Learning through Computer Science Unplugged on Team Assisted Individualization on the Computational Thinking Ability

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Abstract---Technical facilities are an element that can support educational and learning activities, especially for professional students in the fields of technology and information. Computational thinking is also one of the supportive skills that every student must have. This is consistent with the preliminary research conducted by the researchers. The teacher said that when students learned basic programming materials, they found it difficult and slowed down because of the limited media they used and the non-optimal methods. This research is aimed to determine the effect of unplugged media based on team assisted individualization on the computational thinking skills of vocational high school students in basic programming subjects. The method used in this research is Quasi-experiment using pretest and posttest control group design. The results of the survey are as follows. 1) Learning media was declared available by media professionals at a rate of 94.23%, including the "very good" category. (2) The designed learning media can improve students' mathematical thinking skills with an average profit value of 0.49, and the standard of effectiveness is "medium". (3) Student response to the use of learning media shows a 97.87% percentage value in the "Very Good" category.

Introduction

The effective use of technology in education has changed aspects of education and created more educational opportunities. Technology has many roles in education. One of them is to support learning and teaching activities, especially in subjects of Technology and Informatics that is available at Vocational High Schools (Fabry & Higgs, 1997). Vocational High School (SMK) is a formal vocational education institution at the high school level. The success or learning achievement that achieved by a person is the result of the interaction between various factors that influence it both internally and externally (Lewalter, 2003; Hedegaard, 2014). Vocational High School students are also required to be able to solve various problems. Thus, we need a way of thinking that is compatible and practical. Vocational students, especially in the realm of technology and information, need a computational way of thinking.

Teaching computer science (CS) concepts and computational thinking (CT) skills has gained a significantly important role in recent years for people of all ages (Sauppé et al., 2015). Computational Thinking (CT) is important for problem solving, which refers to the thought process in defining problems and proposing solutions (Shute et al., 2017). Computational thinking is a student's basic ability in education that forms the same foundation as the ability to read, write and do math (Zhong et al., 2016). By learning with computational thinking as a basic skill of the entire curriculum, students are prepared to learn abstract thinking, algorithmic and logical thinking and solve complex and unrestricted problems. Computational thinking is a basic learning ability for everyone and represents an important preparation for the future to train young people with computer-aided thinking (Artz & Gil, 2007; Papastergiou, 2009). Activity-based learning strategies support the cognitive growth of young people and can effectively control learning through manipulation and actual expression (Cho & Lee, 2017). Another research used computational thinking to improve cognitive level on the subject algorithm and programming was on development of computational story (Riza et al., 2018) and on using game programming (Riza, et al., 2020).

Various types of cooperative learning have been developed, one of the learning models that can help students improve their computational thinking skills towards the concepts of basic programming subjects, namely Team Assisted Individualization (TAI). The Cooperative learning model is a learning model that emphasizes the use of student groups (Durak & Saritepeci, 2018). The principle to be followed for co-operative groups is that all students in the group have different levels of proficiency (high, medium, low) and, if necessary, come from different races, cultures and ethnic groups. So take into account gender equality (Posamentier & Stepelman, 1990). The Team Assisted Individualization type is designed to overcome student learning difficulties individually (Artut, 2009; Fu & Hwang, 2018). Every learning condition departs from individual differences related to students' abilities and achievement of learning outcomes. With group

learning, it is hoped that students can improve their critical thinking, be creative, and cultivate a high social sense.

Learning support facilities that is not evenly distributed, such as computers, being a limitation in basic programming learning activities, is one of the reasons why researchers use the unplugged method. Unplugged coding activity programs or coding that are not connected in learning, use direct activities with a concrete representation of interrupted activities without computers (Lee, 2020). The unplugged method is one way to facilitate the material by not making the computer the main facility. There were some researches proposed by using unplugged computer science, such as by Bell et al (2009), Bell & Vahrenhold (2018), and Nishida et al (2008).

According to previous research explained, we developed learning media using the concept of unplugged computer science for improving the computation thinking skills of vocational high school students in basic algorithm and programming. On the experiment, we perform the media based on team assisted individualization (Morimoto et al., 2010; Thomas et al., 2016).

Research Method

This research uses a quasi-experimental method. The research design used was a pretest and posttest control group design. The use of this design is to know the increase in students' computational thinking skills after being given treatment. In this design there are two groups, namely the experimental group and the control group which were selected randomly (Wei et al., 2021).

In this study, the group used for the experimental group was class X TKJ 1 and the control group was class X TKJ 2. After the group division was determined, the teacher gave an initial test sheet or pretest so that researchers could find out the initial state of students' computational thinking abilities, then the student is given the treatment (teaching and learning activities) in each class. For the Experiment class, students were given treatment by teaching using unplugged and Team Assisted Individualization methods. For the control class, the treatment given was the conventional or lecture method. After completing the treatment in each class, the researcher gave a posttest to measure the final state of each group. The research design used can be described in Table 1.

Table 1
Pretest-Posttest control group

Group	Pre-test	Treatment	Post-test
Experimental	O_1	x	O_2
Control	O_3	x	O_4

Information:
Experiment   : Students were given unplugged and Team Assisted Individualization methods.
Control   : Students were given conventional or lecture method
O_1 : Pretest Experimental Group

O$_2$: Posttest Experimental Group
X   : Treatment
O$_3$: Pretest Control Group
O$_4$: Posttest Control Group

The research procedure is divided into 5 stages, which are Analysis, Design, Development, Implementation, and assessment. The explanation is as follows:

- Analysis stage, where an analysis of the needs is carried out which will be used as the formulation of the problem and the basis for creating a learning media through unplugged based on Team Assisted Individualization through literature studies and field studies.
- Design stage, at this stage the preparation of things needed in the development of learning media is carried out based on the results of literature studies and field studies that have been carried out. Before going to the next stage, at this stage, validation is carried out by experts, which aims to get criticism and input so that the material, question instruments, and storyboards are in accordance with the needs of unplugged learning media based on Team Assisted Individualization that will be developed.
- Development stage, at this stage media development is carried out from the storyboard design that has been made at the design stage. At this stage, the steps of the Team Assisted Individualization learning model will be applied which are used as the learning media flow that has been designed. Before going to the next stage, at this stage expert validation is also carried out which aims to get criticism and input so that the unplugged learning media based on Team Assisted Individualization is made appropriate and really feasible to use.
- Implementation stage, at this stage when the learning media has been declared feasible. Thus, field trials were carried out. First, students will be given a pretest to determine the students' initial abilities. After students do the pretest, the experimental group will carry out learning activities using unplugged learning media based on Team Assisted Individualization. Meanwhile, the control group carried out learning activities in a conventional way. After that, students will be given a posttest to see the effect of learning activities on students' computational thinking skills. Furthermore, students will be asked to respond to the use of the media they have learned.
- The Assessment stage, at this stage is carried out to find out the results of the research that has been carried out on the experimental class and the control class, namely by analyzing the increase in students' computational thinking skills.

The population in this research were students at SMK Pekerjaan Umum Negeri Bandung Provinsi Jawa Barat. Thus, the sample in this research were students majoring in Computer and Network Engineering (TKJ) class X. Researchers chose class X respondents because they were teaching basic programming subjects.

The instruments used in this research are: Field study instruments in the form of giving questionnaires to students and conducting interviews with subject teachers. Media expert validation instruments are using Multimedia Mania 2004 –

Judge's Rubric North Carolina State University; as well as student response instruments in the form of a questionnaire or questionnaire assessment and given to students who have used unplugged learning media based on Team Assisted Individualization (Kanca et al., 2021).

Results and Discussion

In this section, we illustrate results on developing media using the unplugged computer science. The initial stage in designing unplugged learning media based on Team Assisted Individualization is that researchers conduct initial studies in the form of field studies as well as literature studies (Shomirzayev, 2021). Field studies conducted in the form of giving questionnaires to students and interviews with subject teachers at the SMK Pekerjaan Umum Negeri Bandung majoring in Computer and Network Engineering. In addition, there are also the results of interviews with subject teachers as follows:

- The teacher reveals that in teaching and learning activities, initially students learn with enthusiasm when the teacher uses simulations with web media that combines games with programming, but over time, when students are given case studies, students begin to experience difficulties.
- The learning methods commonly used are Demonstration and PBL which are still less effective.
- The basic programming subject teachers who have been interviewed reveal that the branching material students are still having difficulties, where the branching material is the material found in class X.
- Branching is a mandatory material that students master in basic programming subjects because the following materials require basic branching concepts.
- The teacher reveals that the number of computers is still limited and some computers are not suitable for use.
- The teacher feels that there are several obstacles in teaching and learning activities, especially on computer applications and devices.
- The teacher also expresses interest in developing learning media that can increase student interest in learning because each student has different special characters with diverse learning styles.

Based on the results of the field study, innovation in teaching and learning activities is needed. With the help of unplugged learning media based on Team Assisted Individualization, it is hoped that students will increase their interest in learning so that they can improve students' computational thinking skills (Azzajjad et al., 2021; Altam, 2020).

In the design stage, it is designed to create media in the form of board games with branching material in basic programming subjects for class X to improve students' computational thinking skills. This media is designed as a learning tool, so the Team Assisted Individualization learning method still plays an important role. Then, the media is documented with Animation. Media user interface can be seen as follows:

- Main Menu
  On the main menu page there are competency buttons, introduction, teaching materials, libraries, developer profiles, and credits as shown in Figure 1.

Figure 1. Main menu of media

- Branching Material 1 Condition
  On this page is one of the materials available in learning media. Branching Material 1 Condition there is a video display of learning material for branching 1 condition as shown in Figure 2.

Figure 2. Branching material 1 condition page

After developing the media, we perform expert validation test. It is to test the feasibility of unplugged learning media based on Team Assisted Individualization which has been developed by experts. This validation test refers to multimedia mania 2004. Aspects of media expert validation have 5 criteria, namely mechanism, multimedia elements, information structure, documentation, and content quality.

The value obtained is based on the results of validation by two media experts, namely the mechanism aspect. Meanwhile, based on the validation results by the second media expert, namely the mechanism aspect with a value of 90.63%, it means that all mechanisms (Media, buttons and navigation tools, Spelling and

grammar, and Element) in the media is good. 93.75% of multimedia elements means that all elements (multimedia elements and content, graphics, video, and audio) are used to function according to the purpose so that they are effective in helping learning (Rinartha et al., 2018).

The information structure of 94.38% can be said to be a logical and intuitive series of information. The flow of media and how to get information on the media is direct and clear. Documentation of 97.5% or all sources cited and permission to use all assets and asset copyrights are listed. And the quality of content is 94.9% all media content supports learning objectives, GPA, and is in line with expectations. Based on the assessment of media experts conducted by two media experts, an average value of 94.23% was obtained which was included in the very good category based on the interval validation results and was suitable for use.

Based on the experiments conducted, unplugged learning media based on Team Assisted Individualization has an influence on students' cognitive improvement as seen through the results of the pretest and posttest. The comparison of the values of the pretest and posttest results is used in calculating the gain index. Gain index calculation is done to determine the increase in students' computational thinking ability. The results of the calculation of the gain index in both groups can be seen in Table 2.

Table 2
N-gain analysis results

Group	$\bar{x}$ Pre-test	$\bar{x}$ Post-test	$\bar{x}$ Gain	Effectiveness
Control	46,8	65,5	0,35	Medium
Experimental	50,7	71,6	0,43	Medium

Based on table 2 above, it can be seen that the average gain index in Figure 1 obtained by the control group is 0.35 which if interpreted in the learning effectiveness criteria is "Medium". Meanwhile, the average gain index obtained by the experimental group is 0.43 which, if interpreted in terms of learning effectiveness criteria, is "Medium". Based on this explanation, it can be concluded that there was an increase in student learning outcomes in each group. Then it is also reinforced with data on students' computational thinking abilities from several indicators such as decomposition, pattern recognition, abstraction and algorithm design as in Table 3.

Table 3
Result of N-gain analysis of computational thinking ability

Group	Decomposition	Pattern Recognition	Abstraction	Algorithm
Control	0,46	0,55	0,16	0,42
Experimental	0,68	0,68	-0,13	0,63

From the data above, it can be seen that the students' computational thinking ability from several indicators of students' computational thinking can be

concluded to increase. Hypothesis test was conducted to determine the increase in understanding experienced by students through the significance value. The researcher conducted data processing using SPSS 25. This hypothesis test used a t-test (independent test), which was to test the difference in the mean of two independent groups as illustrated in Table 4.

Table 4
Result of N-gain analysis of computational thinking ability

	Pair Sample	Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest Control	51.00	15	17.647	4.557
	Posttest Control	70.67	15	12.081	3.119
Pair 2	Pretest Experimental	56.00	15	16.605	4.287
	Posttest Experimental	79.00	15	16.279	4.203

From the data above, Pair 1 shows that there is an increase in the mean value between the pretest and posttest of the Control class from 51.00 to 70.67 with 15 respondents and the standard deviation of the pretest is 17.647 and the posttest is 12.081 which shows the variation in the values that occur. Then Pair 2 shows an increase in the mean value between the pretest and posttest Experiment class from 56.00 to 79.00 with 15 respondents and the standard deviation of the pretest is 16,605 and the posttest is 16,279 which shows the variation in the values that occur.

Table 5
Student Response Questionnaire Results

No	Assessment Aspect	Ideal Score	Score	Percentage (%)
1	Mechanism	60	58	96,67
2	Multimedia Element	30	29	96,67
3	Information Structure	60	60	100
4	Documentation	30	29	96,67
5	Content Quality	135	135	96,67
			Total	97,87

From Table 5, it can be seen that from the Mechanism aspect, 96.67% of the media have very good technical, navigation, spelling, grammar, and completion techniques. Multimedia elements have a score of 96.67% have the interface design, content, images, video, audio, and other devices used effectively. Information Structure 100% has information in a logical and intuitive sequence and has an attractive design. Documentation has a score of 96.67% citing sources correctly also there is permission to use assets and copyright to use assets. And the Quality of Content 96.67% of the media proved to be significant in the authenticity of its development as well as media content supporting the expected learning objectives. The average aspect of media assessment through student responses is 97.87%.

Conclusion

Based on the results of research that has been carried out in building unplugged learning media using the Team Assisted Individualization learning model to improve the computational thinking skills of Vocational High School students on the branching material of Basic Programming subjects, hereinafter referred to as BoCaGa. The feasibility has been tested with the results obtained from the validation of learning multimedia experts getting an average of 94.23% which falls into the very good category and is feasible to use.

The improvement of students' computational thinking ability can be seen from the gain index after students do the pretest and posttest. The gain index obtained by the control group is 0.36 with medium criteria. Also, the gain index obtained by the experimental group is 0.49 with moderate criteria. For Computational Thinking Ability based on the gain index obtained in the Control class which is 0.4 with the highest gain index material is Pattern Recognition and in the Experiment class it is 0.47 with the highest gain index material is Decomposition. Based on the gain index obtained, it can be concluded that learning with BoCaGa learning media in the branching material of Basic Programming subjects can improve students' computational thinking skills. The results of students' responses to the use of BoCaGa learning media with the Team Assisted Individualization learning model on the branching material of Basic Programming subjects in improving the cognitive abilities of Vocational High School students gave results of 97.87% with very good criteria.

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