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Relating Motivation and Performance in Learning Algorithms for High School Computer Science

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Abstract A questionnaire on motivation for learning algorithms was developed based on Motivation and Learning Strategies Questionnaire (MLSQ) and the ARCS model. The main purpose of the questionnaire is to assess the motivation of students in an introductory computer science in high school. The questionnaire serves as an instrument, together with a written test, for evaluating the effects of an algorithm learning tool on motivation and performance. Based on the responses to the questionnaire, it has been found that there is an increase in the motivation level of the students after using the learning tool. The questionnaire items also correlate with the test scores of the students. The questionnaire was further analyzed and motivation components were extracted using exploratory factor analysis and a structural model that relates motivation and performance is proposed. The derived motivation components are consistent with the previously proposed components for learning science.

Keyword computer science education; learning motivation; ARCS model, MLSQ

1. Introduction

Computer science has become a regular part of the secondary school curriculum [1]. This is considered to have an impact on the high drop-out problem among computer science majors and the poor performance of students in programming. In connection to this, there is a need to address the issues on learning motivation and performance of the students through the use of instructional aid and tools that that assist learning among novice programmers. Knowing what motivation factors affect young learners when they study computer science, particularly, algorithms, is very important. This paper describes how a questionnaire on motivation and a test on algorithms were used as evaluation instruments along with the implementation of an algorithm learning tool. The objectives are to determine the motivation factors that are related to performance in learning algorithms in an introductory computer science course for high school.

2. Motivation Questionnaires

Initially, two questionnaires on motivation were designed; one is based on the MLSQ or the Motivated Strategies for Learning Questionnaire, developed by the team of Pintrich [2] and the other on the ARCS model. ARCS (Attention, Relevance, Confidence, and Satisfaction) is a learning model that aims to stimulate and sustain motivation among learners [3]. The 12 questions of the ARCS model were reformulated to adapt to the motivation issues for introductory computer science, particularly, algorithms. The two questionnaires were conducted in a pilot implementation among the students of the Information Systems course of TokyoTech High School of Science and Technology. The responses of the students in the pilot implementation were used in revising to form a 24-item questionnaire which was validated in the subsequent implementations of the learning tool among lower batches of Information Systems course, Class II-B 2014 and Class II-B 2015.

3. Data Analysis and Results

The revised questionnaire on motivation and the test on algorithms were analyzed. In order to have a consolidated analysis for the implementation of the revised questionnaire on motivation, the responses of all the students from both Class II-B 2014 and Class II-B 2015 were considered. An alpha value .926 was derived when the internal reliability of the revised questionnaire was checked using the combined responses of the students. In total, there are 64 students for both classes.

Model building was done using exploratory factor analysis on the combined responses of the two classes. Principal Components Analysis for extraction, Varimax for rotating the factors, and Bartlett's test of sphericity were used and the following values were obtained: Chi-square = 946.258, df = 276, $p < 0.001$, and a Kaiser–Meyer–Olkin measure of sampling adequacy, KMO = 0.804, indicating that the matrix is appropriate. Three factors were extracted, *intrinsic motivation*, *self-efficacy*, and *self-determination*, which are consistent with the motivation components for learning science proposed by Sanfeliz and Stalzer [4].

Several models were then tested using structural equation modeling and the hypothesized model shown in Figure 1 is proposed. Possible relation among the three motivation components, intrinsic motivation, self-efficacy, and self-determination, and the posttest performance was investigated on. In the model, intrinsic motivation has influence on both self-efficacy (.80) and self-determination (.55). Among the three factors, it is again self-efficacy that has been found to have a direct effect on the (.42) on the posttest performance of the students.

Using Scale-free Least Squares as estimation, the index fit values are the following: (Goodness-of-Fit Index) = .942; AGFI (Adjusted Goodness-of-Fit Index) = .931; RMR (Root Mean Square Residual) = .247; NFI (Normed Fit Index) = .925; and RFI (Relative Fit Index) = .918.

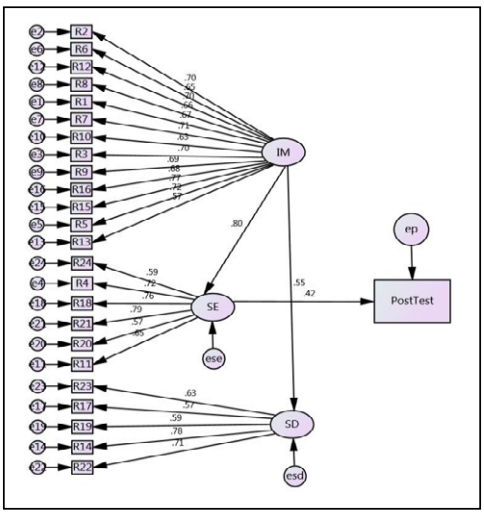

Figure1. Relationship between Motivation Components and Post Test Score

4. Conclusions and Future Work

A questionnaire on motivation and a test on algorithms were implemented with an algorithm learning tool. Three motivation components were derived from factor analysis and a structural model that relates these components with the score in the algorithm test is proposed. The said model may be used to design a questionnaire for evaluating the effects on motivation and performance of algorithm learning tools for high school computer science.

5. References

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