Framework for improved collaborative learning system via concept map and collaborative learning objects (C-LOs) in ODL environment

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Framework for Improved Collaborative Learning System via Concept Map and Collaborative Learning Objects (C-LOs) in ODL Environment

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Accepted Sub-theme: Technology-enhanced teaching and learning

The advances in technology and changes in the educational related domain knowledge put an increased emphasis on teamwork within the knowledge sharing. Collaborative learning enables learners to be able to think creatively with problem-solving skills in encapsulated educational components. Therefore, this paper presents an improved framework for the development and enhancement of critical-thinking skills through Collaborative Learning System via concept map and Collaborative Learning Objects (C-LOs) as one of the primary goals of technology education. Collaborative learning model is drawing much attention among researchers providing learners with maximizing learning autonomy in finding the suitable C-LOs (e.g. learning lessons, learning assets or learning packages) from knowledge web domain. The proposed collaborative virtual environment framework encourages the construction of knowledge using C-LOs that can be assembled with Learning Object Metadata (LOM) and resources to provide larger instructional sequences in courses delivery. This paper discusses the design and development of a Concept Map Web-based Learning System (CMWLS) using concept mapping, establishing the relationship between C-LOs and regulates in collaborative learning system. This paper highlights the features of CMWLS: (1) Assisting the students to include, adapt, manipulate and organize the learning objects in designing the hierarchical outline of the concept map in their learning path; (2) Application of Virtual Collaborative Sessions (VCS) by locating and identifying suitable C-LOs; (3) CMWLS is evaluated in the lessons form of simulations, drill-and-practice and assessments in conducting course delivery emphasis on facts, concepts, principles, procedures and processes; (4) CMWLS is designed to allow learners to generate and design their concept maps in achieving flexible paths towards student learning's process.

1. Introduction

The wide availability of learning objects in Open Distance Learning (ODL) has given rise to new paradigms of learning and knowledge sharing in collaborative learning. Collaborative learning defines a situation in which two or more people learn or attempt to learn in collaborative environment that emphasizes the social creation of knowledge as the basis of learning (Zhao, Li & Kanji, 2001). Researchers report that, regardless of the subject matter, students working in small groups tend to learn more of what is taught and retain it longer than when the same content is presented in other instructional formats. Beckman (1990) specified that students who work in collaborative groups appear to be more satisfied with their classes and group interaction.

Proponents of collaborative learning claim that the active exchange of ideas within small groups not only increases interest among the participants but also promotes critical thinking. According to Johnson and Johnson (1986), there is persuasive evidence that cooperative teams achieve at higher levels of thought and retain information longer than students who work quietly as individuals. The shared learning gives students an opportunity to engage in discussion, take responsibility for their own learning, and thus become critical thinkers (Totten et al., 1991).

The purpose of the research is to design and develop improved framework for Collaborative Learning System with Collaborative Learning Objects (C-LOs) with concept map. This enable student to participate in the collaborative learning activities via Virtual Collaborative Sessions (VCS) made available through the platform. Students are able to construct their own idea with the use of concept map and share with other students by engaging in the proposed system: Concept Map Web Learning System (CMWLS).

2. Collaborative Components

In collaborative learning environment, McGowen et al. (1999) defined that concept maps is an important feature of meaningful learning which enable new data (e.g. Learning Objects) to insert into present data networks and allow the data to be remembered for a long time. In a study conducted by Koli and Silandar (2003), it is expressed that one of the important techniques that improve students' skill to make a connection between old and new data is concept maps technique. In this section, we will discuss how to achieve meaningful learning via the primary components of collaborative learning: Concept Maps and Collaborative Learning Objects (C-LOs).

2.1 Integration of Concept Map

The main function of concept mapping presented in this approach is to improve thinking, problem solving and creative skills of learners to specify and describe concept meanings in domain knowledge by identifying important concepts, establishing the relationship between the concepts and regulates in collaborative learning system. The comparison study for cooperative learning, collaborative learning and improved framework for collaborative learning in CMWLS is illustrated in **Table 1**.

Table 1: Comparison of Related Research in Collaborative Learning Systems

Approaches Components	Cooperative Learning	Collaborative Learning	Improved Framework for Collaborative Learning in CMWLS
Description Features	Cooperative Learning is based on a set of process "teacher centered" in helping to accomplish a specific goal	Collaborative is based on joint intellectual effort by learners and teachers together	CMWLS is based on Collaborative Learning environment with Virtual Collaborative Sessions (VCS), Concept Map and Collaborative Learning Objects (CLOs)
Learning Object Support	Non-related individual LOs	Non-related individual LOs	Collaborative Learning Objects (CLOs) – Sequencing in LOs
Knowledge Building Support	Teacher maintains complete control of the class, students work in groups to accomplish a goal	Interaction initiated via group members enhancing critical thinking	Active interaction initiated via group members, critical thinking and problem-based solving via Concept Map.
Knowledge Domain	Controlled cooperation scripts	Social interaction space	Learning Object Organizer and Concept Map (Hierarchical Learning Paths)
Knowledge Sharing Platform	Forums, emails, chats	Forums, emails, chats	Virtual Collaborative Sessions (VCS)

Jegede, Alaiyemola and Okebukola (1990); Briscoe and LaMaster (1991) have found that concept map technique makes students be aware of their own cognitive levels and help in understanding the content better by organizing the data. Towbridge and Wandersee (1998) have determined that students who involved in concept map design are more confident in their experience and achieving results because of their success exploration within an activity.

2.2 Integration of Collaborative Learning Objects (C-LOs)

Learning object design is an application of object-oriented thinking to the world of learning that are self-contained, reusable chunks of instruction that can be assembled with other objects to provide some larger instructional sequences. The significance of C-LOs in this study is reflected on the integration of lesson objects or courses, taken out from the certain learning context and plugs them into a new context, or delivers them through a new medium presented in Concept Map.

A learning object is defined as an electronic resource that has two main components: Learning Object Metadata (LOM) and resources. The LOM comprises the granularity and metadata of the learning object and serves as the structured description or "catalogue information" which facilitates LOs searching, organization and re-use. The learning objects in this learning context consist of variety formats such as web pages (HTML5), pdf files, graphics and multimedia content. **Table 2** defines the metadata elements standards implemented in this study.

Table 2: Learning Object Metadata (LOM) Standards

Learning Object Metadata (LOM) Base Schema	Data Element
General.Title	Name given to this learning object.
General.Language	The primary human language or languages used within this learning object to communicate to the intended user.
Life Cycle.Version	The edition of this learning object.
Technical.Location	A string that is used to access this learning object (might be a URL, for example).
Educational.Typical Learning Time	Approximate or typical time it takes to work with or through this learning object for the typical intended target audience.
Annotation.Classification	Where this learning object falls within a particular classification system.

The proposed learning system (CMWLS) supports various format of learning objects mainly LO1: Lesson Pages, LO2: Story Board, LO3: Assessments, LO4: Multimedia. The lesson pages as the root of the Learning Objects Organizer is chunked into small units of learning object that contain one to three learning objectives. The C-LOs implemented extends the flexibility of student learning styles and allows students to generate and design their concept maps. The learning object is used to designed and help students to make connection, analyze ideas and develop conceptual frameworks for thinking and problem solving (Rohaida & Kamariah, 2000).

The reusability of the content and learning object design has becomes an important issue in e-Learning due to "its potential for reusability, generativity, adaptability and scalability" (Wiley, 2000). The content development for C-LOs overcomes two types of obstacles: time constraint and cost constraint. The instructional content (Wiley, 2000) can be designed as a self-contained learning object to be reusable in collaborative environment. Furthermore, the use of learning object design will empower online learners in unprecedented ways by enabling them to participate more actively in the contextualization of information (Longmire, 2000).

3. Framework for Improved Collaborative Learning System – CMWLS

CMWLS is designed to enable and help the students to include, adapt, annotate, manipulate and organize the learning objects in designing the hierarchical outline of the concept map. CMWLS is intended to be closely focused toward new knowledge construction by students with their existing knowledge and the new knowledge are shared out to their peers by uploading the created learning objects to the system. The ID model of the design and development of this research prototype consist of CMWLS, Learning Object Organizer and Virtual Collaborative Sessions (VCS). **Figure 1** illustrates the framework of the improved collaborative learning system via concept map -CMWLS.

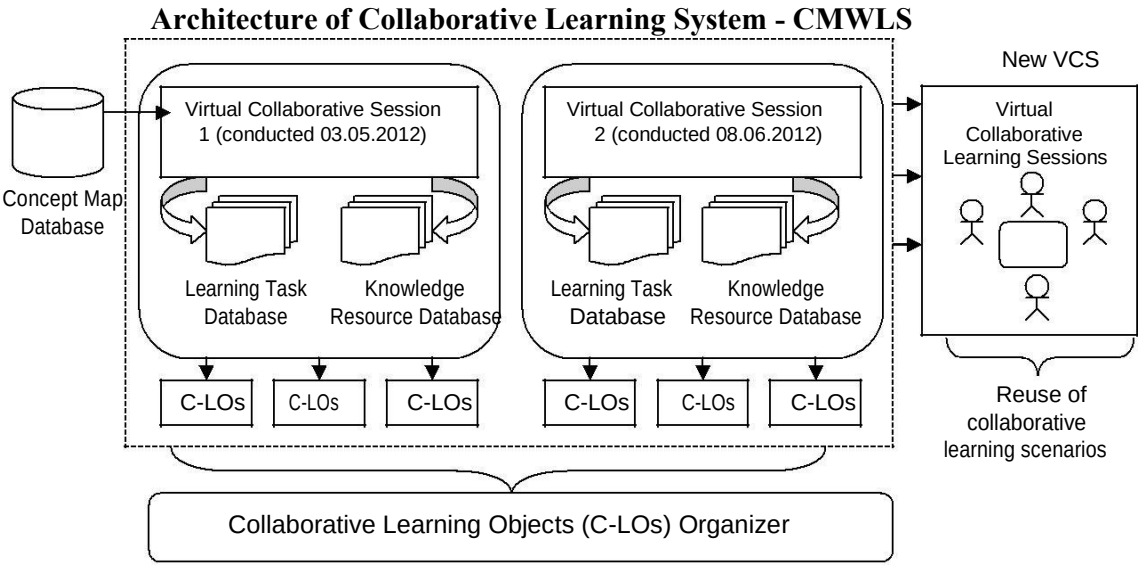

Figure 1: Architecture of Collaborative Learning System with C-LOs – Virtual Collaborative Learning Sessions (VCS)

The Collaborative Learning Objects (C-LOs) Organizer serves as the facilities for storing, retrieving, searching and saving of C-LOs. The C-LOs are stored in such a way that is realized in a Virtual Collaborative Sessions environment with relationships specified between respective objects and inclusion of objectives, outcomes and goals associated for learning activities. The proposed C-LOs design provides an important foundation for the effective reuse of LOs resources in ODL environment. In addition, the CMWLS allows extensive links between learning objects for use in multiple VCS sessions as described below:

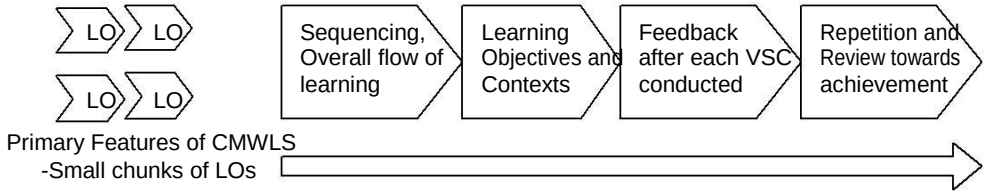

Figure 2: Flowchart of CMWLS - Steps of C-LOs Creation

Architecture of Virtual Collaborative Learning Sessions (VCS)

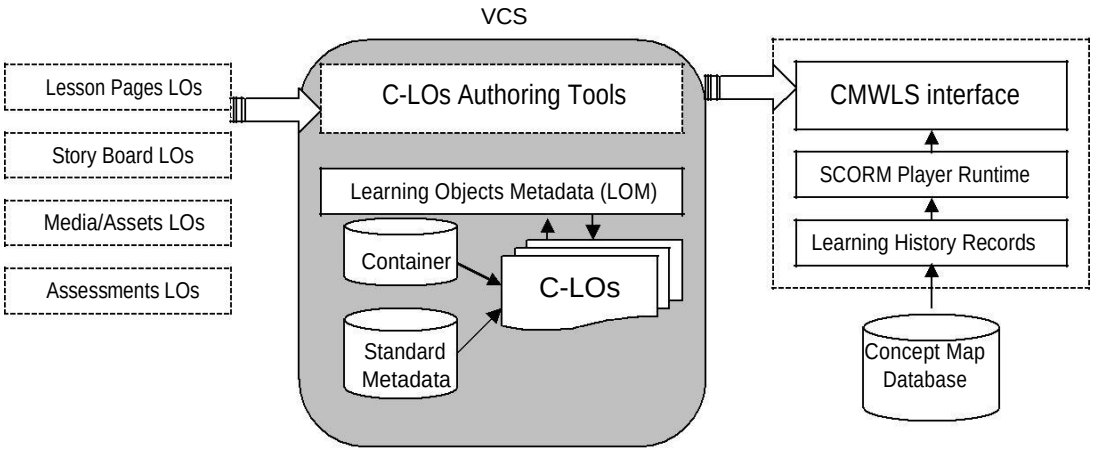

Figure 3: Architecture of Virtual Collaborative Learning Sessions (VCS)

The execution of collaborative learning objects in VCS is achieved through the integration of SCORM Run-Time Environment using TinyLMS SCORM Player that allows the LOs customization, learning history records, adaptation of individual learning sequence/path and high degree level of media/assets LOs across different range of LOs' metadata. The architecture of VCS with integration of SCORM Run-Time Environment and the process of constructing C-LOs repository is described in **Figure 3**.

4. Evaluation of Collaborative Learning Objects (C-LOs)

The framework is evaluated with a representative group of students, lecturers, experts and novice users in assessing the C-LOs embedded in the CMWLS environment. The results obtained for respective group of learners illustrating the assessments evaluation of VCS and Non-VCS Lesson 1, 2, 3 and 4 are shown in **Table 3** (Evaluation Course: Fundamentals of Artificial Intelligence). The VSC for each evaluation group are then observed via representation of LOs metadata (XML) showing how learners discussed and collaborated, increment of discussion threads and posts, C-LOs constructed, refined and consolidated with respect to problem solving assessments while sessions evolved.

Table 3. Evaluation of Assessments in VCS Lessons and Non-VCS Lessons

Users	Average Test Score Evaluation in C-LOs (Total Test Score=10)							
	VCS Lesson 1	Non-VCS	VCS Lesson 2	Non-VCS	VCS Lesson 3	Non-VCS	VCS Lesson 4	Non-VCS
Students	6.5	3.5	6	3.5	6.5	2.5	5.5	3
Lecturers	8.5	6.5	7.5	5.5	8.5	6	7.5	6.5
Experts	9.5	7.5	8.5	8	8	7.5	9	8
Novice	4.5	3	6	4	5.5	4	4.5	3.5

Key findings: Comparisons of VCS Lessons versus Non-VCS Lessons

CMWLS enables the creation of hyperlinks between different collaborative learning objects (Example scenario: C-LOs are designed in accessible form, whereby learners construct their own set of objects with linking paths and to enable learning goals to be met). The students are able to design their concept maps that contain hyperlinks to certain learning objects to represent relationship among the ideas. As the learning objects and links become interrelated in the concept map, a structural knowledge representation depicts the understanding of the lesson. The process of concept mapping engages the students to identify the key concepts and relate them in a more meaningful way. In this study, the students actively construct knowledge as they form the concept maps that contain hyperlinks to various collaborative learning objects.

The C-LOs presented in this study (**Table 4**) demonstrated facts, concepts, principles, procedures and processes. The C-LOs contains in *(i) Lesson Page, (ii) Case Studies & Storyboard, (iii) Assessments & Activities* and *(iv) Multimedia content* can be in the form of simulations, games, drill-and-practice or exercises to facilitate student's learning path in dealing with specific problem-solving scenarios/case studies. The C-LOs evaluation were grouped into four categories mainly lesson page; case study and story board; assessment and activities; multimedia content.

Table 4: C-LOs Analysis in VCS 1, VSC2, VSC3 and VSC4

Collaborative Learning Objects (C-LOs) Analysis				
VCS 1 Number of C-LOs	Lesson Pages 5	Case Studies & Storyboard 6	Assessments & Activities 12	Multimedia content 5
VCS 2 Number of C-LOs	Lesson Pages 3	Case Studies & Storyboard 9	Assessments & Activities 8	Multimedia content 3
VCS 3 Number of C-LOs	Lesson Pages 5	Case Studies & Storyboard 8	Assessments & Activities 11	Multimedia content 2
VCS 4 Number of C-LOs	Lesson Pages 3	Case Studies & Storyboard 7	Assessments & Activities 10	Multimedia content 4

CMWLS contains a Web database platform (to store learning objects and concept map), Apache server (Web Application Server) and MySQL (database management). PHP is used scripting language to connect and communicate the databases in the system. XML is used in the system to design the metadata of the learning objects (LOM).

CMWLS allows the lecturers and the students to upload as well as to share the learning objects within their learning community to form a repository of highly reusable learning objects. The key strategy in this move is the design and development of Web-based

learning system based on learning object design. The learning object design which emphasize on active learning and learner-controlled learning environment to enable students to construct and organize their own learning. The findings show that {Assessment} and {Case Study} are the highest C-LOs, followed by {Lesson Page} and {Multimedia} that assist in all VCS sessions as indicated in **Figure 4**.

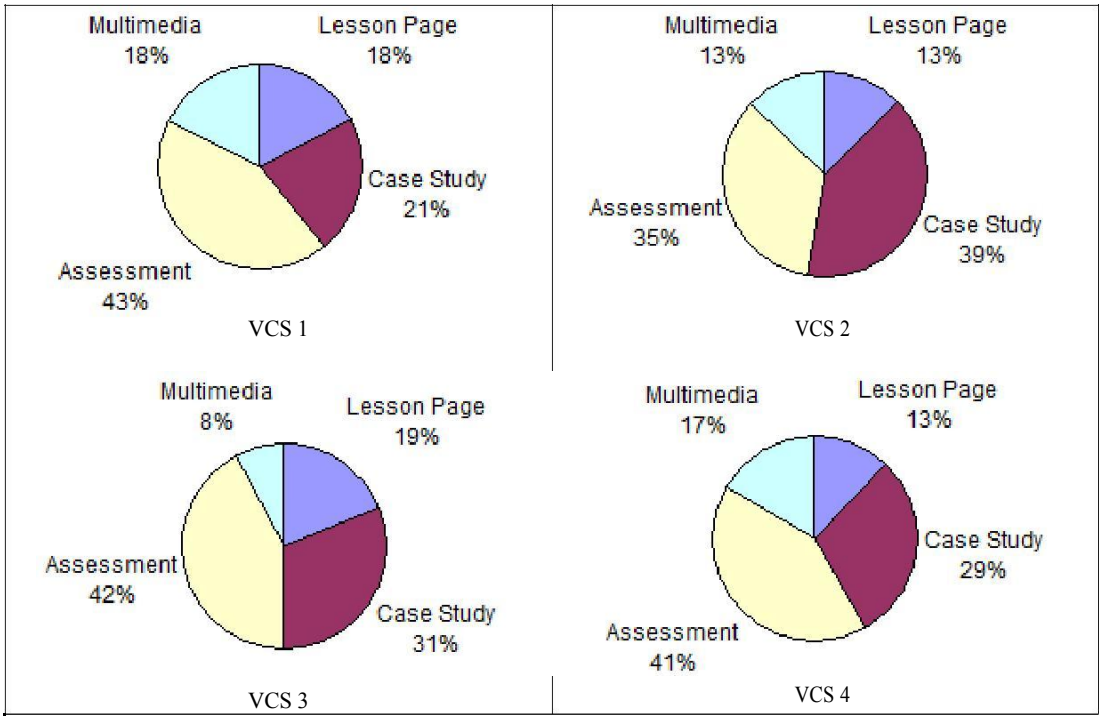

Figure 4: Distribution of C-LOs for Learners Access in VCS 1, VCS 2, VCS 3 and VCS4

Key findings: Relative Importance of different C-LOs in Virtual Collaborative Sessions for knowledge building support domain

5. Conclusion and Recommendations

The proposed study presents an improved framework, CMWLS for collaborative learning system to facilitate knowledge construction and offer learners the opportunity to construct or re-construct their knowledge by assimilating and accommodating new knowledge with concept mapping and C-LOs. The CMWLS shows that learners are able to generate their ideas and construct their learning actively in the evaluation of assessments achieved during multiple VCS Session (VCS Lesson 1 - VCS Lesson 4) by connecting and generating relationships between the learning object designs with the use of concept mapping to achieve a seamless knowledge flow among the collaborative team members. The main design for the framework is presented as a mechanism which

facilitates the ODL environment and reuse of collaborative learning scenarios. Particular recommendations that have emerged include:

1. Layered LOM

Multiple layers of Learning Object Metadata (LOM) description may be useful to students for locating a learning object and beneficial to hold them in searchable repository (Learning Object Repository).

2. Concept Mapping

Concept mapping encourages students to actively and generatively construct, relate and organize their concepts via Virtual Collaborative Sessions (VCS). The concept of Concept Mapping provides design guidance for collaborative learning environment in ODL and highly flexible paths by pointing learners to different types of C-LOs in the students' learning process (e.g. building networked communities of learning objects).

3. Impact of media richness (C-LOs)

Richer content-presentation C-LOs may be employed in future study by assisting learners in achieving learning objectives. Results obtained from this study have practical implications for researchers interested in integrating {Assessments}, {Case Study}, {Lesson Page} and {Multimedia} into collaborative learning to determine specific LOs presentation types and acceptance behavior.

In summary, the approach of this development has the potential to speed the practical adoption of learning objects and reassembles in concept mapping that support individual instructional goal. This study of collaborative learning via improved framework in the proposed prototype system, CMWLS aiming to provide learners with C-LOs, concept maps and promotes the growing of knowledge and expertise in ODL environment.

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