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Design of Interactive Computer-based Laboratory Tool for Inquiry-based Learning Environment

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Abstract. Introducing student to the culture of science research for developing conceptual understanding of scientific concepts, scientific inquiry, and nature of science has been so widely discussed in the recent reforms of science education, and technology-enhanced learning environments have been recognized as a vital approach in order to foster student scientific literacy. The purpose of this paper is to demonstrate how to design computer-based laboratory tool to support student practices of scientific inquiry. An interactive computer-based laboratory tool, called Nose Simulator, is illustrated on an example electronic nose application. In the end, the paper puts forward to the design consideration of a computer-based laboratory environment platform, which could provide references for developing computerized inquiry tool in school science education.

Keywords: Computer-based laboratory tool; Inquiry-based learning environment; Open inquiry; Instructional design; Pedagogical support

1. Introduction

With respect to human endeavor of scientific inquiry, recent education reform efforts for science advocate the design of learning environment that involves students into learning actions via the diverse ways of scientific inquiry [1], especially experiencing with scientific laboratory works. Unfortunately, educational researchers have reported that most of inquiry-based learning environment caused students to unappreciated perceive its important and the nature of scientific inquiry in which they experienced [3,4]. Additionally, they cannot internally conceptualize scientific principles and do not develop positive attitudes to science [5]. In regard to these problems, open-inquiry laboratory experience has been identified as important to student development of scientific literacy and understanding of the essence of science [2]. Consequently, the need for pedagogical supports responded to the demands of this more ambitious learning environment has been inquired and suggestions were to incorporate scaffoldings into students' learning activities [6], to help student succeed in their inquiry learning process.

Nowadays, the use of computer technology has not only become the essential tool in the practice and advancement of science, but also in the learning process and environment for school science education, promoting scientifically and technologically literate citizens. Research on technology-enhanced inquiry environments suggests that computer-based tools can support students' thinking and learning about scientific content and processes [7].

2. Design of Interactive Computer-based Laboratory Tool, Nose Simulator, for Inquiry-based Learning Environment

Design considerations of the Nose Simulator to address its provision to support and assist the processes of scientific inquiry are physical, functional, and cognitive features as follows.

2.1Physical Feature

This feature could amplify the space the students are engaged in during their activities includes the devices, but is not limited to the space within the computer screen. The physical movement of the students was in focus of their inquiry process. Fig. 1 displayed hardware and software parts within set up of the Nose Simulator.

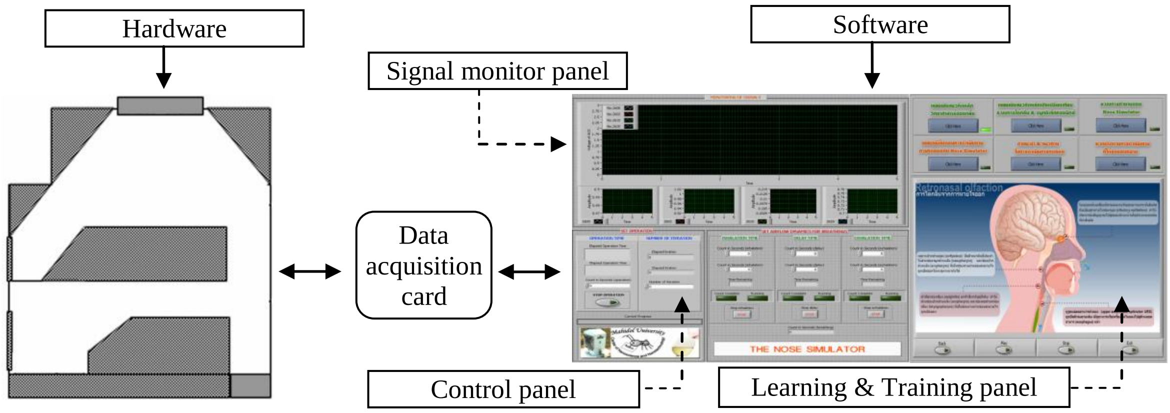

Figure 1. Set up of the Nose Simulator

2.2Functional Feature

This feature was designed for purposeful action to afforded student in control of variables and manipulation of parameters, which supports an independent context for scientific inquiry practices. Fig. 1 also displayed the signal and control panels of the Nose Simulator.

2.3Cognitive Feature

This feature aimed to enable users for (1) sense making of the basic science and technology concepts by providing visual conceptual organizers to reduce cognitive loads during the construction of scientific understanding, (2) supporting the management of scientific inquiry processes by providing guidance on the processes, and (3) affording reflections and articulations by using reminders and guidance to monitor their practical inquiries and enhance articulations during experimenting with the tool, as the learning and training panel in Fig. 1.

3. Conclusion

The design features of the Nose Simulator illustrated the way to support scientific inquiry practices for students in science learning and to enhance understanding construction of scientific inquiry processes. Hardware architecture was designed and constructed to fit uniquely for providing advantages to the performing of experiments and the construction of scientific understanding. User interface design of software was also created with determining the sufficiency of scaffoldings (inquiry assistances) to support experimental processes of scientific inquiry. Based on the design, the pedagogical approach of conducting experimental work is a needed for students in order to provide authentic context of scientific practices through the inquiry process. In students' experimentation, they should be engaged to perform research tasks, as similar as scientists actually carry out, that contrast from the traditional way of their classroom inquiry learning. The task also needed them to process scientific and technological information, experimental data, and to understand practical work of scientific research in nature. To promote a sense of responsibility as happened in real science, students should be undergone collaborative process in doing their own experiment in that students take charge of their own learning and develop a sense of ownership of topics that are personally relevant to them. Students must have the opportunity to develop their performance to think, act to perform, sense to learn, and communicate to debate in scientific experimentation. Finally, Instructional tools must be designed to allow students to engage and manipulate resources and ideas, and assist individual and group mechanism, such as ways of thinking, performing, feeling, negotiating, in investigative tasks of learning to achieve success. This paper could be a direction for developing computerized inquiry tool to support student scientific inquiry in school science education

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