Learning basic programming using CLIS through gamification

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Learning basic programming using CLIS through gamification

H W Prabawa*, H Sutarno, J Kusnendar and F Rahmah
Departement of Computer Science Education, Universitas Pendidikan Indonesia, Bandung, Indonesia

*Corresponding author’s e-mail: harsawara@upi.edu

Abstract. The difficulty of understanding programming concept is a major problem in basic programming lessons. Based on the results of preliminary studies, 60% of students reveal the monotonous of learning process caused by the limited number of media. Children Learning in Science (CLIS) method was chosen as solution because CLIS has facilitated students’ initial knowledge to be optimized into conceptual knowledge. Technological involvement in CLIS (gamification) helped students to understand basic programming concept. This research developed a media using CLIS method with gamification elements to increase the excitement of learning process. This research declared that multimedia is considered good by students, especially regarding the mechanical aspects of multimedia, multimedia elements and aspects of multimedia information structure. Multimedia gamification learning with the CLIS model showed increased number of students’ concept understanding.

1. Introduction
Sekolah Menengah Kejuruan (SMK) or known as vocational school is considered as one of Indonesian secondary educational institutions which has important role in preparing Indonesian young generations for the future by improving their intelligences, knowledge, personality, good character, moral, skills, and independence to continue their studies based on their vocational programs (Permendiknas No. 23, 2006). However, there are many obstacles in the teaching and learning process in accordance with the early visions of the establishment of SMK. In line with this, Asian Development Bank (ADB) in their research showed that there are some major weakness towards the learning process of SMK within the quality of graduates as employee. Thus, some of major weaknesses consist of the quality of teaching and learning process (around 23%) and teachers’ ability in teaching (around 4%), facilities, infrastructures, curriculum, general skills, special skills, relevance, and the length of cycle [1]. Therefore, the quality of teaching also is influenced by the applied learning model during the learning process. This condition realize or not, will influence students’ ability towards the material concepts and some subject skills. Furthermore, related to the previous study that have been applied in some vocational schools majoring Teknik Komputer dan Jaringan (TKJ) or computer and network engineering in Bandung, basic programming is indicated as the hardest subject learning. It is proved from the given questionnaire to some students that feel hard to learn basic programming. Moreover, some students also said that some obstacles were caused by less varied learning model and one direction learning media where students would only pay attention to the learning material which made them bored and less motivation in the process of teaching and learning process.
Relevant to the previous elaboration, one of the appropriate and common learning model in teaching algorithm is Children’s Learning in Science (CLIS). Basically, CLIS consists of constructivism towards students’ experiences and early concepts where the learning focuses are on some hands and natural activities [2]. Moreover, CLIS is considered to make students more independent, especially in solving problems and creating some creative things so that they will cooperate each other within the comfort class situation [2]-[4].

In the implementation of teaching and learning process, the role of multimedia learning should help students in comprehending the learning content ideally or just increasing their motivations to interact and keep with multimedia. This study attempts to offer gamification-based learning media as the learning aids in programming. Nick Palling introduces the term gamification in 2002 at TED (Technology, Entertainment, and Design) event. Gamification is interpreted as the utilization of game mechanical elements to give some practical solutions through group building interest (engagement) [5]. Gamification is also defined as the utilization of game mechanical elements and logical games to bind people, actions motivate, promote the learning, and solve problems [6]. In line with this, gamification method is a method that focuses on introducing, changing, and operating the service system between people and computer which takes its inspirations from mechanic game. Besides, it also encourages business to be more fun by involving mechanic game [7].

According to the implementation of gamification in the learning process, some theories says that gamification gives positive impact towards the students’ understanding and interest through the learning material [8] [9].

1.1 Programming Learning Problems
Du Boulay (1989) states that at least there are five potential difficulties in the programing learning [10], as follows:

- General Orientation, it relates with the orientation of program development that also involve the reason in developing program and some successful programs as the positive results of the program development.
- The Notional Machine, it is considered as an abstract model from the process of computing work that used in planning some programs by using computer. For instance, programming language or code.
- Notation, it usually relates with the programming language used which consist of syntax and semantics.
- Structures, it consists of scheme and program development plan
- Pragmatics, it relates with the skills in doing the analysis, planning, developing, testing, conducting the debugging process, and others

Furthermore, Du Boulay (1989) notes that computing learning is the early obstacles, including the programming which is discovered when students attempt to try finishing some problems in the same time. Thus, it potentially raises over-generalization and misapplication of analogy [10]. Over-generalization is defined as students’ tendency to observe some problems or condition through programming which cannot be changed and tend to make generalizations. However, misapplication of analogy is described as mental process where students tend to create representation from one concept by doing analogy (it is aimed to make them easy in remembering and comprehending the concept), nevertheless the used analogy is inaccurate to represent the concept.

In the basic programming subject, the early understanding is needed by the students as the trigger to be more skillful in creating some programs. It means that students should have early understanding or picture of the concept so that they will not find some big problems to acquire the next learning concept. Furthermore, lack of understanding concept happened since the students only memorizing some basic questions or exercises without giving its own and also memorizing some vocabularies without
comprehending the real meaning. Relevant to previous elaboration, to achieve such purposes, the study attempts to address these questions:

- How does multimedia of gamification learning integrated with Children Learning in Science (CLIS) model affect the development of vocational students’ ability through the basic programming subject course?
- How is vocational students’ response towards the gamification learning that integrated with Children Learning in Science (CLIS) model through the basic programming subject course?

2. Methods

This study applies quantitative approach with One Group Pre-test and Post-test design. This design has a paradigm that there are one group got treatment and hereinafter the result were observed, however, before giving the treatment, there should be a pre-test to know the early conditions. Therefore, the result of treatment will be more accurate since it could compare with the previous situation. Thus, by applying this design, there are two observations which implemented - before the experiment (pre-test) and after the experiment (post-test) to gain the results of students’ development.

Furthermore, the data were collected in one of vocational school that majoring computer and network engineering in Bandung city, West Java, Indonesia and involved 31 students. In collecting the data, this study used two instruments, such as 1) students’ ability test, the test was given in the early and end of learning process. The early test is purposed to measure the real students’ ability while the last test was aimed to see students’ ability after the treatment and learning process; 2) observation instrument through the component of Technological Pedagogical Content Knowledge (TPACK).

Moreover, this study was implemented in four meetings in one week. The detail observations were first meeting during 1 course hour for pre-test, second meeting during 2 course hours for branches of algorithm 1 and 2 conditions by using multimedia gamification learning and CLIS learning model, third meeting during 2 course hours for branches of algorithm 3 and 4 conditions by using multimedia gamification learning and CLIS learning model, and last meeting during 2 course hours for implementing post-test and media instrument assessments.

Furthermore, this study also divided the students into the main groups such upper group, middle group, and lower group. It is aimed to know the impact of using multimedia gamification learning and CLIS learning model towards the development of vocational students’ ability. Therefore, from the calculation, the upper group consisted of eight students middle group consists thirteen students, and lower group consists of eight students.

3. Result and Discussions

Besides involving rewards system as one of elements from gamification media, the developing media also involves some gamification elements, such as: the existence of players; aesthetic elements and engagement. Therefore, in this multimedia, the players move to the right side, to the left side, and jump in some position to get the points as much as they can. Moreover, the players also have to finish each stage and challenge that available on the games until they reach the finish. The aesthetic element in this multimedia provided the harmony of color, picture, and themes in each stage of the game. Themes that are provided from gamification related with nature and the adventure of players in collecting the coins and finishing all stages of the games, so that the color will be dominated by green from grass and trees, brown from the soil, and blue from the cloud. The changes of the color in each stage are aimed to provide students with various games and themes. The engagement elements which are known as different stages in each level and also different cases in each level that should be finished by the players. Table 1 provided some information towards the process of adoption of CLIS learning stages into multimedia activities.
Table 1. The adoption of CLIS learning activities into learning media

| The stages of CLIS method | The implementation of CLIS stages through the learning media |
|---------------------------|----------------------------------------------------------------|
| **1. Introduction**       | User login and the presentation of general learning objectives  |
| **2. Orientation stage:** | In this stage, students’ attention and interest were raised by the teacher who gave some examples of natural phenomenon that quite interesting and related with daily activities. |
|                           | Media showed video about branching algorithm cases in daily life |
| **3. The stage of Idea**  | In this stage, teachers need to give some problems to encourage students’ idea. |
|                           | Media showed branching algorithm cases where the students should solve that problems later |
| **4. The stage of rearrangement of ideas** | Media gave chance for students to share their ideas in solving and fixing the given cases. Therefore, media showed a character in games to provide students’ discussion to get clear and final ideas. |
| a. Disclosure and exchange of ideas | In this stage, students revealed the early ideas that they know, then they need to discuss with their group. By doing the discussion, students were expected to reveal and share their ideas. |
| b. The change of conflict situation | By sharing ideas with the character in the games, students were expected to get new ideas. Thus, some cases also showed on the media where students were expected to answer those cases. |
| c. The construction of new ideas | Media showed another cases that should be answered by the students. In this stage, the students offered different answers after sharing previous ideas with their group. |
| **5. The application of ideas** | Media showed new cases through the evaluation form, but the media should show video of learning material in accordance to help and add students’ knowledge related to the theory of branches algorithm. It is aimed to make students steadier in finishing the test. |
| **6. Reviewing the changes of idea** | The teachers invited students to compare the new ideas with the previous one. |
Figure 1. Gamification interface in stage of idea

Figure 2. Gamification interface in stage of rearrangement of ideas 1

Figure 3. Gamification interface in stage of rearrangement of ideas 2
The involvement of gamification elements in the CLIS staging is focused on the exchange and disclosure of ideas and evaluation. In the stage of exchange and disclosure of ideas in the form of non-player character (NPC) which is a virtual character who plays a role in helping students solve challenges. While in the evaluation stage, gamification is more emphasized on the mechanical aspects of leveling, point system and score (Figure 1-3).

The impacts of multimedia gamification learning that integrated with Children Learning in Science (CLIS) model towards the development of students’ understanding within the concept are presented in Table 3.

### Table 2. The Result of One-way ANOVA test

| Source of Variation | SS  | df | MS          | F      | P-value | F crit  |
|---------------------|-----|----|-------------|--------|---------|---------|
| Between Groups      | 0,392 | 2  | 0,196380    | 29,68665| 1,94E-07| 3,369016|
| Within Groups       | 0,171 | 26 | 0,006615    |        |         |         |
| Total               | 0,564 | 28 |             |        |         |         |

### Table 3. Gain Index and Satisfaction towards Multimedia Learning

| Group | Pre-test | Post-test | Gain | Questionnaires |
|-------|----------|-----------|------|----------------|
| Upper | 31,00    | 83,00     | 0,76 (high) | 93.75 |
| Middle| 38,15    | 75,54     | 0,61 (average) | 80.77 |
| Lower | 34,00    | 64,00     | 0,44 (average) | 71.88 |

Referring to Table 2, there are the differences on average enhancement of students’ understanding based on the statistical test by using one-way ANOVA test. It is also supported by the result on Table 3 where the calculation of gain index normalized <g> referred to Hake’s (1999) calculation, informs the differences of students’ enhancement in understanding the basic programming. The finding shows score <g> for the upper group is 0,76 and belong to the highest criteria, score <g> for the middle group is 0,61 categorizing to the average criteria, while score <g> for the lower group is 0,44 which indicates as the average criteria. The achievement of highest criteria score <g> from the upper group and average criteria score <g> from the middle and lower group are happened since multimedia gamification learning through CLIS learning model employed in the teaching and learning process. Besides, it also influenced by some elements in the games on the multimedia learning which motivated students sin they had a happy and fun learning. The Pearson correlation score puts in 0,61 which shows that the relation of those scores were high. It means that the students’ response towards the used multimedia in line with the gain scores in each group.

Furthermore, beside the effect of multimedia and games, other factors that influence students’ ability is Children Learning in Science (CLIS) model that applied in the learning process. In the early meeting, students are showed some scenes that related with branches algorithm by reflecting to their daily life, then the students should finish some branches algorithm cases by exploring and sharing ideas, after that students get learning material which will be related with their ideas before they move to evaluation stage. Therefore, in the evaluation stage, students are expected to reach perfect score or 100 to be able to move to the next learning material, if not, they should repeat the material until they reached the perfect score.

Moreover, the observations in this study also informs that there are some students who lack of focus in the learning material stage (most of them came from lower group), especially when they watched
video about branches algorithm. It is caused by the differences of students’ learning style that have not organized well yet towards the developing media.

4. Conclusion
Relevant to the findings and discussions, it can be concluded that multimedia gamification learning using Children Learning in Science (CLIS) learning model give positive impacts towards students’ ability and development from the upper group, middle group, and lower group. Therefore, each group shows different development, the most significance is gained from the upper group which compared to middle and lower group. Furthermore, students show positive response towards the implementation of multimedia gamification learning using CLIS model. Regarding to the percentage of the result that put in 81, 90%, it is suggested that the use of multimedia gamification learning through CLIS model is considered as an alternative in delivering material to the students in the teaching and learning process.

For further study, since the study only focuses on the use of multimedia gamification learning and CLIS, it is better to involve TPACK for the next research at vocational school that majoring in technology [11].

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