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Information Communication Technology as a Cognitive Tool to Facilitate Higher-order Thinking

by

Gary Wayne Collins

Submitted in partial fulfilment of the requirements for the degree Philosophiae Doctor in Computer Integrated Education

in the

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Supervisor: Professor Dr J G Knoetze

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Full names of student: Gary Wayne Collins
Student number: 29564272

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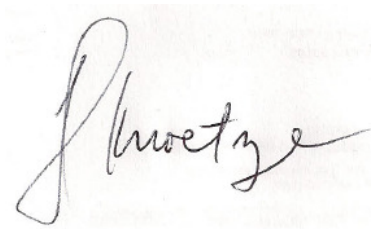

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Summary

Title:	Information Communication Technology as a Cognitive Tool to Facilitate Higher-order Thinking
Candidate:	Gary Wayne Collins
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Digital educational technology is capable of contributing supplementary strategies that can be used to address various educational challenges faced by higher education. Foremost among these challenges is the widespread lack of academic preparedness of students who enter South African higher education institutions. The legacy of Apartheid, teachers' poor domain knowledge and command of the language of instruction, together with a lack of commitment to the cognitive development of learners are some of the reasons why students have not developed the cognitive skills required to engage in meaningful learning.

Meaningful learning requires a high level of conceptual engagement and development. To assist in the learning process, educators must focus on student learning rather than on the instructor and the technology used in the instruction. A powerful means of supporting meaningful learning is through a process of model building. Computer technology can effectively be used to facilitate the building of conceptual models. By encouraging students to use computer technology to build models that represent their personal understanding, the students are performing the role of designer and the technology is used as a cognitive tool. Using digital technology as a cognitive tool allows students to engage in critical thinking and higher-order learning. An expert system shell is one way in which technology can be used as a cognitive tool. When students build expert systems they are required to demonstrate the reasoning of an expert and to exhibit an understanding of causal relationships and procedural knowledge. There is very little evidence of

research concerning the application of expert systems as a cognitive tool in education.

The primary aim of this study is to formulate design principles in the form of conjectures and principles related to a learning environment that uses technology as a cognitive tool in the form of an expert system shell to promote higher-order thinking skills.

The second aim of this study is to explore the experiences of students who are exposed to a learning environment based on the conjectures and principles formulated during the design phase of the research.

The conjectures and principles formulated during this study are expressed in terms of the characteristics, procedures and arguments associated with a learning environment that uses technology in the form of an expert system shell to facilitate higher-order thinking. These conjectures and principles were separated into seven interrelated clusters that can be summarised as follows:

- Initial exposure
- Guided discovery learning
- Designing the expert system on paper
- Creating domain awareness
- Linking conceptual understanding to a representation of that understanding
- Hands-on development
- Problem engagement

These conjectures and principles could guide similar endeavours undertaken by lecturers or instructional designers.

Keywords

Cognitive tools
Conceptual models
Constructivist learning
Critical thinking
Design principles
Educational technology
Expert system shell
Higher-order thinking
Modelling
Problem- solving

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List of acronyms

AI	Artificial Intelligence
CAD	Computer Aided Design
CAQDAS	Computer Aided Qualitative Data Analysis Software
HOT	Higher Order Thinking
HOTS	Higher Order Thinking Skills
ISD	Instructional System Design
PBL	Problem Based Learning
TUT	Tshwane University of Technology
ZPD	Zone of Proximal Development