An Intelligent Mediating Model for Collaborative e-Learning Management Systems

Akanbi Caleb [1] and Adagunodo Rotimi.[2]

[1] Department of Information and Communication Technology, Osun State University, Osogbo, Osun State, 23436, Nigeria

[2] Department of Computer Science and Engineering,Obafemi Awolowo University, Ile-ife Osun State ,Nigeria

Abstract

E-learning management systems(e-LMSs) lack ontologies for sharing their domain knowledge learning objects with others due to differences or non-uniformity in architectures, platforms, protocols and representations. The effect of this on e-learners is that collaboration with other e-LMS during learning processes is not permitted. Hence, learning process is restricted only to the knowledge base of a particular E-LMS adopted by an institution, which may limit the mastery level of learners.

To provide a remedy to this problem, an intelligent multi-agent mediating system model is proposed in this study using hybrid rule and case based reasoning scheme. Unified Modeling Language(UML) is used as a design tool to specify the active and passive entities of the model in form class The model proposed provides a collaborative platform for sharing of the learning objects across multiple e-LMSs, during learning processes.

Keywords: *Collaborative Learning, Web-based , Learning Management System, Artificial Intelligence, Unified Modeling Language (UML)*

1.Introduction

The advent of the Internet Technology has motivated various institutions of higher learning offering distance learning programmes to embrace e- learning programmes as an alternative. A number of these institutions have acquired suitable educational software platforms called Web-based learning Courseware systems(E-LMSs) such as WebCT, Convene, Blackboard Authoware, Learning Space, Course Info, Cyber Proof, Mallad, CM Online [1]

These e-LMS systems lack ontologies for sharing their domain knowledge learning objects with others [2]. This is due to differences in architectures, platforms, protocols and representations. This does not permit collaboration with other e-LMS during a learning process particularly, when a learner needs further adaptive and intelligent supports to compliment the learning process. The limitation of this scheme to the e-learners is that learning process is restricted only to the knowledge base of a particular courseware which may reduce the mastery of a learning concept.

To overcome this drawback, we specified an intelligent component of mediating architecture that uses hybrid rule and case based reasoning model to provide a collaborative platform for making possible, the sharing of the learning objects across multiple e-LMSs, during a learning process in this paper .

1.1 Intelligent Mediating System

An intelligent mediating system is a software agent that exploits encoded knowledge about certain sets or subsets of data in different knowledge/data base to create information for a higher layer of applications. Mediator improves the management of the integrated system through the amalgamation of le arning objects coming from different knowledge base of diverse learning objects[3].

Learning object is a smallest digital reproducible and addressable resources of a learning contents stored in various Knowledge base of management systems[4].

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2.1 Literature Review

2.1.1 Artificial Intelligence

An artificial intelligence (AI) is an area of computer science focusing on creating machines that can engage in behaviours that humans consider intelligent [5]. Different artificial intelligence approaches have been employed to provide intelligent reasoning for agent-based systems. Notable among them according to [6] include *rule-based reasoning,Case-based reasoning*dapts,*Pattern recognition* using neural network, fuzzy logic,and *Hybrid /integrated approaches*

Rule Based, Case based and hybrid reasoning approaches are discussed in details in this paper because of their relevances to this study.

2.1.1 Rule-Based Reasoning (RBR)

The idea of rule-based reasoning is to represent a domain expert's knowledge in a form called rules. A rule-based system consists mainly of three items : *facts, rules and an inference engine* that acts on them. Rules represent knowledge and facts represent data. A rule-based system solves problems by applying rules on facts (i.e. matching facts with rules' *if* clauses). The common knowledge base rule is production rules which consist of two parts: conditions (*if* clauses) and actions [7]. These *rules* occur in sequences and are expressions of the form:

if <*conditions*> then <*actions*>

where if the *conditions* are true then the *actions* are executed. The action part of a rule might assert new facts that fire other rules. When rules are examined by the inference engine, actions are executed if the information supplied by the user satisfies the conditions in the rules. Two methods of inference often used are *forward* and *backward chaining. [7],[8].*

2.1.2 Case-Based Reasoning (CBR)

CBR is a method to solve new problems by adapting solutions that were used to solve past problems [7]. With CBR, past cases that are analogous to the current case are searched for. The solutions of the most analogous past cases are then used to create a solution for the current case. In case-based reasoning (CBR) systems expertise is embodied in a library of past cases, rather than being encoded in classical rules. To solve a current problem, the problem is matched against the cases in the case base, and similar cases are retrieved. The retrieved cases are used to suggest a solution which is reused and tested for success. If necessary, the solution is then revised. Finally the current problem and the final solution are retained as part of a new case

Two major classes of CBR are problem-solving CBR and precedent-based CBR [9].

(1) Problem Solving CBR

In problem solving CBR, the typical focus is on using past cases to find a detailed problem solution (e.g., a plan, a course of action), where the new solution is generated by *adapting* a previous solution. Industrial design and planning are paradigmatic examples of problem-solving CBR

(2) Precedent based CBR

Precedent based CBR is distinguished by its focus on the use of past cases ("precedents") to *justify* a solution and explain its rationale This this could be textual. conversational or structural.

2.2 Hybrid Reasoning Approaches

Hybrid systems combines different artificial intelligence approaches. The believe is that using multiple techniques emphasizes the advantages of each and overcomes the individual disadvantages [10] . For example, rules are applied when the cases are not enough to provide a solution.

Hybrid reasoning approach consisting of both rule based and case based was adopted in the modeling of intelligence of the mediator system architecture proposed in this study.

2.3 Related Works

[10] in attempt to solve the problem of reusability of existing software resources, developed a scalable, fault tolerant management middleware architecture that combines *publish-subscribe* and *service-oriented computing* principles for managing a set of distributed entities. The service oriented architecture employed provided interoperability to the management process.

Also, in [11] a brokering architecture that exploits semantic web technologies for locating multimedia learning objects was proposed. Central to their architecture is the Brokering Web Service, which provides lightweight query processing and reasoning in response to Requestor OWL-OQL queries. They described the use of this broker, its associated ontologies and its reasoning mechanism in an intelligent multimedia learning object search engine prototype].

While all of them have modeled a mediator that search through a knowledgebase of a learning management system , this study attempt to model a mediator that searches through several learning management systems.

3.1 Mediator System Architecture

The system architecture is shown in appendix 1 . It consists of two agents which are collaborative agent for searching for learning modules (learning objects) and filtering agent for recommending suitable learning modules. It consists of three main components;

(i) Courseware Mediator Interphase (CMI).
(ii) Recommender Engine
(iii) Knowledge Base

(i) Courseware Mediator Interphase (CMI)

This query is typed in by the active learner (who needs collaborative supports) through the Graphical User Interface (GUI) in the client side of the requesting courseware (R-courseware

Courseware). Also the suitable learning objects recommended by the mediating system are sent to the requesting Courseware (R-courseware) through this module.

(ii) Recommender Engine(RE) :

Recommender engine is the intelligent (reasoning) component of the mediator architecture. It consists of two major categories of agents:

(i) Filter agent (FA) which is stationary carries out the filtering process with the ultimate goal of recommending suitable learning objects to the active learners.

(ii) Collaboration agent (CA) which is mobile is created automatically by the broker agent when there is a service request to search for suitable learning objects ($LO_{J(1....m)}$) from the *P-courserware* systems that matches the ALQ.

(iii) After arriving at a location, the agent intelligently fetch required learning objects using rule base reasoning (RBR) scheme.

Knowledge Base.

This is the knowledge repository for the mediator system. It consists of two categories of repositories as shown in figure 2 which are:

(i) Matched Learning Object Repository

(ii) Recommended Learning Object Repository

3.2 Embedded Intelligent Frameworks in Mediator System.

The Hybrid reasoning approach consisting of case Based reasoning (CBR) and rule based reasoning(CBR) is adopted to provide intelligencefor mediator system in this study. It takes advantage of the strengths of both CBR and RBR to retrieve learning objects that are highly similar to active learner query (ALQ) based on their computed similarity values which is the average of concept and relational similarity values as shown in equation 1

Similarity Value

= (Concept_SimVal + Relational_ SimVal) / 2 …………(1)

Where Concept_SimVal

$$= \begin{cases} 0 \quad \text{no common concepts} \\ \text{same set of concepts,} \\ \text{otherwise} \end{cases} \quad ………………(2)$$

and

$$\text{Relational\_ SimVal} = 2*\Sigma lna_i b_i / \Sigma lna_i^2 + \Sigma lnb_i^2 \quad …………….(3)$$

where vectors A and B are filled with the number of concept nodes of graph G1 represents ALQ learning objects and graph G2 represents P-courseware visited by the collaboration agent.

The suitable learning object is obtained from both current filtered results and previous recommendation results all stored in the knowledge base. This demonstrates the capacity of mediator to improve upon a pure rule-based or case-based system. In addition to accuracy benefits, having rules together with the cases allowed three innovations in AI technology:

(i) the rules provided a natural way to index the cases (prediction-based indexing)

(ii) CBR then becomes a postprocessor that improves on the approximate similar result provided by rule base.

(iii) combine multiple independent knowledge sources achieve higher accuracy.

3.3 Intelligence in Filter Agent

Intelligence in filter agent was achieved using the hybrid reasoning scheme consisting of rule based reasoning (RBR) and case base reasoning (CBR) scheme as shown in figure 2. RBR was employed for service request and transition while CBR was used in searching and retrieving previous cases stored in the knowledge base. This is done by comparing the active learning object to past cases (learning objects) in the knowledge base.

3.3.1 Filter Agent RBR

The courseware mediating intephase(CMI), collaboration agent and knowledge base assert the facts into the fact list of the recommender engine. The fact list is the input to the artificial component of the filter agent. Rule base filtered the message and come out with result which may be active learner query (ALQ) or recommended learning objects. Filter agent was equipped with RBR to handle among others, these three activities:

(i) identifies the alert messages

(ii) creates collaboration agent

(iii) recommend suitable learning objects

In order to handle these service requests and transitions, filter agent uses a simple RBR scheme called “ECCA” rule which has four parts:

- *Event*: The event that triggers this rule.
- *Condition*: The condition that needs to be checked before the action is performed.
- *Action*: The action to be performed when the condition is true.
- *AltAction*: The action to be performed when the condition is false.

Filter agent CBR

Filter agent uses CBR to retrieve relevant cases (Learning Objects) and accurately from the knowledge base. Filter agent builds an indexing knowledge structure that will return the most appropriate case(s) at high speed. Case base indexing minimizes the number of cases that have to be evaluated at run time and is required for a large set of cases as linear searched will yield a probability long retrieval time [12].

3.4 UML Model for the Mediator Architecture

A Unified Modeling Language(UML) is adopted in this study as software engineering tool for the modeling of this design The interaction protocol specified in this is represented by the Unified Modeling Language UML class diagram in appendix 2 . The model shows the relationship between the primary entities (actors) and passive entities of the developed system..

Appendix 2 is the class diagram specifying various object-oriented design connections between the active and passive entities. The active entities are R-courseware, P-courseware, Collaboration Agent and the Learners while the passive entities are Courseware Mediating.
Interface(CMI), Filter agents, and SynonymsDB . The active and passive entities contain various cases and rules.

3.5 Protocol Interactions in the Class Diagram

The mediating agent model adopts the following protocol interaction.

(i) Filter agent receives ALQ and creates collaboration agent to execute

(ii) Mediator collaboration agent migrates to other courseware in the collaborative environment, to search for similar learning objects (LOj) one after the other.

(iii) Collaboration Agent Wrapper Module (CAWM) generates the XML. file format for the active learner query file (ALQ_i), and the learning object files $LO_{J(1......n)}$ found in P-courseware.

3.5 Implementation

We are currently developing this prototype intelligent mediating system using appropriate program language such as JAVA (Java expert shell.
software(JESS) and Java Agent Development Environment (JADE) Technologies). It is believed that the full implementation of this mediating model will go a long way to solve the interoperability problem among diverse e-learningmanagement systemsin various institutions of higher learning.

4.0 Conclusion

The major problem of existing e-learning courseware has been highlighted, An intelligent mediator architecture for collaborative e-learning systems was designed in this paper, The architecture model uses hybrid reasoning mechanisms consisting of rule based for collaboration agent and case and rule-based reasoning for filter agent is proposed in this paper to provide a collaborative platform for the sharing of the learning objects across multiple E-LMSs, during a learning process.

The UML model specifications of class diagrams is presented to show various interactions in the design.

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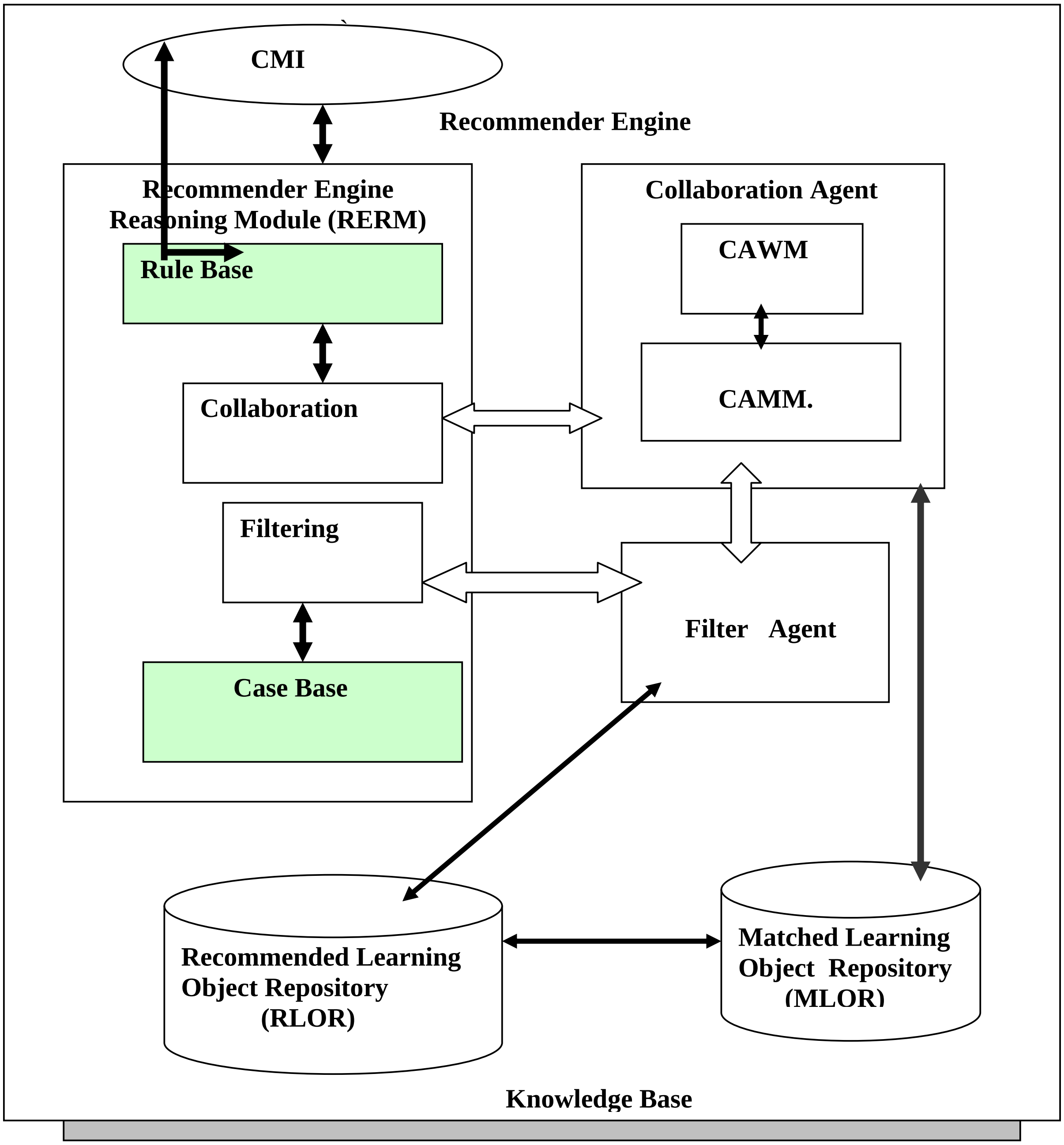
First Authors : *Dr. Akanbi C. Olufisoye.*

Department of Information and Communication Technology, Osun State University, Osogbo is a lecturer I in the above named Dept. He obtained his first degree (B. Sc. Mathematics) in 1991, from University of Ilorin , He holds M.Sc. and Ph.D degrees in Computer Science in 1999 and 2010 respectively from Obafemi Awolowo University, Ile-Ife. He is the Acting Director of Information Management and Technology Centre Osun State University Osogbo. His area of specialization is electronic learning (e-learning), collaborative Learning , Multi-Agent System, and Artificial Intelligence .

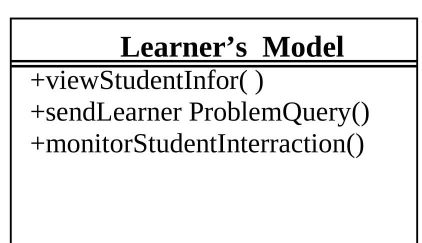
Second Author : Prof. Adagunodo E. Rotimi.

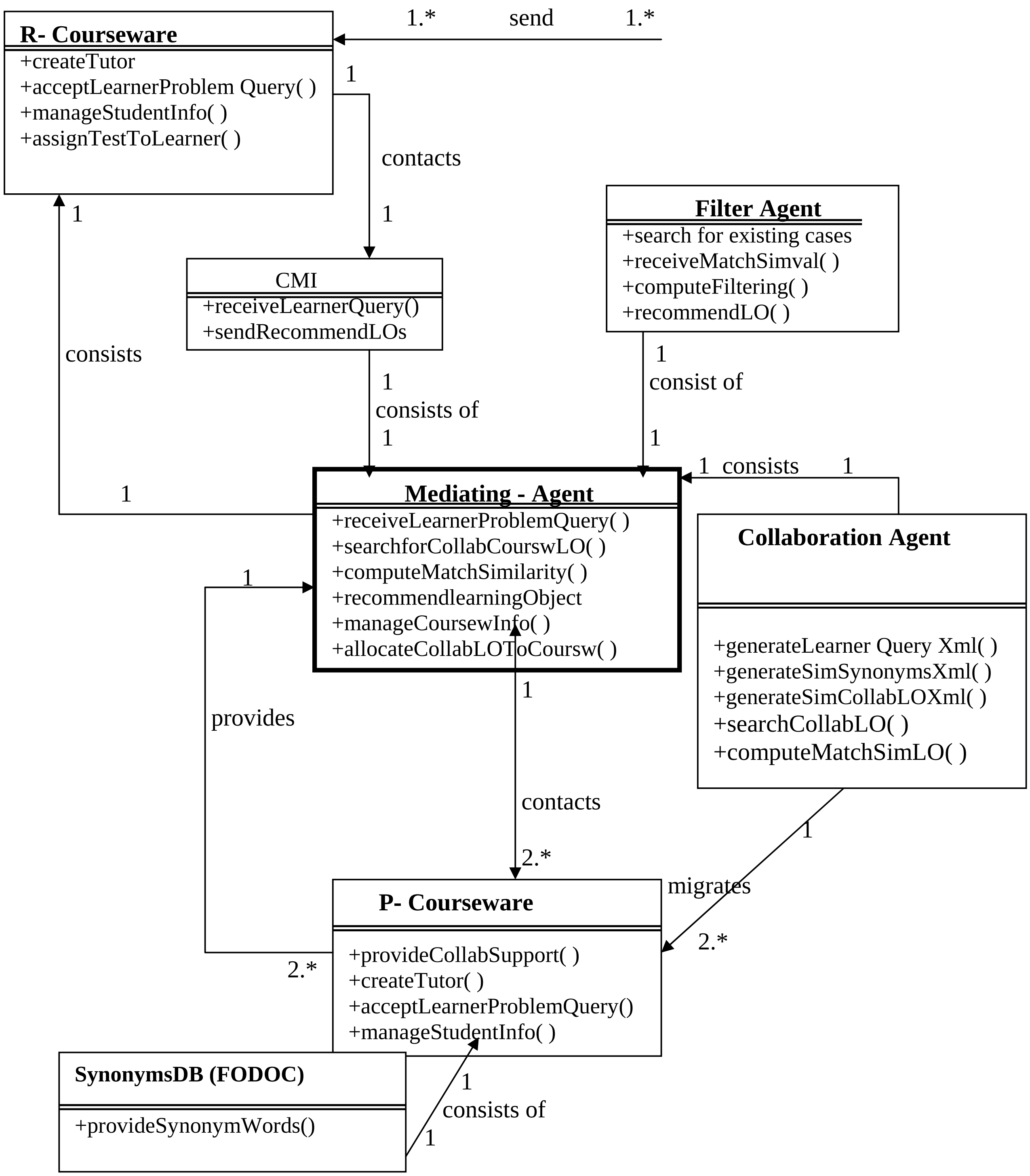
Department of Computer Science and Engineering ,Obafemi Awolowo University, Ile-ife is a Prof. of computer science. He obtained his B.Sc, M.Sc and Ph.D in Computer Science from the same University. He is currently the Head of department of Computer Science and Engineering, He has supervised many M.Sc and Ph.D students and published in many international and local journals. Prof. Adagunodo area of research works include operating system, e-learning and soft computing.

LOs



Appendix 1 : Intelligent Mediator System Architecture





CAWM = Collaborative Agent Wrapper Module
FODOC = Free Online Dictionary of Computing
CA = Collaborative Agent
CMI = Courseware Mediator Interphase

Appendix 2: The Proposed Mediator Model: Class Diagram