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# Formalization of Higher-level Intelligence through Integration of Intelligent Tutoring Tools

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## **Abstract**

In contrast with a traditional Intelligent Tutoring System (ITS), which attempts to be fairly comprehensive and covers enormous chunks of a discipline's subject matter, a basic Intelligent Tutoring Tool (ITT) (Patel & Kinshuk, 1997) has a narrow focus. It focuses on a single topic or a very small cluster of related topics. An ITT is regarded as a building block of a larger and more comprehensive tutoring system, which is fundamentally similar with the emerging technology "Learning Objects" (LOs) (LTSC, 2000a). While an individual ITT or LO focuses on a single topic or a very small cluster of knowledge, the importance of the automatic integration of interrelated ITTs or LOs is very clear. This integration can extend the scope of an individual ITT or LO, it can guide the user from a simple working model to a complex working model and provide the learner with a rich learning experience, which results in a higher level of learning.

This study reviews and analyses the Learning Objects technology, as well as its advantages and difficulties. Especially, the LOs integration mechanisms applied in the existing learning systems are discussed in detail. As a result, a new ITT integration framework is proposed which extends and formalizes the former ITT integration structures (Kinshuk & Patel, 1997, Kinshuk, et al. 2003) in two ways: identifying and organizing ITTs, and describing and networking ITTs. The proposed ITTs integration framework has the following four notions:

- (1) Ontology, to set up an explicit conceptualisation in a particular domain,

- (2) Object Design and Sequence Theory, to identify and arrange learning objects in a pedagogical way through the processes of decomposing principled skills, synthesising working models and placing these models on scales of increasing complexity,
- (3) Metadata, to describe the identified ITTs and their interrelationships in a cross-platform XML format, and
- (4) Integration Mechanism, to detect and activate the contextual relationship.

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# TABLE OF CONTENTS

<b>Chapter 1</b>	<b>Introduction.....</b>	<b>1</b>
1.1	The Context of Traditional Intelligent Tutoring System.....	1
1.2	The Context of Intelligent Tutoring Tools.....	2
1.3	Motivation for the Research.....	3
1.4	The Research Steps.....	5
1.5	Structures of the Thesis.....	6
<b>Chapter 2</b>	<b>Review of Learning Objects Technology.....</b>	<b>7</b>
2.1	<b>Learning Objects.....</b>	<b>7</b>
2.1.1	Definition.....	8
2.1.2	Characteristics of the learning objects.....	13
2.2	<b>Metadata.....</b>	<b>15</b>
2.2.1	Metadata Concept.....	16
2.2.2	Classification System in Libraries.....	16
2.2.3	Dublin Core.....	22
	2.2.3.1 Design Principles.....	23
	2.2.3.2 Summary.....	25
2.2.4	Gateway to Educational Materials (GEM).....	26
	2.2.4.1 Design Principles.....	26
	2.2.4.2 Summary.....	28
2.2.5	Education Network Australia (EdNA).....	28
	2.2.5.1 Design Principles.....	29
	2.2.5.2 Summary.....	30
2.2.6	IEEE LTSC Learning Object Metadata (LOM).....	31
	2.2.6.1 Design Principles.....	32
	2.2.6.2 Summary.....	33
2.2.7	Metadata Mapping.....	35
2.3	<b>Architecture.....</b>	<b>38</b>
2.3.1	Learning Object Repository.....	38
	2.3.1.1 Functions.....	38
	2.3.1.2 Architecture of Learning Objects Repository.....	41

2.3.2	LMS and LCMS.....	42
2.3.2.1	Comparisons between LMS & LCMS.....	43
2.3.2.2	Integration of LMS & LCMS.....	46
2.3.3	Sharable Content Objects Reference Model (SCORM).....	49
2.3.3.1	CAM.....	51
2.3.3.2	RTE.....	53
2.3.3.3	SN.....	55
2.3.3.4	Summary.....	58
<b>2.4</b>	<b>Vision and Benefits.....</b>	<b>59</b>
<b>2.5</b>	<b>Challenges.....</b>	<b>61</b>
<b>2.6</b>	<b>Summary.....</b>	<b>64</b>
 <b>Chapter 3 ITT Integration Framework.....</b>		<b>65</b>
<b>3.1</b>	<b>Learning Systems Overview.....</b>	<b>66</b>
3.1.1	SCORM.....	66
3.1.2	Multimedia Learning Objects (MLO) Project.....	67
3.1.3	Summary.....	69
<b>3.2</b>	<b>Necessity of the New Framework.....</b>	<b>70</b>
3.2.1	Scenario.....	71
3.2.2	Goals.....	72
3.2.3	Values.....	74
<b>3.3</b>	<b>Characteristics of the ITT Integration Framework.....</b>	<b>74</b>
3.3.1	Ontology.....	77
3.3.2	Instructional Design and Sequence Theory.....	78
3.3.3	Metadata.....	81
3.3.4	Integration Mechanism.....	82
<b>3.4</b>	<b>Summary.....</b>	<b>83</b>
 <b>Chapter 4 Toward the Prototype of Intelligent Tutoring Tools Integration System.....</b>		<b>84</b>
<b>4.1</b>	<b>Prototype Development.....</b>	<b>84</b>
<b>4.2</b>	<b>Initial Analysis.....</b>	<b>87</b>
<b>4.3</b>	<b>Prototype Objective.....</b>	<b>88</b>

<b>4.4</b>	<b>Specify a prototype.....</b>	<b>90</b>
4.4.1	System Analysis.....	90
	4.4.1.1 Ontology.....	91
	4.4.1.2 Learning Objects Design and Sequence.....	94
4.4.2	System Design.....	98
<b>4.5</b>	<b>Construct Prototype.....</b>	<b>106</b>
4.5.1	JAVA.....	107
4.5.2	XML.....	108
4.5.3	JBuilder.....	109
4.5.4	Code Example.....	109
4.5.5	Screenshots of the Prototype System.....	114
<b>4.6</b>	<b>Summary.....</b>	<b>120</b>
 <b>Chapter 5 Formative Evaluation of the Prototype.....</b>		<b>121</b>
<b>5.1</b>	<b>Participants of the Evaluation.....</b>	<b>121</b>
<b>5.2</b>	<b>Evaluation Questionnaires and Summary.....</b>	<b>122</b>
<b>5.3</b>	<b>Analysis of the Feedback.....</b>	<b>127</b>
 <b>Chapter 6 Future Work and Conclusion.....</b>		<b>129</b>
<b>6.1</b>	<b>Future Work.....</b>	<b>129</b>
6.1.1	Examination in a real world learning system.....	129
6.1.2	Extension of the Scope.....	130
6.1.3	Combination with the other ITT Features.....	130
6.1.4	Authoring and Metadata Mapping Tools.....	131
<b>6.2</b>	<b>Conclusion.....</b>	<b>131</b>
 <b>References.....</b>		<b>134</b>



## List of Figures

### Chapter 2 Review of Learning Objects Technology

Figure 2.1 Reusable learning object (RLO) structure.....	11
Figure 2.2 Graphic representation of the learning objects characteristics.....	15
Figure 2.3 Hierarchical view of learning object metadata elements.....	34
Figure 2.4 Architecture of a typical centralized learning objects repository.....	41
Figure 2.5 LMS and LCMS integration in an e-learning environment (Brennan, et al., 2001).....	49
Figure 2.6 Assets and shareable content object in SCORM.....	51
Figure 2.7 Content packaging in SCORM.....	52
Figure 2.8 Meta-data corresponding to content model components.....	53
Figure 2.9 SCORM conceptual run-time environment. (ADL, 2003c).....	54

### Chapter 3 ITT Integration Framework

Figure 3.1 Sequence Mechanisms in SCORM.....	67
Figure 3.2 Schematic layout of format for Learning Object realization (Boyle, 2003).....	68
Figure 3.3 Schematic representation of a syllabus structure (Boyle, 2003).....	69
Figure 3.4 JAVA and related concepts at the whatis.com® web site.....	72
Figure 3.5 Integrated Learning Objects in the self-learning environment.....	73
Figure 3.6 Intelligent tutoring system on Internet and its linking with various ITAs (Kinshuk & Patel, 1997).....	75

Figure 3.7 ITT integration framework.....	76
Figure 3.8 Principled skill decomposition. (Wiley, 2000, p.60) and Work model synthesis. (Wiley, 2000, p61).....	80
Figure 3.9 Domain map with a unidimensional scale of expertise (Wiley, 2000, p.63).....	81

## Chapter 4 Toward the Prototype of Intelligent Tutoring Tools Integration System

Figure 4.1 A prototype life cycle (Bennett, et al., 2002, p52).....	86
Figure 4.2 Intelligent tutoring tools integration system use case diagram.....	89
Figure 4.3 A subset of the network of inter-relationships for capital investment appraisal.....	93
Figure 4.4 Principled skill decomposition of capital investment appraisal.....	95
Figure 4.5 Synthesized working model for capital investment appraisal.....	96
Figure 4.6 Work models with one-dimensional scale.....	97
Figure 4.7 Partial class diagram for intelligent tutoring tools integration system (capital investment appraisal).....	98
Figure 4.8 Partial sequence diagram for intelligent tutoring tools integration system (capital investment appraisal).....	105
Figure 4.9 Partial object class diagram for intelligent tutoring tools integration system (capital investment appraisal).....	106
Figure 4.10 Code example of method “getrelatedconcept():”.....	111
Figure 4.11 Code example of method “activation():”.....	112

Figure 4.12 XML example describing ITT function and interrelationships with other ITTs.....	113
Figure 4.13 Capital investment appraisal window.....	114
Figure 4.14 Net present value concept window.....	115
Figure 4.15 Net present value calculation window.....	116
Figure 4.16 Parameter set up window.....	116
Figure 4.17 Discount factor returned window.....	117
Figure 4.18 User entry for other information window.....	117
Figure 4.19 Net present value result window.....	118
Figure 4.20 Discount factor concept window.....	119
Figure 4.21 Discount factor calculation window.....	119

## List of Tables

### Chapter 2 Review of Learning Objects Technology

Table 2.1 Dewey Decimal Classification (DDC) System.....	21
Table 2.2 GEM 2.0 Elements and Semantics (Extension from DC only).....	26-27
Table 2.3 GEM 2.0 Controlled Vocabularies (GEM.Pedagogy.Grouping).....	27-28
Table 2.4 EdNA v1.1 Elements and Semantics (Extension from DC only).....	29-30
Table 2.5 EdNA 1.1 Controlled Vocabularies (EdNA.Audience.Sector).....	30
Table 2.6 Mapping to Unqualified Dublin Core (Draft Standard for Learning Object Metadata. (2002). Table B.1 – Mapping to Unqualified Dublin Core).....	35-36
Table 2.7 GEM mapping to LOM (Gong, 2002).....	36-37
Table 2.8 EdNA mapping to LOM (Gong, 2002).....	37
Table 2.9 Differences Between LMS And LCMS.....	45-46
Table 2.10 SCORM Coverage (ADL 2003b).....	58-59

### Chapter 3 ITT Integration Framework

Table 3.1 Relation Category in Learning Object Metadata (LOM, 2002).....	82
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### Chapter 4 Toward the Prototype of Intelligent Tutoring Tools Integration System

Table 4.1 Actors And Use Cases In The Intelligent Tutoring Tools Integration System.....	88
Table 4.2 A Subset Of Concepts In Capital Investment Appraisal Domain.....	91

Table 4.3 Use Case Correlating To The Integrated “Capital Investment Appraisal”  
Learning..... 99  
Table 4.4 A Subset Of The Main Objects And Their Responsibilities..... 102