An Instructional Design Model for Constructivist Learning

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Abstract

The emergent requirements for effective e-learning calls for a paradigm shift for instructional design. Constructivist theory and semiotics offer a sound underpinning to enable such revolutionary change by employing the concepts of Learning Objects. E-learning guidelines adopted by the industry have led successfully to the development of training materials. Inadequacy and deficiency of those methods for Higher Education have been identified in this paper. Based on the best practice in industry and our empirical research, we present an instructional design model with practical templates for constructivist learning.

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Keyword: constructivist learning, instructional design model, learning objects, information objects, e-Learning

1. Introduction

As learning environment evolves, learners have become increasingly demanding on personalised learning which allows them to build their own knowledge pathway. This significant change in learning requirements imposes a new learning paradigm which ensures learner-centred, with flexible mode of content configuration, and adaptive delivery and assessment. To achieve this end, an important issue to be addressed is the learning content management. Although in the past several years, LMS providers have upgraded system functionality to tackle content management; the fundamental design principles of the LMS constrain in meet the emergent requirements.

Learning content management systems (LCMS), the next generation of learning management systems, can directly offer creation and management of content with key features of content conversion and configuration, personalised adaptive delivery, collaborative authoring and editing, learning object repository, meta-tagging for search capabilities, and integration with LMS (Edmonds and Barron, 2002). With these advancements, learners and tutors may find their roles are changing. Learners are able to be actively engaged in their learning experience with their preferred content rather than passively receive information. Within such constructivist learning environment, an appropriate instructional design for the learning materials becomes critical. Tutors will be involved in designing and constructing learning content based on their knowledge, expertise and educational experience. Learners can be assisted for knowledge construction and problem-solving through face-to-face discussion during which the relevant learning content can be introduced accordingly. If such results are expected through the use of learning management systems, a rigorous instructional design is essential and real-time support is needed during the learning process is required.

In response to the paradigm shift in learning content design, we adopted the concept of Reusable Learning Objects (RLO) (Cisco, 2001) for the design of the learning content, but soon released the limitations of RLO for higher education, though that approach is effective for industrial training. Revolutionary changes are required to conceptualise various types of learning objects (e.g., content, assessment, and practical) and their granularity. It is not difficult to break down the big chunk of learning material into small build blocks, but it is not easy to organise them in such way that they are reusable for reconfiguration, customisable for personalisation, and flexible for real-time support. To assist tutors in the design of learning content, we present an instructional design model for authoring e-learning courseware for constructivist learning, drawing the strength from the best practice in the e-learning research community and industry.

2. Constructivist learning and its impact on learning content design

Constructivist learning encourages learners to acquire necessary knowledge and skills for finding meaningful solutions to the real world problems. Their leaning involves learner-centred, goal-directed and situated activities. There are experiences in the traditional classroom where constructivist learning process is practised across various subject disciplines, but to transform the constructivist learning to the e-learning environment remains challenging. There are two main reasons: 1) It requires adequate learning content design skills to ensure flexibility, reusability and interoperability to meeting learners' requirements; 2). Learning content designed must allow a sound educational purpose to enforce knowledge construction.

2.1 Knowledge construction process

An effective learning content design is not driven by the advancement of technology. It has to be rooted in the sound learning theories and appropriate instructional strategies. Constructivist paradigm (Savery and Duffy 1994; Honebein *et al.* 1993) offers instructional design philosophy that guides learners to conduct and manage their personalised learning activities, and encourage collaborative and cooperative learning for critical thinking and problem-solving. Semiotic paradigm (Peirce 1931-35; Liu 2000) emphases that understanding is a subjective process where the prior knowledge affects the interpretation of a given sign, and vice versa. It is difficult to assume for all agents (i.e., learners) involved that they will derive the same association between a sign and an object, as it involves issues such as meaning, cognition, behaviour, culture and social context.

Understanding the learning process as knowledge construction based on semiotics and constructivist theory enables us to identify some important features of learning (Sun *et al*. 2003; Liu and Sun 2002). Within the constructivist realm, knowledge is constructed through interaction with the environment in which a process of personal interpretation of the perceived world and the negotiation of meaning from multiple perspectives takes place. Constructivism advocates that there are no cause-effect relationships between the world and the learner; learning to a large extent depends on the subjective view of the learner. Semiotics promotes educational strategies that emphasise many sign systems, or many ways of knowing. Constructivism emphasises that learning emerges from the human organism in ways which conserve adaptation and organisation - learning is to apply some sort of conceptual system upon the phenomena and to bring forth a world including those phenomena. Learning is situated, and it should occur in realistic settings. The process of semiosis enables us to structure our experiences and reveal the nature and culture of our understanding. Signs as codes of experience are related to social settings where learning takes place; learning is never a private act. The constructivist approach notes that living systems survive by fitting with one another and with other aspects of the surrounding medium. These features can be incorporated into the learning content design based on an appropriate instructional strategy for e-learning.

2.2 The current practice on instructional strategies

The big effort from SCORM (2003), IEEE (2003), and IMS (2003) has produced the e-learning standards which enable content designers to practise their instructional design. A common element in these standards is the concept of learning objects which is the notion of reusable instructional components in multiple contexts (Wiley, 2003). Cisco Systems (Cisco 2001) has been a pioneer in the development of the e-learning solution architecture and application of learning objects and content objects.

From Cisco's view, Reusable Learning Object (RLO) is a learning object based on learning objectives built from a collection of static or interactive content and instructional practice activities. Each RLO can be mixed and matched to generate complete, personalised courses, lessons, and instructional events. An RLO consists of Overview, Reusable Information Objects, Summary, Practice and Assessments which support specific learning objectives (Cisco 2003). In Cisco's reusable learning object strategy, the guidelines with templates show the practicality of instructional learning content design in the industry. Based on the Cisco's guidelines, we have adapted and extended their templates for learning content design to meet the educational requirements in Higher Education (HE).

3. Instructional design model with practical templates

A design of learning content in HE requires a holistic approach to embed the pedagogy in the subject context. A common practice in the traditional content design is to follow a degree programme (e.g., BSc in Computer Science) in conjunction with module descriptors. In face-to-face delivery any problems such as incomplete content and incorrect instruction can be addressed and rectified on the spot, especially if a lecturer is experienced. It is very different from the content design for e-learning, because it has to accommodate the searchable, configurable, reusable and interoperable functions. Figure 1 shows a conceptual model for a module in a degree course that assists transforming instructional design of learning content for e-learning. There are five major components: Overview, Information Object, Practical Object, Assessment Object and Summary. Practical Objects are optional depending on the requirements of the subject context.

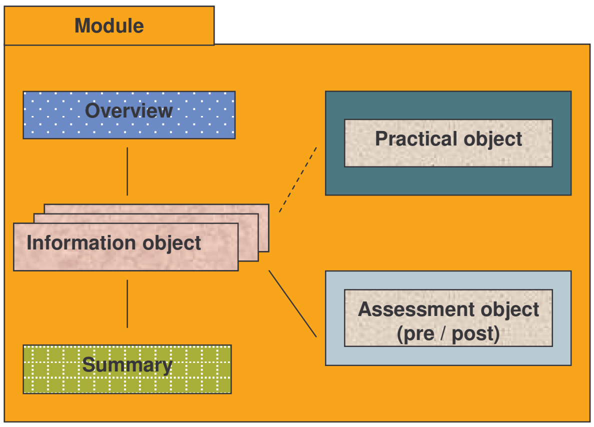

Figure 1. Template for module package.

The *Overview* offers general information about the module, such as the module code, level, aims, pre-requisites, co-requisites, learning outcomes, indicative content, assessment strategy, and credits (see figure 2). In this template, the attribute of *Indicative Content* is associated with

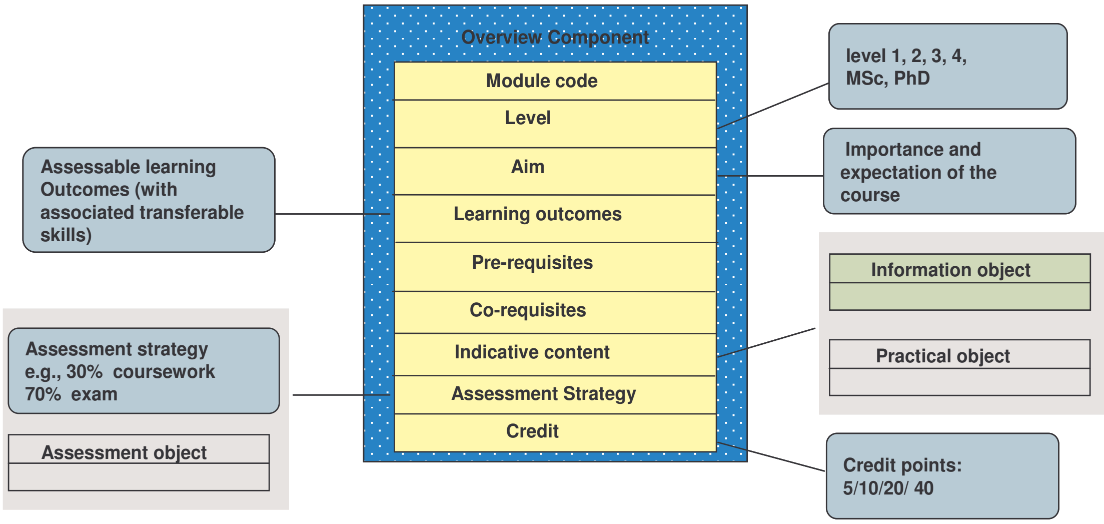

Figure 2. Template for the Overview component.

information objects representing a set of selected topics at appropriate granularities. The attribute of *Assessment Strategy* is embodied in *Assessment Objects*. This information can be obtained from module descriptors that are academically accredited and institutionally recognised across Schools in a university. The *Overview* is useful to various stakeholders, e.g., content providers, subject tutors, students, and accreditors, to share information consistently. In our course design, the *Overview* component is built within the ontology for subject disciplines to provide semantics for discovering and comparing relevant content and packaging the degree courses.

The *Summary* component (see figure 3) concludes the module to review the subject which will assist students in self-assessment and self-reflection on understanding of the topics and applying knowledge and skills for problem solving at large. Recommendation on related areas may be provided to guide students to extend their knowledge for deep-learning. These related areas are offered in the form of learning objects which are associated with the defined aims and learning outcomes rather than general reading.

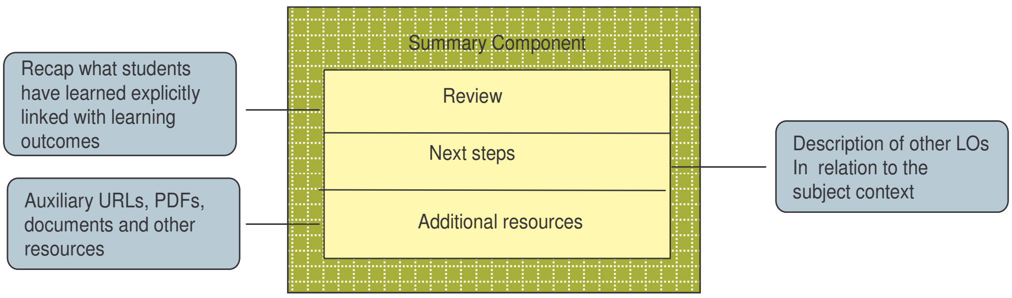

Figure 3 Template for the Summary component.

The *Information Object* component is the place where the core content is contained. The pedagogical and technical considerations will determine the quality of the Information Object, hence directly affect learning.

An information object represents a topic in the module learning object, e.g., algorithm design in a Programming module. Figure 4 visualises the conceptual template of the *Information Objects*. The attributes of the *Information Object* have respective content objects, such as *Introduction*, *Concept/Principle*, and *Examples*. By adopting the views from constructivism and semiotics, some content objects are domain-specific to situations in contexts whiles others are domain-independent. *Description*, the content object, defines and describes concepts and principles in the scientific form. It is considered as domain-independent so that it is highly sharable and reusable. The content object *Purpose* contains the general information which sets the scope of the topic. It may fall in to either domain-independent or domain-specific situation. We find that

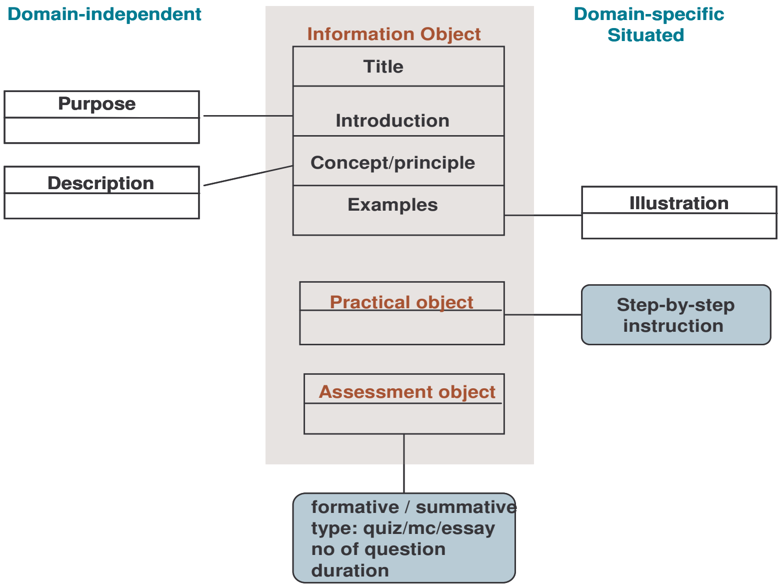

Figure 4. Template for Information objects and content objects.

introductory information for many computer science topics is domain independent. The content object *Illustration* includes a number of examples which demonstrate how the concepts can be applied in a context. These content objects aid knowledge construction in solving real world problems. The content object *Illustration* is therefore domain specific and is related to the social and culture context; because the applications of the principles must incorporate rules and constraints which are derived from the context. An *Illustration* object should perform personalised learning functions which allow students to engage interaction and self-reflection while they are learning.

During the design of an Information Object, it is also important to identify necessary *Practical Objects* and *Assessment Objects* which are integrated with the corresponding Information Object. Practical Objects can be optional and delivered in a mixed mode of on-line and off-line. The Assessment Objects are used as a mechanism to obtain feedback of learners' performance and to determine sequencing of Information Objects during a learning process. Form the experience of our module design, we use quiz in the form of self-assessed (SA) questions associated with each Information Object. The results from the students are statistically analysed and used for personalised tracking and support.

We have described the static view of conceptual templates for learning objects, Information Objects and Content Objects for instructional design on learning content. In Figure 5, an integration of these objects is presented from the pedagogic perspective. A number of design conditions need to be checked in this model. When selecting Information Objects and the associated Content Objects, content suitability and difficulty level should be satisfied according to the learner's requirements by checking against the *Overview* component. Assessment objects (presented as SA in the model) should be concurrently selected in terms of type of test, format of questions, number of questions, and duration based on the *level* defined in the *Overview* component. Sequencing for the Information Objects can be indicated with arrowed lines as a default option. We recently have developed the content configuration algorithm which extends sequencing functions to include personalised options (Sun *et al*. 2003). This algorithm captures personal learning style and prior knowledge from a pre-assessment and generates the parameters to determine the relevant content and the option for sequencing. *Learning Outcomes* (LOs) from the *Overview* component are listed to ensure each of them is covered in the content and assessment. Consistency between the learning content and assessment is also maintained through explicit reference to the learning outcomes.

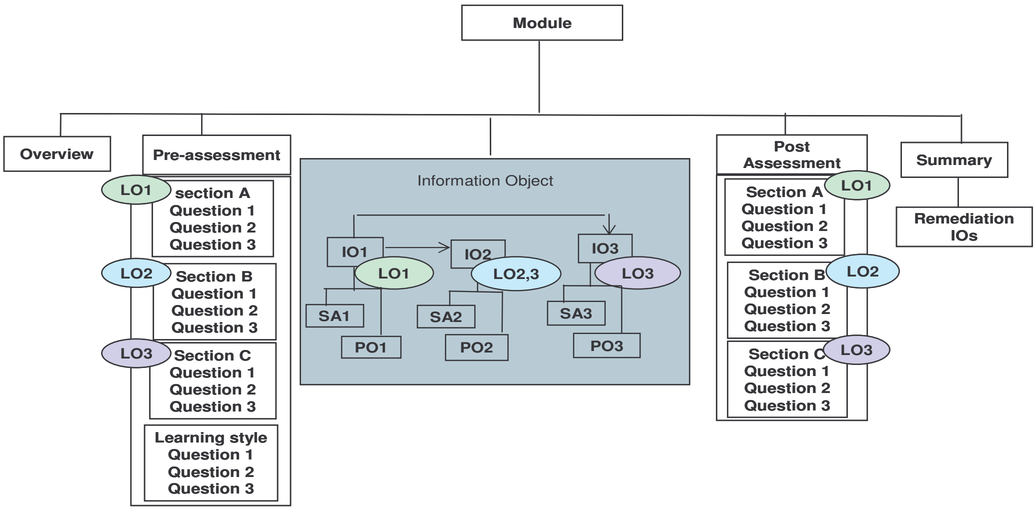

Figure 5. Instructional design model for generating learning content.

4. Discussion and Future work

The instructional design model is created based on the sound learning theories – constructivist and semiotics, and the best technical practices in the research community and industry. Some extensions for designing learning contents are made to address the needs of Higher Education. A practical use of the instructional design model has been prototyped in our undergraduate module, e.g., Programming and Design. The existing learning materials were analysed and structured into learning objects, information objects and further into content objects. They are partially implemented in the Blackboard system to support our students in the constructivist learning. There is related research work on articulation and representation of learners' requirements. The algorithms as the outcomes of this work will be integrated with the instructional design model to devise some underpinning design principles for learning content in e-learning environment. Furthermore, an intelligent tracking mechanism will be designed to facilitate personalised learning through real-time feedback to students and content providers on learning content decisions.

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