. Learning contains CNC programming, drawings, ability test questions, CNC work, program simulation videos, and virtual explanations of learning materials. The material's content comprises text, images, and graphics capabilities of attracting and increasing students' understanding [24]. The presentation of virtual reality videos aims to provide an accurate picture of how the program is run. Students practicing critical and creative thinking skills are given some difficult jobs [25].

Implementation

This stage was carried out using an experimental model with a pretest-posttest random control group pattern to compare it with the control subject. The model formulations are shown in Table 2.

Table 2) Model group of pre-test-post-test design

Group	Sampling method	Pretest	Treatment	Postest
E	R	O_1	X	O_2
K	R	O_3		O_4

Table 2 shows R random sampling, E experimental group, K control group, X treatment, 01 Pre-test experimental group, 02 Post-test experimental group, 03 Pre-test, and 04 Post-test control group.

Evaluation

The evaluation process was carried out by analyzing the results using descriptive statistical techniques and independent T-tests [21]. The results of statistical tests can be seen in table 3.

Table 3) Descriptive analysis of the control and experimental groups

Group	Minimum	Maximum	Mean	SD
Pre-test Experiment	35.00	61.00	43.32	6.05
Post-test Experiment	36.00	77.00	62.00	10.91
Pre-test Control	31.00	63.00	43.08	7.40
Post-test Control	31.00	63.00	46.73	8.39

Table 3 shows the difference in the mean value of the pretest-posttest in the control and experimental classes. The significance value of the control class was 0.08, and the experimental class was 0.21. The data were distributed normally, and an independent t-test can be performed. The independent t-test showed that Levene's test value for the equality of variance was 0.017, so the data homogeneity was not met. There was a significant difference between the control and experimental classes in applying mobile learning techniques (p=0.001).

The second research question comprised two aspects: strategies used to measure students' learning outcomes and their higher-order thinking skills to improve. First, the students' learning outcomes were measured by developing HOTS-based written test instruments after the implementation of ML. The test instrument is an argumentative multiple-choice question based on HOTS, as shown in Figure 1. It consists of 20 questions that differ from other test questions. This test is based on students' criteria to select the correct answer. However, they also need to provide the appropriate reason. Second, a validated assessment rubric was used to simplify the entire process and the HOTS-based questions and answers. According to Bloom's criteria, the developed test items were revised by Anderson in the form of cognitive domains from C4 to C6. Specifically, the selected active verbs aentiatere analyzed (C4), evaluated (C5), and created (C6). The results from the item validity test are shown in Figure 1.

Validation of the items using the Infit Mean Square (MNSQ) criteria ranges 0.77-1.30. The results of the analysis of the instruments valid showed that the 20 questions tested were valid. The reliability test was carried out on the items measured using the Quest program with a value of 0.61. The reliability of the items was included in the good category.

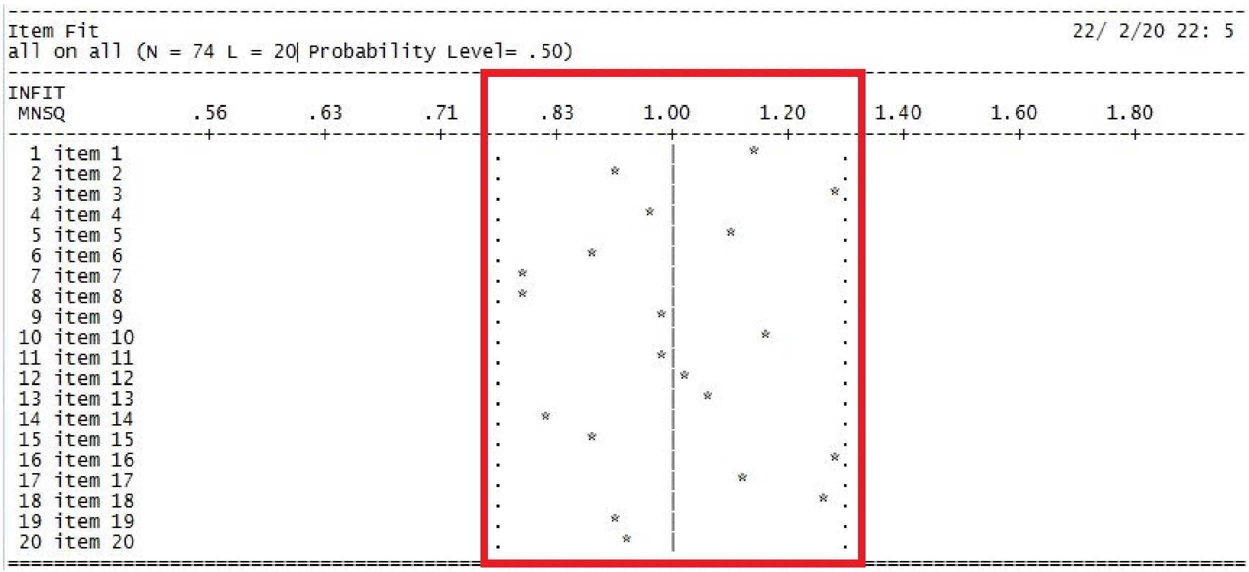
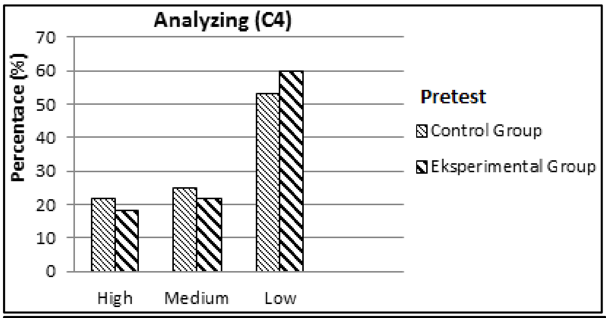


Figure 1) The results of the item validity test.

Reliability test to determine the consistency of the items used. The reliability coefficient criteria below 0.40 are bad, and 0.40 to 0.59 are quite good. Furthermore, when the reliability criterion is between 0.60 and 0.74, it is good and very good between 0.75 and 1.00. This experimental-based research's final stage measures the students' higher-order thinking skills (HOTS). The results are shown in Figure 2.

Figure 3 shows the students' ability to answer the questions at the analyzing level. Meanwhile, students' analytical skills improved significantly from 18.33 to 83.33% and in the high category after mobile-based learning.



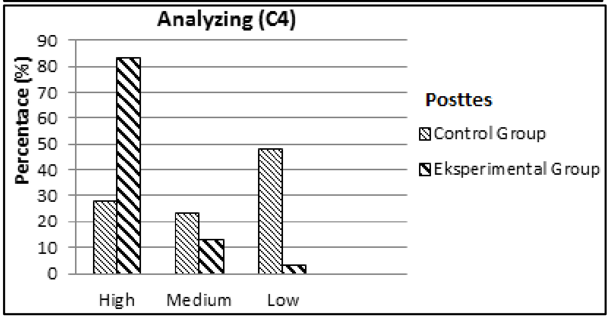


Figure 2) Student's ability to answer the questions in analyzing category (HOTS Level-C4)

Discussion

The data from the descriptive statistical analysis showed the difference in the mean scores of the control and experimental classes. The control class has an average value of 43.09 pretests and 46.73 post-test. The experimental class average value of the pretest was 43.32, and the posttest was 62.00. The increase in student competence is significant after using mobile learning. The use of mobile learning improves the quality of learning in students and teachers [11, 26]. It also increases students' involvement in learning. Thus, mobile learning changes the way humans learn.

Furthermore, students' large number of smartphones serves as a suitable learning medium. Mobile learning media allows students to learn independently and be guided by the teacher [26]. In addition, the developed mobile learning is accessed either online or offline. This proves that developed mobile learning has numerous advantages [27].

The presentation of appropriate content to support mobile learning positively affects students. The Approach presented during mobile learning is developed in images, text, and virtual reality simulation videos. Virtual reality simulation videos help students understand correctly the material being taught and increase learning motivation [28]. In addition, they believe it aids them in acquiring first-hand knowledge regarding how the program works, thereby avoiding misunderstandings when concluding.

Therefore, mobile learning is an effective process that greatly affects learning outcomes. Furthermore, mobile learning models also reveal the weaknesses and strengths of the teachers and students [29]. Consequently, it is perceived as a domain of improvement and enhancement for both of them. To date, teachers still believe that evaluation is a valuable process for determining students' learning outcomes. However, they have also realized that it is also helpful for measuring a teacher's readiness to teach after applying this model.

Conclusion

The development of a mobile-based learning approach stimulates students' higher-order thinking skills (HOTS). Students show an increase in critical and creative thinking skills. This is evident in their ability to answer test questions accompanied by rational reasons. This causes the students to be eager to learn and dare to work on more challenging questions. A mobile-based instructional approach supports independent learning and boosts students' confidence. HOTS provides an overview of teachers to improve 21st-century learning skills. The teacher's role in implementing mobile learning in CNC programming is significant. The teacher makes appropriate learning scenarios and provides feedback on the importance of using mobile learning to produce competent students. The mobile-based learning approach facilitates students' ability to learn anywhere and anytime. Students tend to assess their abilities before asking for reinforcement from the teacher.

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