A FRAMEWORK FOR DEVELOPING COMPUTER-BASED MATHEMATICS LEARNING SYSTEMS

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Abstract

Computer-based learning has been one of the most significant application areas of computer technology. However, the use of computer-based learning has different effects depending on the area to which it is applied. For example developing a system for, learning mathematics is challenging. This is because computers provide a means for physical realisation of the world. In contrast mathematics promote abstract thinking. Thus, how far computers can help abstract thinking is a crucial issue.

In addressing the above, this study exploits a learning theory particularly specific to mathematics learning to develop a computer-based intelligent learning system for mathematics.

Learning theories are classified into three basics, namely the behaviorist theory, cognitive theory and the constructivist theory. Since mathematics is based on concepts, the cognitive learning has been selected for this study. In the cognitive field many theorists have contributed several theories. Out of this David Ausubel's Subsumption theory says that *"the most important single factor influencing learning is what the learner already knows, follow this and teach accordingly"*. This idea has a great importance when dealing with learning mathematics and this study shows that it will be more appropriate for modelling a learning environment for mathematics. By exploiting David Ausubel's theory the researcher has postulated a three-layer architecture with expert system features,

that allows navigating from a *visual level* to an *abstract level* via a *conceptual level.* At the visual level according to Ausubel any concept of mathematics is presented by visual comprehension and the process is identifying and manipulating of visuals and the outcome is to make sense of the concept by visuals. When it comes to the conceptual level the ability that was gain as the output of the previous level, is treated as the input for this level and the process is conceptualising the visuals into numerical. The output is the numerical understanding of the related concept of mathematics. Finally at the abstract level the knowledge that was gained, as out put in the conceptual level will be the input to the abstract level of the system. The process at this level is to manipulate extensive problem solving in abstract manner. At this level there will be only numbers and without visual aids. The final output of the system is to give ability of solving problems in abstract manner.

At the visual level a user will interact with the system with the knowledge already having, and at the conceptual and abstract levels, the input to the system will be what was gained at the preceding level. Thus, all the three levels comply with David Ausubel's Subsumption theory.

A special feature of the system is that the levels are restricted in going back in the process from abstract level to visual level. The implementation of the three levels are completed by using the multimedia authoring tool 4 software known as "Authorware 4" which can be run on Windows platform.

The system developed has been tested for manipulation of fractions. This has been chosen where the area of mathematics knowledge is proven to be very poor according to a survey done on secondary education.

A validation study was done with sixty students of grade eight which examined differences in pre and post-test performances that gave a feed back of the use of the developed system. In conjunction with the analysis it revels the value and the importance of this framework to serve in assisting to students to solve problems in abstract manner. The advantage of a computer-based environment for mathematics is that there is a system-user interface which enables students to build their knowledge at the proper concept than practising questions for a training purpose.

Although the approach has been evaluated by manipulation of fractions, it can be used as a general framework for mathematics learning. Finally, the limitations of the approach will be forwarded.

Further work would be to extend this system to provide a web-based environment and also to produce as a shell for developing mathematics learning environments.