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Design of Cognitive Tools to Enhance Problem-Solving in Computer Language Programming for High School Students

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Abstract: Programming is a complicated science and includes many skills, and it is also a key part in promoting problem-solving and higher-order thinking skills of students in the 21st century. The purposes of this research are to design and to develop the cognitive tools to enhance the problem-solving skill in computer language programming for high school students. The research study is a developmental research, and the statistic method includes document analyses, surveys and case studies. The participants are experts in content validity, instructional design, media learning design, learning environment, and evaluation. In terms of the research procedure, this study was carried out through 5 steps: a study of the theories and research; a study of the context; a synthesis of theoretical framework of cognitive tools; a synthesis of designing framework of cognitive tools; and an evolution of the efficiency of the cognitive tools designing framework. The data analysis employed an interpretation and conclusion by the researcher. The result revealed that the designing framework consisted of 7 essential elements which were: Problem-Based Tools, Information Seeking Tools, Information Presentation Tools, Knowledge Organization Tools, Knowledge Integration Tools, Knowledge Generation Tools, and Communication Tools. According to the expert review, the designing framework was of efficiency.

Keywords: Cognitive Tools, Problem-Solving, Programming

1. Introduction

Programming is an important skill to which everyone pays attention in 21st century and significantly related to the problem solving process of students (VanLengen & Maddux, 1990). Programming is a complicated science and difficult to understand because it involves many aspects of problem solving (Jonassen & Reeves, 1996). Truly, most of students in the class are unable to analyze and design solutions as well as they should. This is something that all students have to face inevitably.

To write a program successfully and effectively, programming should be separated into three phases: problem solving and implementation. In addition, when a program has been written, it involves the third phase: maintenance (Dale et al., 2007). All of these are integrated to a continuous cycle of programming.

Computers and the Internet technology is state of the art which support and expand the thinking processes of students as cognitive tools for creative communication and knowledge exchange (Chaijaroen, 2008). The tool is an intellectual partner of students, which supports problem solving and facilitates a meaningful learning (Jonassen & Reeves, 1996). Using the computer as a cognitive tool to support learning is different from traditional instruction because the students will analyze problems, design and manage their own learning process (Samat, 2008).

In light of this, the principles of using cognitive tools to support programming and to enhance problem solving in essential way for learners in the 21st century have been presented. To enhance problem solving in computer language programming, the cognitive tools have been designed based on the web-based learning environment which applies and modifies the information-processing model (Iiyoshi & Hannafin, 1998) and students will learn through mission scenarios and be supported by the tools.

2. Designing Framework

The designing framework of cognitive tools is as shown in Figure 1.

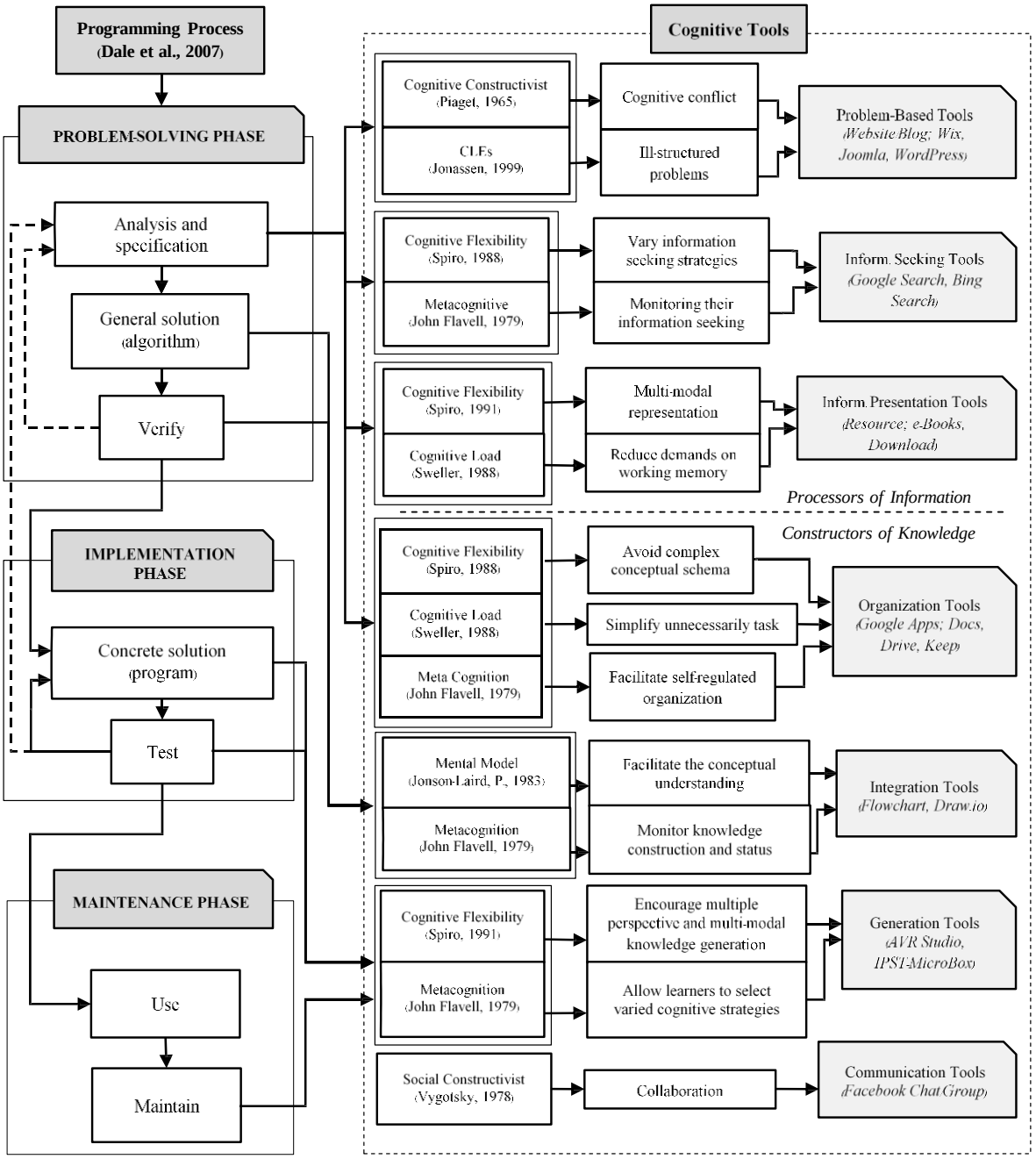

Figure 1. Designing Framework of Cognitive Tools to Enhance Problem-Solving in Computer Language Programming

3. Results

The designing framework of the cognitive tools to enhance problem-solving in computer language programming is based on: 1) Programming and Problem-Solving Base, 2) Psychological Base, 3) Pedagogical Base, 4) Media Theory and Technology Base and 5) Information-processing Base which consist of 7 essential elements: (1) Problem-Based Tools which present the ill-structure problem in a real context with an online learning environment such as website and blog, (2) Information Seeking Tools which provide multiple perspectives via various information seeking strategies such as search

engine, (3) Information Presentation Tools which provide multi-modal representations and reduce demands on working memory while processing information such as e-books, knowledge bank, (4) Knowledge Organization Tools which help students to simplify a complex cognitive task and facilitate self-regulated organization while constructing knowledge such as Google application, (5) Knowledge Integration Tools which facilitate the conceptual understanding such as flow chart, (6) Knowledge Generation Tools which encourage multiple perspectives and multi-modal knowledge generation of students such as compiler and microcontroller, and (7) Communication Tools which help student to communicate and share their problem solving via multiple perspectives such as social network.

4. Conclusion and Future Work

The design of cognitive tools to enhance problem-solving in computer language programming indicated 7 essential elements which are: Problem-Based Tools, Information Seeking Tools, Information Presentation Tools, Knowledge Organization Tools, Knowledge Integration Tools, Knowledge Generation Tools, and Communication Tools. In terms of deployment, the elements should be adapted into the learning style of students, course context and appropriate learning materials. To put it more explicitly, they require contribution of other high-order thinking skills and should be integrated to learning taxonomy of students.

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