Designing CBL Systems for Complex Domains using Problem Transformation and Fuzzy Logic

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Publications

The following publications are made out of this research.

1. Mohanarajah, S., R. H. Kemp, and E. Kemp. 'Towards a Computer Based Learning System for Object-Z. Proceedings of the International Conference on Computers in Education 2003 (ICCE'03), Hong Kong.
2. Mohanarajah, S., R. H. Kemp, and E. Kemp. 'Towards an Interactive Learning Environment for Object-Z'. Journal of Issues in Information Sciences and Information Technology Education Vol 1, 2004, pgs 0993-1003 ISSN: 1539-3585, Informing Science, Institute Santa Rosa, California USA. Paper presented at the International Conference on Information Science and IT Education 2004 (InSITE'04), Rockhampton, Australia (awarded Best Paper medal)
3. Mohanarajah, S., Kemp, R.H., Kemp, E., and E.Heinritch. 'Unfold the scaffold & Externalizing Learner Models", World Conference on Educational Multimedia, Hypermedia, and Telecommunications 2005 (ED-MEDIA'05), P. Kommers, G. Richards (Eds.), Association for the Advancement of Computing in Education, Norfolk, USA, pp 4004 - 4009.
4. Mohanarajah, S., R. H. Kemp, and E. Kemp. 'Intelligent Pedagogical Action Selection under Uncertainty'. International Conference on Artificial Intelligence in Education 2005 (AIED'05), Chee-Kit, L, McCalla, G., Bredewreg, B. and J. Breuker (Eds), IOS Press, Amsterdam, Netherlands, pp 881-883
5. Mohanarajah, S., Kemp, R.H., and Kemp, E.. 'Opening a Fuzzy Learner Model', Proceedings of the Workshop (LEMORE) at the International Conference on Artificial Intelligence in Education 2005 (AIED'05), Amsterdam, Netherlands.
6. Mohanarajah, S., R. Kemp, H., et al. (2006). Adaptable Scaffolding - A Fuzzy Approach. LNCS 4053 - Intelligent Tutoring Systems (ITS' 6). M. Ikeda, K. Ashley and T. W. Chan. Berlin, Springer-Verlag: 604-614.

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Abstract

Some disciplines are inherently complex and challenging to learn. This research attempts to design an instructional strategy for CBL systems to simplify learning certain complex domains. Firstly, problem transformation, a constructionist instructional technique, is used to promote active learning by encouraging students to construct more complex artefacts based on less complex ones. Scaffolding is used at the initial learning stages to alleviate the difficulty associated with complex transformation processes. The proposed instructional strategy brings various techniques together to enhance the learning experience. A functional prototype is implemented with Object-Z as the exemplar subject. Both objective and subjective evaluations using the prototype indicate that the proposed CBL system has a statistically significant impact on learning a complex domain.

CBL systems include Learner models to provide adaptable support tailored to individual learners. Bayesian theory is used in general to manage uncertainty in Learner models. In this research, a fuzzy logic based locally intelligent Learner model is utilized. The fuzzy model is simple to design and implement, and easy to understand and explain, as well as efficient. Bayesian theory is used to complement the fuzzy model. Evaluation shows that the accuracy of the proposed Learner model is statistically significant. Further, opening Learner model reduces uncertainty, and the fuzzy rules are simple and resemble human reasoning processes. Therefore, it is argued that opening a fuzzy Learner model is both easy and effective.

Scaffolding requires formative assessments. In this research, a confidence based multiple test marking scheme is proposed as traditional schemes are not suitable for measuring partial knowledge. Subjective evaluation confirms that the proposed schema is effective. Finally, a step-by-step methodology to transform simple UML class diagrams to Object-Z schemas is designed in order to implement problem transformation. This methodology could be extended to implement a semi-automated translation system for UML to Object Models.

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