Chapter 3 Architecture of VCLE

Chapter Outline:

3.1 Introduction and problem statement
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3.3 Proposed conceptual model for VCLE
3.4 Requirements of the system
Chapter 3

This chapter introduces the problem statement, states the general objectives of the study, proposes the conceptual model for virtual collaborative learning environment, and finds the major requirement criteria to be considered for the system.

3.1 Introduction and problem statement:

As the different landscape like education, business and others change rapidly; the environment in the knowledge society in 21st century is no longer linear or foreseeable. Survival and success depend upon the ability to adjust to the dynamicity of the domain environment. Everyone needs to address knowledge, knowledge generation, knowledge sharing, and collaboration to be able to compete in an unpredictable market environment. Knowledge Management is a newly emerging and interdisciplinary model that possesses the knowledge within the framework of the domain. This helps in gathering, accessing, representing, promoting, transferring and assessing the knowledge and measures the overall impact of it in the real time domain.

Education and learning plays a vital role in overall in development of individual, society, nation and globe as a whole. Recently worldwide education focuses on academic, extracurricular activities and bridge courses that narrow down the gap between an institute and the industry. With the excessive use of Internet and Information and Communication Technologies (ICT), world has become a global village. More and more personalized digital content is expected from the user makes life of the programmer more miserable.

Like Computer-Assisted-Learning (CAL) and Computer-Supported Collaborative Learning (CSCL); virtual collaborative learning aims to generate technological instrumental learning processes in which learners
can work together in a group to generate, formulate, and disseminate knowledge. This type of environment provides rich opportunities to build knowledge, improving the critical thinking and problem solving capabilities for the learner and also enriches and refines the knowledge pool.

Different tools are initiated and being used in the environment that synchronously as well as asynchronously communicates and shares resources available. The environment may use two different approaches to communicate: action-oriented approach and/or text-oriented approach. The action-oriented approach captures the knowledge of learner and disseminates. This may be considered as transforming the tacit knowledge of an individual. In the text-oriented approach the learners are sharing their explicit (written) knowledge.

Learner of 21st century experiences the virtual learning environments in traditional classrooms. These virtual technologies offer confirm access to relevant content and learning resources without requiring much more effort from learner. These new technologies and digitization of content offer tremendous potential to the learners as they enable new form of learning by combining face-to-face learning with the virtual space. As online communities have more obstacles in comparison with face-to-face groups because of the heterogeneity of the group.

The objective here is to propose a web-enabled tutoring system that act as a supplement to traditional teaching learning process and should also help the human teacher to identify the competency skill level of the learners in the system. Such self-driven learning system should also help learner to have their own learning pedagogy, offerings with their own preferences, learning content according to their learning efficiency and learning pace.
By taking into consideration above mentioned objectives for a web-enabled system, a virtual learning environment can be classified with following stages:

(1) Beginning and forecasting of learning process;
(2) Offering various preferences;
(3) Observing the access of preferences;
(4) Observing of learning activities;
(5) Guiding and adjusting of the learning process; and
(6) Reproducing and reacting.

Looking at the above mentioned stages, the major advantages which can be obtained from the system can be as follows:

(3) Personalized content to the learner as per their competency skills;
(4) Reading and evaluation learner preferences, activities, learning pattern;
(5) Mapping of the activities of learner and calibrating the action with action expected results; and
(6) Personalized evaluation pattern generation as per the average competency level of the cluster.

In the view of importance of learner, learning outcomes, learning objectives, tutors, tutors objectives and tutors outcomes; an implementation model (VCLE) need to be designed and outcomes are to be proposed through an experimental model.

Considering these facts, the problem statement for the research work can be given as follows:

“Design and implementation of teaching learning simulation tool to assist tutor as well as learner in achieving learning psychology in an educational habitat.”
3.2 General objectives of study:

Studying many learning portals available, that provides the collaborative learning environment. These portals offers learner to have an opportunity to upgrade his/her knowledge. They allow scheduling as well as planner facilities that make the portal more interesting and interactive. These portals also help tutors in generating the fixed evaluation pattern with learner tracking activities.

An adaptive education system has to be personalized in nature towards an individual need. In the collaborative environment; the understanding, learning skills, learning pattern and background of every learner is different and so, everyone demands their own pattern and pace of learning. Every existing learning environment provides different functionalities, which records active behaviour, learning pattern, involvement of the learner, history of learner and preferences of learner. This opened a way to provide an adaptive agent that accumulates the learner detail, behaviour, preference; performs data analytics on the content as well as on the learner behaviour and provides real-time ready to use content. To offer this personalization, the agent needs to find competency level, learning pattern, and learning pace in the environment. This helps an agent to generating personalized content as well help tutor to generate the evaluation pattern accordingly.

To overcome the problems of tutor in identifying the learner’s level, setting the evaluation pattern according to the overall learner’s competency scale, evaluating learning pattern of the learner, and also delivering the content to the learner according to the learning style, pace, preferences and learning effectiveness; a new model of collaborative learning environment is designed, proposed and developed. The model uses supervised as well as unsupervised learning model and both forward as well as backward chaining mechanism by the inference engine. Later in this thesis,
documentation on a prototype system is provided with design, implementation detail and comparative analysis.

The major objectives of the research work are as follows:

(1) To study the impact of technological revolution, digitization and data analytics in a collaborative learning environment;

(2) To study and analyze existing solutions to identify the common limitations of such environments;

(3) To propose the general purpose architecture for virtual collaborative learning environment that try to minimize the limitations of existing solutions;

(4) To develop an agent that help learner to have personalized content based on their interest as well as learning level;

(5) To develop an algorithm in the environment that foster teachers’ ability to identify competency skill, preferences, learning pattern and accordingly generate the evaluation pattern;

(6) To offer a service to share resources, knowledge, content and also improve the critical thinking and problem solving ability of learner; and

(7) To document as well as publish the research work as well as tacit knowledge in the collaborative environment.

3.3 Proposed conceptual model for VCLE:

Looking at these objectives, observations and need of the learners, herewith we are proposing a conceptual model for a virtual collaborative learning environment (VCLE) which is shown in the figure 3.1.
To modularize the tasks of the proposed model, the general model is divided into three-tier:

1. Interface tier;
2. Service tier; and

The basic working of the model in which, knowledge based agent which is responsible in storing and retrieving knowledge uses inference techniques. The hybrid inference technique is used by the model which consists of forward chaining as well as backward chaining. To impart intelligence to the system, an agent can be designed and developed in such way that it (i) learns from the learner behaviour (ii) deduce future behaviour and assists the tutor.

**Fig.3.1 Proposed model**

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At the initial stage, knowledge based agent retrieves the basic details from the learner and then algorithmic approach is being applied to derive knowledge out of it. This is by using forward chaining mechanism. Then this algorithmic approach involves evaluating, retrieving and integrating information from multiple sources and from multiple actions. As learner explores the system, the previous knowledge which was generated for the learner using learner behavioural read then shall be calibrated. Agent which calibrates this behaviour may generate new knowledge or support the existing knowledge using the backward chaining.

The three-tiers of the model:

3.3.1 Interface tier:

This includes the user interface layer to produce the content to the client i.e. the learners in the virtual collaborative learning environment. This framework works as a medium to retrieve content and present it to every stakeholders of the system.

A web-enabled user interface via any browser allows different stakeholders of the system to access the system. Two main categories of the stakeholders in the system are identified with their role in the proposed VCLE model.

(a) Tutor / Administrator:

(i) Works as knowledge engineer;
(ii) Feeds the content of educational data into the content base;
(iii) Feeds the multiple choice question in the pool for evaluation;
(iv) Feeds the descriptive questions in the question pool;
(v) Manages the course and course syllabus (outlines);
(vi) Prepares and generates evaluation scheme (System generates the paper after identifying the overall class effectiveness in the system); and
(vii) Manages the notifications related to the education excellence;

(b) Learner / Student / User:

(i) Can refer the content (Content is generated by the system after identifying the learning style, pattern, competency and effectiveness in the system);
(ii) Can give ranking to the content;
(iii) Can raise the question as well as answer the question(s)(forum);
(iv) Can read/write blog (Implicit knowledge can be transformed into explicit knowledge);
(v) Can refer online library as an external pool of resource;
(vi) Appears for the evaluation;

3.3.2 Resource tier:

The resource tier contains the domain knowledge, learner profile, and history/log of the learner. Separate user log, user profile and content are stored in the pool. This explicit knowledge helps in identifying the behavior, learning pedagogy, preferences of the learner in the system that helps in inferring the general understanding of the learner effectiveness and activeness in the system.

The gathered details here can be better utilized in the system that infers the learner behavior to provide more relevant as well as personalized content to the learner. The main objective here is to create an interest as well as to increase learning capabilities of the learner as an individual and as a team in the collaborative learning environment.

As major portion of the knowledge in the globe is implicit which needs to be utilized and better being used for an individual growth
and for the betterment of the team and society as whole. This service tier tries to fetch and store the implicit knowledge of the learner by storing it in blogs and keeping it in the forum that also helps in capturing the critical thinking of the learners.

This tier also has the heuristic functions that inform the search about direction towards goal. This heuristic function provides well defined way to guess what to take and what to skip to reach towards the optimum outcome. These heuristic functions help all the stakeholders in generating the optimum outcomes. The heuristic algorithm which is designed that helps in identifying the average competency skills of the learner in the environment with similar cluster.

### 3.3.3 Service tier:

This tier works as an agent and observes the learner's behavior; learner's learning pattern, activeness, preferences and other usual activities being performed in the system.

This tier uses various heuristics on the existing details as well as the current state of the learner which helps it inferring new knowledge from the existing one. This helps observing the user more closely and efficiently that can provide more flexibility to the system to produce personalize content to the user by connecting leaner objectives with learning outcomes.

Broad perspective is to provide the personalized content through the interest analysis. The general flow of the VCLE is shown in the activity diagram shown in the below figure 3.2.
The general activity flow indicates that using an interface user can perform majorly three tasks:

(a) Select the preferences;
(b) Use the content; and
(c) Update the details/profile.

All these activities being carried out are stored and kept in the resource pool i.e. in the resource tier. The action/activity is being monitored by the service tier then being used by the service tier. Service tier typically work as an agent evaluates the content of the resource tier and determines the learning pattern and pedagogy, preferences, involvement, evaluation parameter and its overall impact, competency skill and many more criteria. These evaluations help the agent in providing more personalize content generation for the user. The service tier in the VCLE consists of major four activities in a cyclic manner:

(1) **Involvement**: Engage the learner as an active component of the system. Encourages the learner to involve into the system by
offering various preferences and choice based content mapped with his/her proficiency.

(2) Facilitate: Engage and facilitate the learner in shaping and improving their learning and to provide and produce the content which learner demands and deserves.

(3) Grant: Enable and empower learner to access the relevant resources in the personalized manner to make them competent in the challenging environment.

(4) Inspire: Inspire learners to change and share their learning resources around them, reassure higher level of anticipation, and dissemination of the tacit knowledge around to make the environment more live, vibrant and resourceful.

These four activities allow the service tier/agent to trace and track the learner involvement and make the resources healthier. These heuristic which are applied makes resource pool more strong and allows the service tier to infer new knowledge from the existing and makes the environment a “smart environment”.

The tier mainly focuses on the learner profile and learner activities. The learner profile data, activity log and content pool are majorly affected by the same and shall be utilized by the tier to infer the new knowledge out of the existing as well as recent knowledge from the resource tier. As we know that the data are increasing day by day and to process the data available in the pool to generate the optimum solution one needs to focus all the minute level detail and has to apply all heuristic algorithms and functions in an effective manner.

Increasing the data in the resource tier requires effective analysis on it to optimize it to make it more meaningful. This increases difficulty in the
service tier to make the data more personalized. The outlined phases can be derived in the following manner and which is shown in the figure 3.3:

![Figure 3.3 Phases of data in real time system](image)

**Fig. 3.3 Phases of data in real time system**

Raw data → information → characterization → personalized content (optimized)

Here the data available in the resource tier is considered as a raw data. The data then is being processed and converted into information. The information is then being bifurcated into operational and non-operational category. To help achieving the optimization, the raw data needs to pass through several phases shown in figure 3.4.

Phases can be categorized as follows:

(a) Capture and analyze;
(b) Organize and cluster / characterize;
(c) Refine and predict ; and
(d) Transfer the semantic / meaningful / personalization.
Moving towards the semantic and personalized content, process to achieve involves overlapping between all three components of the system: learner, tutor and technology.

To generate more such content, one needs to consider the processes of service-tier i.e. an agent as knowledge processor. These include knowledge creation, dissemination, upgrade, and application towards the environment survival. 95% of the information is preserved as tacit (implicit) knowledge. These need to be retrieved and being utilized in such a way that the competency skill of the every learner in the environment increase.

As the volume of data increases with number learners in the system, one needs to perform the data analysis to have more personalization to the learners. To provide this, the tasks of an agent i.e. service-tier in the
system has to be more specific and critical. These tasks of an agent can be divided into five major steps:

(1) Selection of data and cleaning of data

These two stages focus on the operational repository that contains the domain knowledge. The domain knowledge here is learning resource pool in different mode.

(2) Splitting the data and applying heuristics on the data

These two stages bifurcates the content and also stores the heuristics to be applied on the content. This helps in categorizing the content and provides more personalization approach to the model.

To apply these levels of personalization, several parameters are being taken that helps in studying the actual behavior. Every parameter is being assigned scale. The defined scale maybe higher to lower or lower to higher that depends upon the impact on the assessment object. The elementary piece of information may be either be individual score or average score over population being considered for considering the collaborative effectiveness of the group. The study based on the defined parameter helps model in taking the actual behavioral approach and as a result anomalies can be identified and can be resolved.

The steps applied to bifurcate and the types of heuristic being applied in the content, several methods are being applied which arranges the content, ranks the parameters based on the following methods:

(a) Regression Analysis:

This analysis can be used on the continuous data associated with the learner in the system. The majorly this analysis and
application is to read the continuous behavior of the user in the system. Every like or dislike of the content, like or dislike of the learner’s blog, like or dislike of the responses of the learner in the system, every answer being given in the evaluation pattern in the system are considered as the input parameter for the regression analysis. All these parameters are measured accordance with the time to respond to the criteria.

(b) Anomalies Detection:

This step is used to identify unusual activity being carried out by the learner in the system. This step helps confirming the learner behavior and gives a strong support to the facts being gathered and then processed outcomes being generated by the regression analysis. This detection of anomalies tries to eliminate the action or activities which are actually not being involved in measuring the learning outcome of the learner. Two major types of anomalies are being handled and being implemented that help in generating the personalized content as well as to measure the overall competency skill of the learner.

(i) Statistical anomaly

A statistical anomaly is an occurrence when something falls out of a normal scope for one group but at the same time it is not a result of being that group.

(ii) Content anomaly

Content anomalies are problems that can occur in poorly planned data and issues related to the data stored in the database.

(c) Clustering Algorithm
This step uses the result of regression analysis as well as anomaly detection outcomes in classifying the content in the domain database. The usage of the content, the acceptance or liking of the learner for the content and the outcome of the learner after use of the content are the major criteria being used to classify and cluster the content in the system.

(d) Prediction / Categories

This last phase helps in categorizing the content as well categorizing the learner in the environment. This helps the system in generating the more personalized content, helps tutors in understanding the group of learner with their competency skills, and help in generating the continuous evaluation pattern according to the understanding level of learners in the environment. This step uses the predictive analysis that helps in estimating the learner, learner behaviour and accordingly helps in generating the relevant content.

(3) Evaluate the effectiveness of the data

This phase uses the learner’s activity log and accordingly predictive analysis is performed on the content before being presented by the learning simulation tool. The effectiveness is not only being measured of the content but the model also tries to measure the effectiveness of the evaluation parameter. To do so the calibration process is used that helps identifying the effectiveness of the input and output parameters of the model. The calibration process helps in generating the test and the outcome of the evaluation once again being mapped with the content as well as with the evaluation parameter too by assigning the discriminate index and the rank to the questions as well as the content.
In nutshell, the major components for the system shown in the figure 3.5, classified into three components: (a) client (b) Portal framework (c) Services.

![Diagram of system components]

**Fig. 3.5 Components of system**

There are major three components:

(a) Client:

User or learner in the system which accesses learning environment using browser of any electronic gadget

(b) Portal Framework:

Consists of major three components:

(i) Authentication;

(ii) User Manager; and

(iii) User profile.
Main task of this framework is to generate the content and bifurcate content for different types and different level in the VCLE.

(c) Services:

Services being offered are:

(i) Raw data;
(ii) Mining and predictive analysis;
(iii) Reporting and analysis; and
(iv) Workflow.

3.4 Requirement of the system:

Looking at the technological revolution worldwide, the requirements as well as the expectation also changes. In the teaching-learning environment, the technology revolution has played a dramatic role. The digitization has increased digital content the resource pool, which has created many issues to provide the learner centric content to the learner. Few criteria to be taken into consideration that has made the use of technology in teaching-learning environment that improve the learning.

(8) Presenting learning simulation like audio, video, text that focuses on the learner (learner centric content presentation);

(9) Provision with the open library connection that connects the learner with the real-world;

(10) Developing the evaluation patterns by focusing the overall competency skill of the group of learners;

(11) Calibrating the learner on the evaluation;
(12) Calibrating the content as well as the evaluation pattern for the learner;

(13) Monitoring the activeness of the learner in the environment on the different facets being offered and inferring the new knowledge about the learner in the environment; and

(14) Monitoring the usage of implicit knowledge of others as well as sharing one’s implicit knowledge in the group to improve the learning outcome.

To impart these above mentioned functionalities to the learning simulation tool, measuring scales are being used with different parameters in the working architecture. These scales are assigned weights as per their effectiveness in the system. The outcome of each step is being considered as an important assessment object in identifying the effectiveness of the learner in the system. The competency skill of the cluster is being passed to the algorithm which is responsible in generating the evaluation pattern (question paper) for the learner.