論文 / 著書情報
Article / Book Information

題目(和文)	高校の専門教科向けアルゴリズム学習ツールの設計と評価：使用性，教育効果，動機づけの考察
Title(English)	Design and Assessment of an Algorithm Learning Tool for High School Computer Science: Usability, Pedagogical and Motivational Considerations
著者(和文)	ｱﾊﾞﾝｾﾆｱｴｲﾐｰ ﾃﾚｯｻ ｽﾜﾝ
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Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

（博士課程）
Doctoral Program

論 文 要 旨
THESIS SUMMARY

専攻： Department of	人間行動システム　専攻	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of　(Philosophy)
学生氏名： Student's Name	Avancena, Aimee Theresa Suan	指導教員（主）： Academic Advisor(main)	西原 明法 教授
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

This research attempted to address the issue of low performance and motivation among high school students of computer science by designing and developing an online algorithm learning tool with Algorithm Visualization (AV) technology. The learning tool offers lecture notes and visualizations of four fundamental algorithms (Linear Search, Binary Search, Selection Sort and Bubble Sort) which are included in the curriculum of a special science and technology high school in Japan. The tool offers two types of visualization, one with more input menu options and control and another with less. Along with the learning tool, a written pretest and posttest on algorithms and a questionnaire on the usability and pedagogical effectiveness of the tool were designed based on previously proposed AV evaluation properties (symbol system, interactivity and didactic structure) and the Categories of Algorithm Learning Objectives (CALO) (Lee & Rößling, 2010). Two motivation questionnaires were also designed, one based on the Motivation and Learning Strategies Questionnaire (MLSQ) (Pintrich & DeGroot, 1990) and the other on the ARCS (Attention, Relevance, Confidence, and Satisfaction) model (Keller, 2008) which were later combined to form one questionnaire on motivation. These evaluation instruments were employed along with the algorithm learning tool both in the pilot implementation and in the validation phase of this study.

The results of the pretest and posttest on algorithms show an increase in the performance of most of the participants. In the absolute scale, the students who used the AV type that provide more input options and control have better improvement in the posttest. However, the differences in the scores between the control group and the treatment group are not big enough to produce statistically significant results. After using the learning tool, the students have proven to be capable of performing certain tasks based on CALO, namely, the abilities to identify algorithms ("Descriptive"), to fill in missing lines of codes ("Coding") and to provide the output of an algorithm simulation ("Demonstrative and Decoding").

The questionnaire on the usability and pedagogical effectiveness of the tool underwent a revision and validation process. Following the two-step model building by Byrne (2001), factors that correspond to the three properties for evaluating AV tools were obtained: (1) Interface Assessment ("Interactivity"), (2) Algorithm Learning Objectives ("Didactic Structure") and (3) AV Characteristics ("Symbol System"). These factors were used in building a measurement model using confirmatory factor analysis and a structural model that relates the factors and the posttest scores of the students. The structural model indicates that the AV features integrated in the design of the learning tool are effective in meeting the targets set by the Algorithm Learning Objectives. This further implies that the algorithm learning tool developed for this study is successful in meeting some of the learning goals set by the learning objectives normally used in CS education. Hence, the structural model may be used as a guide in designing an algorithm learning tool and its corresponding evaluation instrument to assess the tool's usability and pedagogical effectiveness in high school computer science.

The motivation questionnaires also underwent revision and validation to come up with one motivation questionnaire referred to as the Questionnaire on Motivation, Self-Efficacy and Learning Attitudes. Applying the two-step model building, motivation components (intrinsic motivation, self-efficacy, self-determination and learning preferences) were derived. Confirmatory factor analysis shows that the questionnaire items measure well their corresponding factor while the structural model indicates that among the motivation components, self-efficacy and learning preferences were found to correlate with the students' posttest performance in algorithms. The questionnaire and the constructed models may be used for future studies on motivation for learning CS and algorithms. Analysis of the responses to the motivation questionnaires (both the initial and the revised) signify that there is a general increase in the learning motivation of the students after using the algorithm learning tool.

In summary, the results of this study may be used to address the poor-performance and low motivation problems among high school students of computer science. As computer science is now being offered in the secondary school curriculum with the aim of helping students prepare for a CS-related degree in the university, the need to improve performance and to sustain student interest and motivation in learning CS have become crucial issues in computer science education. The models proposed in this study, which relate Algorithm Visualization features, learning objectives, motivation, learning strategies and performance may be considered in the design and assessment of algorithm learning tools. The tool developed for this research may be extended to include other fundamental algorithms taught in introductory computer science. The tool may also be implemented and examined among a bigger sample size of participants for better analysis results.

備考 ： 論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。
Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).
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