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The use of CIPP model for evaluation of computational algorithm learning program

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Abstract. The objective of this research was to evaluate the learning program of computational algorithm subject in two private universities in Surabaya. The evaluation was performed by using the theoretical framework of CIPP model. There were two research questions presented in this study: what is the research design to evaluate the learning program and what is the profile of the learning style-based computational algorithm learning program according to CIPP model. The results showed that the research design consists of 5 steps, which are: to determine the focus of the research, to collect the data, to test the instruments' validity and reliability, to analyse the data, and to draw a conclusion. Every research step is formulated based on 4 components, which are: context, input, process, and product. The learning program has several profiles. Firstly, the pre-required environment does not correspond with the characteristics of the population. Secondly, students' mathematical ability does not meet the qualification set in the lesson plan. Thirdly, the supporting learning facility and instruments are not sufficient. Next, the implementation of the lesson plan is adjusted according to students' condition. Lastly, the average of students' computational algorithm scores is 49. It is recommended to conduct matriculation program before the actual learning program for students that do not meet the pre-requirements stated in the lesson plan. The matriculation module consists of the basics of mathematical reasoning, which includes: arithmetic logics, algebraic logics, and mathematical logics.

1. Introduction

Context, Input, Process, and Product (CIPP) is the first evaluation model used for education and was introduced by Stufflebeam in 1965[1][2][3]. In this work, this model was used because it focuses on the system improvement instead of proving a certain point inside the system [1][3]. Moreover, CIPP is systematically designed as the guide to evaluate the learning process, starting from the beginning of the assessment (context and input evaluation), during the implementation (input and process evaluation), to the final evaluation of the learning outcomes (product evaluation) [2]. The nature of this model corresponds with the objective of this research, which is to improve the design of computational algorithm for students with below-average competency in basic arithmetic skills. Additionally, these students had the tendency of having kinaesthetic and/or tactile learning style [4][5].

The learning process has been improved since 2013 [6]. The improvement was made by adding media devices, such as software applications. The purpose of the media devices was to help the students to visualize the concept of design and iteration. The result showed an improvement in the average score. However, the dimension of the cognitive process, which was based on Bloom Taxonomy [7], remained in C1.

Another research also improved the learning model by using the theoretical framework of APOS [8]. The result showed an increase in the cognitive process dimension from C1 to C2. However, this result could only be achieved when outside stimulus, which was the logic and algorithm learning software application, was present. Based on the characteristics, this level of understanding was categorized by Asiala [9], DeVries [10], Dubinsky [11], and Tall &Vinner [12] as the understanding in the action level.

On the other hand, the learning outcome of the computational algorithm subject is to be able to create logical automation processes, which are presented in the form of flowchart and pseudo code [13]. By having this characteristic, the knowledge learned in the programming algorithm subject is considered as metacognitive knowledge [7]. As stated by Skemp [14], in order to learn metacognitive knowledge, the ability to draw a correlation between one concept to another so that a new, more complex concept is produced, is needed. This new and more complex concept is called schema. In the APOS theoretical framework [9][10][11][12], the establishment of schema corresponds to the highest level of understanding. APOS itself stands for action, process, object, and schema.

In this work, there is a very wide gap between the students' level of understanding and the learning outcome of computational algorithm subject. Because of this reason, evaluation of existing learning design is essentially needed. In this research, there are two important research questions: what is the research design for computational algorithm learning program evaluation based on the learning style, and what is the profile design of learning style based computational algorithm subject learning according to CIPP model.

2. Method

The program was evaluated by using the quantitative research paradigm, with the process approach. For this reason, CIPP was chosen as the evaluation model. The scheme of CIPP is described in Figure 1.

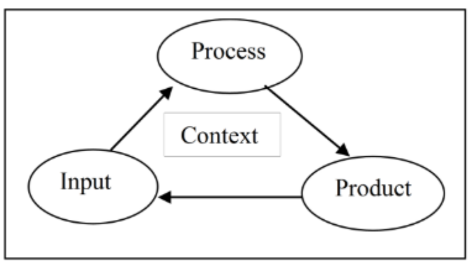

Figure 1. CIPP evaluation scheme

There are 5 steps to design the evaluation of the research program, which are: (1) to determine the focus of evaluation, (2) to determine the data collection procedure, (3) to make the instrument used for data collection and to test its reliability and validity, (4) to analyse the data by using descriptive statistics, (5) to draw a conclusion based on the 4 components of CIPP.

The focus of the evaluation was determined based on the 4 components of CIPP. Context evaluation aims to obtain the profile of the program environment, unmet needs, the characteristics of the targeted population, and the objective of the program [1][2][3]. Input evaluation aims to obtain the profile of human resources, facilities and supporting instruments, funds or budgets, procedures and regulations required to fulfil the objective [1][2][3]. Process evaluation aims to check if the prepared plan can be directly executed or requires further improvement and innovation [1][2][3]. Product evaluation stresses on the achievement of the purpose determined during the planning [1][2][3].

The subjects of this research were the students in the batch of 2015/2016 and 2016/2017. The data collection techniques were tests, document reviews, questionnaires, observations, and interviews. The tests were given in 4 topics, which were: learning style, arithmetic ability, algebra, and programming algorithm. The data analysis used was the descriptive statistic with the observed parameters of mean and proportion.

3. Result and discussion

The focus of the evaluation in this research was the 4 components of CIPP. The subject of the research was the students in the batch of 2015/2016 and 2016/2017. From the learning style test result, it was learned that 8% of the students had the tactile learning tendency, 3% had kinesthetic learning tendency, and 88% had not the tendency of visual, auditory, kinesthetic, and tactile learning style. The result of learning style test was only used as additional information, as the main focus of this research was the learning program of computational algorithm subject based on the students' learning style.

The data were collected using tests, document reviews, questionnaires, observations, and interviews. The validity of the instrument was tested by using content validation. On the other hand, the reliability of the instrument was tested in timely manner, where the subjects were tested in different occasions with three weeks intervals. The data was then analysed by using the average parameter. The conclusion was drawn based on CIPP model, by comparing the value of an average parameter with the learning achievements in the syllabus.

3.1. Context evaluation

The focus of this components is to get the profile of program environments, unmet needs, targeted population's characteristics, and the objective of the program [1][2][3].

The profile of program environments was obtained by reviewing the syllabus of programming algorithm subject in the academic year of 2015/2016 and 2016/2017. The document review results showed that the syllabus was arranged to accommodate the different learning styles of every individuals [15], especially for students with kinesthetic and tactile learning tendency. The learning media used was the software applications aimed to help students with kinesthetic and tactile learning styles to understand the abstract concepts in learning the computational algorithm subject. The abstract concepts involved variables, data, constants, operators, data processing, and flowchart [8]. The students that took the program were expected to be proficient in arithmetic operations, be it integers or fractions, and to understand the logic of basic mathematics.

In order to obtain the data of students' proficiency in arithmetic operations and basic mathematics logics, a test was conducted to the research subjects, which were the final year students in the batch of 2015/2016 and 2016/2017. The test consisted of 3 main topics, which were: (1) integer arithmetic operation problems, (2) fractional arithmetic operation problems, and (3) basic mathematics logic problems. The test results showed that: (1) the average score of integer arithmetic operation test was 76.85, (2) the average score of fractional arithmetic operation test was 43.24, and (3) the average score of basic mathematic logic test was 45.67. These results showed that the pre requirement of the program environment did not match the characteristics of the population.

The objective of the program that was written in the syllabus was that "after taking this subject, semester 1 students are able to design algorithms and evaluate their designs to solve computational problems, which are presented in the form of flowchart and pseudo codes, both individually and in team, and to possess 3 pillars of characters: honesty, responsibility, and teamwork". The data collection technique that was used to achieve the objective of the program was tested. The test instruments consisted of 2 main problems, which were to create a computational algorithm with simple variables and 1-dimensional array. The test results showed that the average score of the students was 49 and only one student scored 70. This result showed that the objective of the program was not achieved yet.

3.2. Input evaluation

The focus of the input evaluation was to obtain the profile of human resources, facilities and supporting instruments, funds or budgets, procedures, and regulations required to reach the objective [1][2][3].

The human resources that became the focus of the research were students. The profiles of the students were obtained by using questionnaires. The questionnaires' results showed that nearly 70% of the students worked while studying at the university, and paid the tuition fee with their own salaries without their parents' financial supports. The students also chose the major in information technology because it was regarded as a field with better job opportunities when compared to their current jobs. The average of the students' salary was less than 2 million rupiahs. Additionally, 90% of the students were not aware that mathematical ability was required to learn information technology.

The data of the facilities, supporting instruments, budgets, procedures, and regulations required to achieve the goal was obtained through observations and interviews. On the other hand, the data of the supporting instruments possessed by the students was obtained by questionnaires. The observation results showed that the facility and supporting instrument available in the class during the lessons was LCD projector. Neither computers nor laptops were available. There were also no additional facilities and supporting instruments to increase the students' abilities because of the very low tuition fee. On the other hand, the number of students that owned laptop was less than 30%. The procedures and regulations to fulfill the objective were inputted into the assessment system by the lecturer.

The results showed that: (1) 70% of the inputs were from the lower middle economy class, (2) 90% of the inputs were not aware that mathematical ability was needed to learn information technology, and (3) the facilities and supporting instruments used for learning needed to be improved.

3.3. Process evaluation

The data for process evaluation was obtained through observations, interviews, and document reviews. The results showed that before the lesson started, arithmetic and basic mathematic logic test was conducted in the first meeting. The results of the test showed that the average of arithmetic and basic mathematic logic scores was 55. Because the factual condition did not match the determined pre-requirement, the syllabus was modified since the first meeting by the lecturer. This data was discovered through interview and document review of class schedule report.

The material aimed to be given in the first meeting was only able to be delivered in the third meeting. In the first and second meeting, the lessons were conducted by explaining the use of the learning media. Next, the students were asked to use and re-study the learning media in groups at home. One group consisted of 5 students. The groups were formed by the lecturer, with the students whose score were greater than or equal to 60 chosen as group leaders. Every group was then given a task similar to the problem introduced in the learning media. The evaluation of the assignments submitted showed that every group obtained the score of 100, with the characteristics that every group had the same task.

In the third week, the students were given a quiz which questions were similar to the given assignment, different by only small modifications. The test results showed that only 5% of the students were able to receive the score of 100. On the other hand, the average of the test scores was below 49.

The learning evaluation at the end of the semester showed that 100% of the students were able to answer the questions well when outside stimulus that was similar to test questions existed. The mistakes that were made by the students were: (1) to determine the sequential priority of the arithmetic operations, (2) to estimate the variables used in the transformation processes, (3) to explicitly arrange algebraic equation as a form of input to output transformation, (4) to put the algebraic equation and in equation in the correct flowchart symbols, (5) to determine the truth value of a relation, and (6) the learning objective written in the syllabus was not met.

The findings showed that: (1) the proposed learning plan could not be implemented so that adjustments with students' condition were needed, (2) the learning media used by the lecturer could not increase the students' understanding to a level higher than action.

3.4. Product evaluation

The data for product evaluation was obtained through the document reviews of final scores of the programming algorithm subject and interview with the supporting lecturers.

From the interview results, it was learned that the assessment process was done in two stages. The first stage used the authentic final score. In the second stage, the authentic final score was then readjusted by considering class attendance, activeness during the lessons and honesty during the tests. The document review results showed that the average of an authentic final score was less than 49. Only one student received the authentic final score of 70. The authentic final score was taken from individual midterm test, final test, and quizzes that were given during the lessons. The discussion in this research only used the first stage assessment.

The data of the honesty, hard work, and discipline value were obtained through document reviews. The students that were honest in the test were given the score of 100. On the other hand, dishonest students were given 0. The component of the honesty value was for students to do the midterm test, final test, and quizzes by using their own ability, and did not attempt to ask for other students' help during the tests. In the tests conducted, students were allowed to open and read their notes. The activity during the lessons and assignment scores represented the value of hard work. The students that were actively doing the exercises during the lessons received the score of 100. The students that finished the assignments as instructed also received the score of 100. The assignment score consisted of 2 aspects, which were the correctness of the answer and the discipline value. The assignment scores and punctual attendance represented the discipline value. The students that submitted their assignments on time were given a score of 100. The document review results showed that the honesty score reached 80%, hardworking score reached 30%, and discipline score reached 80%.

These results showed that: (1) the average ability of students to design computational algorithms was 49. This score indicated that the students' abilities were far from what was expected in the syllabus, (2) the honesty score reached 80%, hardworking score reached 30%, and discipline score reached 80%.

4. Conclusion

It can be concluded that there are five steps used in the research design of CIPP implementation on the evaluation of computational algorithm learning program. In the first step, the four components of CIPP, which are the context, input, process, and product evaluations, are determined as the research focus. In the second step, several data are collected. Document reviews and tests data are collected for context evaluation. Questionnaires, observations, and interviews data are collected for input evaluation. Observations, interviews and document reviews data are collected for process evaluation. Interviews and document reviews data are collected for product evaluation. In the third step, the validity of the instruments, which are tests and questionnaires, is tested by using content validation. To test the reliability of the instruments, re-tests are conducted with 3 weeks interval. In the fourth step, the data is analysed by using the average parameter. In the fifth step, the conclusion is drawn based on the data analysis results according to CIPP components. The profile of algorithm learning program according to CIPP is presented as follows. The research focus is based on the CIPP model. The context evaluation result shows that the pre-requirement of the program environment does not correspond with the population characteristics. The input evaluation result shows that 70% of the students come from the lower middle economy class, 90% do not know the importance of mathematical thinking in learning computational algorithm subject, and the supporting facilities and instruments are not sufficient. The process evaluation result shows that the lesson plan is adjusted according to the students' condition and the learning media used has not functioned optimally. The product evaluation result shows that the average of computational algorithm score obtained is 49.80% of the students are honest, 30% of the students are hardworking, and 80% of the students are disciplined. Based on the profile, it is recommended to conduct matriculation program before the actual learning program for students that do not meet the pre-requirements stated in the lesson plan.

The matriculation module consists of the basics of mathematical reasoning, which includes: arithmetic logics, algebraic logics, and mathematical logics.

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