An Overall Lifecycle Modeling Method for E-Learning Services and the Cooperative Mechanism Based on PCDA

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***Abstract*—This paper proposes a model, namely eL-PCDA, for overall lifecycle process management on e-Learning service by considering learner's behaviours during e-learning services, scheduling policies and monitoring mechanism of learning activities. Business process modeling for e-Learning services can be taken according to the study ordering of the knowledge points by using workflow modeling technology and process enactment mechanism. Overall lifecycle process management of Knowledge is addressed by combining knowledge product modeling, knowledge resource modeling, and credit polices for member selection in research team by considering trust value of learners, advisers and providers in e-Learning services. The proposed method can be used for supporting the sustainable development of e-Learning services from planning and design, organizing e-Learning process, maintenance e-Learning process, to process improvement, as well as to support learners and advisers to effectively complete innovative team study and complex computation study.**

Keywords-E-Learning Modeling; Cooperative Computation, Knowledge Management, PCDA

I. INTRODUCTION

In recent years, some new technology and new concept become hot spots in the field of IT, such as SOA (Service Oriented Architecture), SaaS (Software as a Service), Cloud Computing and so on, which has quickly attracted widespread attention in industry as well as academe. The widely use of these computing technologies effectively promoted the development of CSCW (Computer Supported Cooperative Work).

CSCL (Computer Supported Cooperative Learning) is a perspective of CSCW in education industry. These new technologies make it possible for people to carry out cooperative learning efficiently anywhere and anytime.

As the network education of China has enter into the service era from 2007, and the learning activities become more individualized and virtualized. It has great significance and wide application to study the service mechanism of CSCL on e-Learning service and e-Learning service computing modeling.

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II. RELATED WORK

Many scholars are engaged in the research of CSCL and the development of cooperative learning environment, and they have made a number of achievements [1-5]. Some learning theory, such as Problem Solving-base Learning, Constructivism, Situated Learning and Cooperative Learning, has been applied into the area of CSCL gradually.

Yang and Liu [3] discussed the advantages and disadvantages of traditional network education system and designed a web-based virtual online classroom which includes the instruction and communication environment and the cooperative learning environment. Zhang and Nunamaker [4] summarized the development of e-Learning, enabling technology and its learning theory in which the learning mode has been changed from traditional teacher-centered to student-centered, and they also introduced related technology of e-learning. Janssen et al., [5] proposed a visualized graphic technology in which a circle is used to illustrate how to observe learners' dynamic learning process according to the positive degree of their participation in activities. Huang et al.,[6] developed an intelligent learning diagnosis system supporting for Web-based thematic learning mode, to provide appropriate instruction to learners and assisting them in improving their learning behaviour by analyzing the WebLogic to understand the learner's learning behaviour online in past time. Chen et al., [7] thought that children's academic performance and social competence in school is positively associated with parent involvement during the growth of children. So that they proposed an Education Wheel Model (EWM) which includes students, teachers and parents in the education environment, and designed an E-Home-book System (EHS) with agents to observe and record students' e-learning behaviour through the web log. They adopt a trigger function to analyze the students' learning behaviour from Internet as well as from classroom and evaluate overall performance to guide and assist the students who need to revise their learning attitude.

Scholars in China have done a lot works on e-learning and establishing a virtual learning community. The virtual learning community of Capital Normal University （http://www.etkeylab.com:8081/）is one of comparatively mature, which includes not only curriculum development,

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curriculum supporting and teaching management, but also intelligent decision support tool, introspection tool and teaching-evaluated tool. The virtual community of University of Jinan (http://bbs.ujn.edu.cn/), with a more comprehensive contents containing modules of learning communication, my university, recreation centre, sports and community management, provides a platform to download resources and exchange study experience. The research on virtual learning community in China is mainly done focusing on the perspective of technology implementation and knowledge management. For example, Gan *et al.*, [8] discussed the relationship among e-learning, knowledge management, and virtual learning community as well as their common core issues, and proposed an integrated framework combining e-learning, knowledge management and virtual learning community.

Analyzing present e-learning system, we can find two critical characteristics in designing learning process. They are student-centered which focus on the cultivation of students' ability [9] as well as knowledge sharing, and learning process concerned [10]. Currently, many virtual learning communities are student-centered and pay attention to outcome of learning, but pay insufficient attention to the dynamic monitoring of learning activities. In recent years, concept of educational resources cloud and knowledge cloud is exaggerated. What it emphasizes still knowledge sharing without the combination of educational resources sharing and learning process. It is difficult to accomplish cooperative learning for creative knowledge and complex combined knowledge with the lack of deep understanding of learning process, dynamic monitoring mechanism of learning process, and automatic updating of knowledge. The ways of evaluating e-learning proposed by Yu et al, [11], contains process evaluation and summarization evaluation, in which it was emphasized to pay more attention on collecting evaluation basis for process evaluation.

Research on how to choose partners or service for team cooperative learning in complex learning process, how to evaluate the credit of them, e-learning process dynamic modeling, and e-learning process enactment and scheduling are still in a primary stage. Maja et al. [12], only introduced the model and concept of the European empirical study with e-learning process management. Therefore, the forward research for e-learning should focus on what kind of intelligent service is needed by the system, how to accomplish intelligent characteristic expected by people, how to evaluate the learners' behaviour and how to intelligently and individually regulate the learning process.

This paper introduces trust policy and knowledge management to e-learning service process, discussing controlling e-learning process according to trust dynamic evaluation and trust policy based on SADT (Structure Analysis and Design Technology) model. Besides, combining BPI (Business Process Intelligent) [2] with characteristic to manage the overall lifecycle process of e-Learning, this paper proposes a management model oriented to e-learning service, namely el-PDCA, to address the issues of CSCL mechanism and critical technology of e-learning oriented service.

III. E-LEARNING SERVICE ORIENTED MANAGEMENT MODEL: EL-PDCA

Automatic control technology has been applied to many fields of industrial production, social life and high and new technology. Blended it into e-learning, automatic control of e-learning process can be accomplished.

Feedback control is the most basic and most widely used control in automatic control system. It controls process according to deviation, namely when a deviation appears due to control variable deviating from expected variable for any reason, there must be a corresponding control reducing or eliminating the deviation. Applied it to life-cycle modeling for e-learning services, a feedback control system model for e-learning process is proposed, as showed in figure1.Let users' needs be expected variable and measurement result be controlled variable. By comparing expected variable with feedback variable which is transformation from measurement result to what kind of needs have been met, measurement result accords with users' needs gradually.

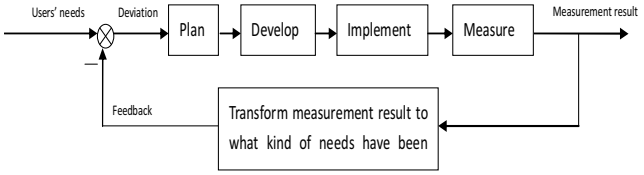


Figure 1.feedback control system model for e-learning process

As one of cross field of computer science technology and modern education technology, eLearning-oriented service computing can help learner to gain needed knowledge, which includes learning knowledge of some course and even professional education. The CSCL mechanism mainly study process dynamic modeling of e-learning service and how to learn cooperatively.

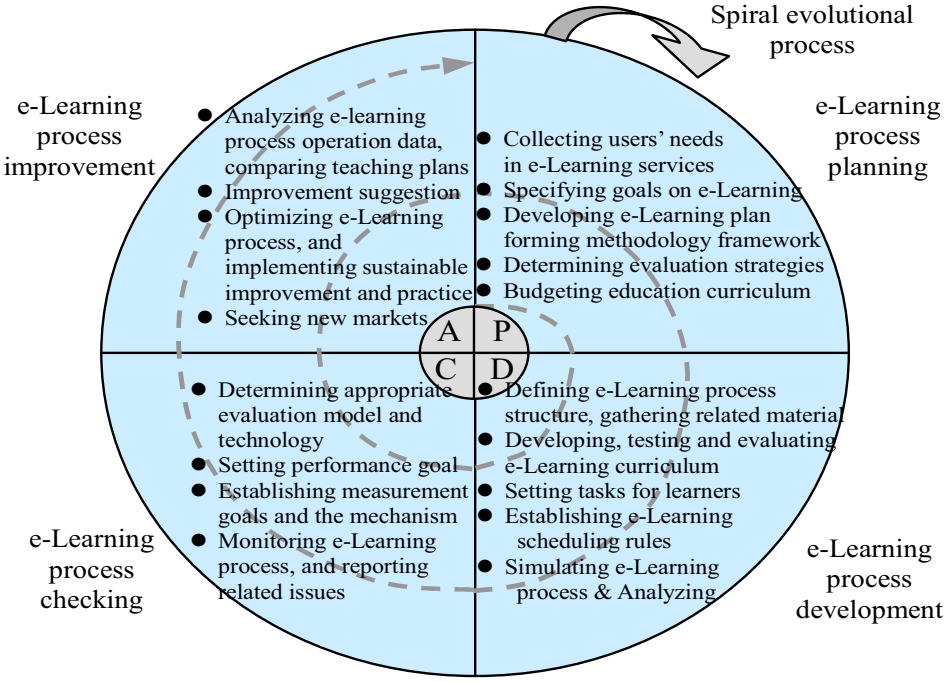
A cycle-life process management model for e-learning service, namely eL-PDCA, is proposed based on traditional methodology of PDCA (Plan-Do-Check-Act) /PDSA (Plan-Do- Study-Act). eL-PDCA is a spiral evolutional process containing four stages, such as planning, development, checking and improvement of e-learning process, and it can support sustainable development of knowledge e-learning process. The contents discussed are showed in Figure 2.

Dynamic modeling of e-learning process above is based on traditional process engineering theory and technology. The critical problem is how to propose methodology of process modeling, simulation, optimization and implementation for e-learning service in order to form CSCL mechanism supporting e-learning process management.

In accordance with e-learning service, the methodology of process modeling and analysis for research project can be adopted in the simulation, optimization and enactment of e-learning process. Optimized knowledge product model for e-learning service can be created with longest remaining processing time first service rule to instruct e-learning process enactment for e-learning service.

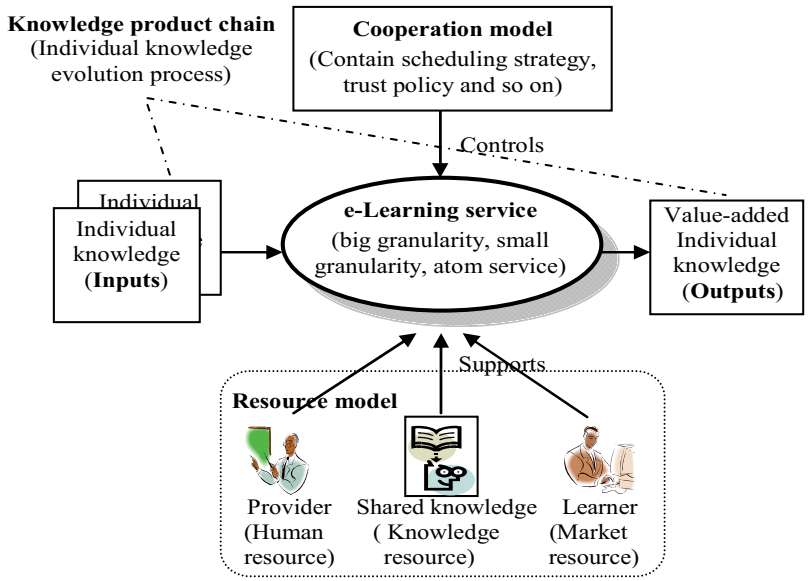
A. *Process Modeling for e-Learning Service*

Analog to SADT-based process model of enterprise system, we can model the cooperative model, product model and resources model for e-Learning services. Trust policy mechanism should be considered into cooperative model for selection of cooperative member in innovative team study and complex computation study. In e-Learning service, knowledge product modeling is a key research like product model in conventional enterprise modeling, BOM (Bill of Materials) of knowledge, as well as resource model considering on human resource as knowledge provider, shared knowledge resource and market resource referring to knowledge learner. As e-learning service is operated in network environment, some hardware resources such as device and site are not taken into resource modeling for e-learning process.



- Figure 2. e-Learning Services-Oriented Lifecycle Process Model: eL-PDCA

E-learning process model framework is proposed as shown as Figure 3.



- Figure 3. SADT-Based e-Learning Process Model Framework

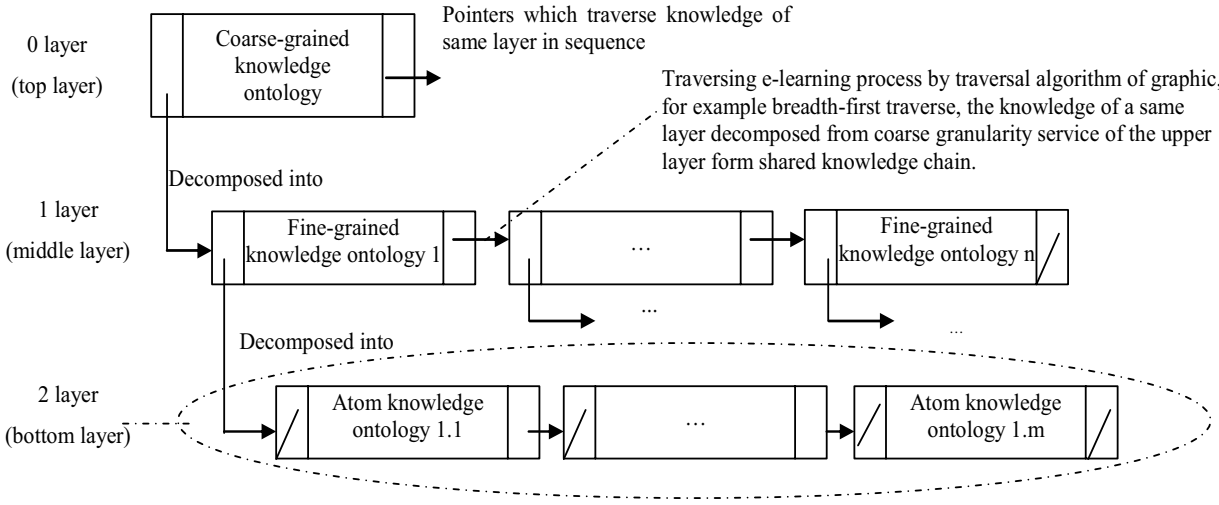
In a similar way with traditional enterprise process modeling, e-Learning service oriented process modeling may adopt layered process modeling technology to address e-Learning service modeling for complex knowledge.

B. Knowledge Product Modeling

The trust level of knowledge providers, instructors and learners during e-learning services in past time must be considered for knowledge product modeling and knowledge resources modeling to support the overall lifecycle knowledge management. This overall lifecycle process of knowledge can be accomplished by providing e-learning service and sharing knowledge. In such process, knowledge providers response for knowledge creation, coding, storing and publishing to provide knowledge and services for knowledge learner through e-learning service computing platform. Learners can gain economical network knowledge and services conveniently with the service platform to finish their own learning plan and tasks.

In the e-learning process, individual knowledge may be created as an e-learning service or a media resource by knowledge providers. We call it as knowledge product, which is divided into atom knowledge and granulated knowledge. And usually, organized knowledge refers to the sharing knowledge within an organization which has made from someone project, course or professional training. It can also be classified into atom knowledge and granulated knowledge, which belongs to knowledge resource. To learn a complex knowledge (called coarse-grained knowledge as well), it can be achieved by running a complex e-learning service process. In other words, a complex knowledge is a structured knowledge consisting of a large number of atom knowledge, which should be studied orderly. It may be in a parallel process structure or branch structure for complex innovative learning within a team or group.

The structure of coarse-grained knowledge can be organized by traversing complex e-learning service process and tracing knowledge product chain. In accordance with hierarchical structure of e-learning service process, a coarse-grained knowledge can be expressed and stored with multi-level chain structure through decomposing knowledge, as Figure 4.



- Figure 4. Hierarchical Structure Model for Storing Granularity Knowledge

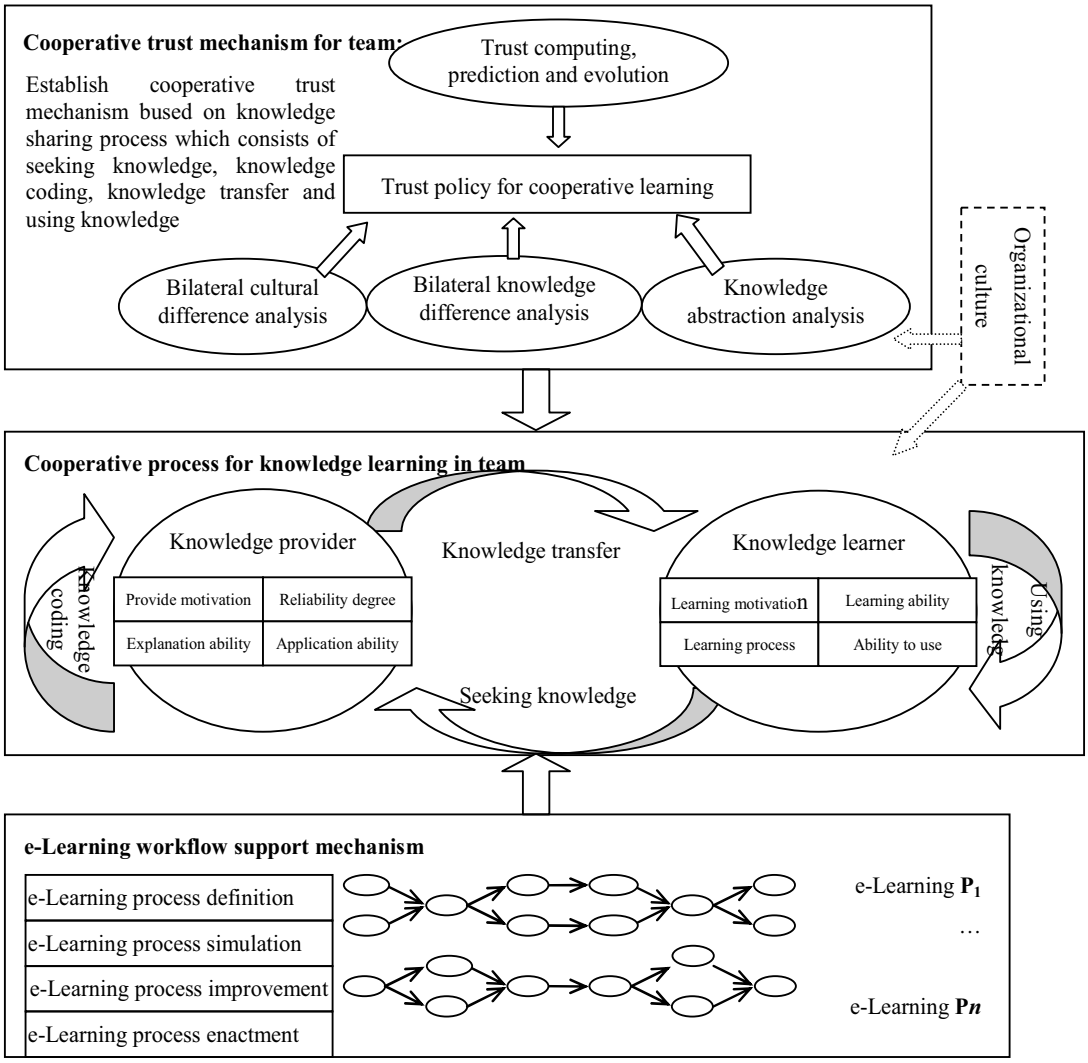
In the definition of e-learning service process, content of individual knowledge extracted by tracing the knowledge product chain of its e-learning service process can be stored in above structure. Analyzing support resources of all e-learning service activities in the organization, organized knowledge also can decompose coarse granularity knowledge and store in the knowledge chain as shown in Figure 3. The number of layers of coarse granularity knowledge is corresponds to coarse granularity e-learning services. It is significant for e-learning service process management to manage individual and organizational knowledge. Individual knowledge management called K-PDM, just like PDM (Product Data Management) in enterprise systems managing BOM (Bill of Materials) of product, dynamically manages every knowledge products in e-learning process effectively. Organizational knowledge management, liking ERP (Enterprise Resource Planning) system of knowledge enterprise, can provide e-learning service for knowledge enterprise with dynamic assigning knowledge resources, knowledge utilization statistics and benefit calculation. We call it K-ERP.

C. CSCL Mechanism

According to learners' development demand and their current knowledge level, how to quickly choose appropriate cooperative way and service provider as well as its e-learning service provided to finish their study plan and study tasks of complex knowledge is an e-Learning service process. It is a partially ordered set of some atom knowledge learning activities. In contrast, knowledge providers can seek new

learning requirements, explore market resources and provide with appropriate e-learning service and instruction to meet the learning need of clients through service computing platform.

As shown as Figure 5, we can obtain the predicted trust value of e-Learning service based on trust modeling and performance evaluating of the current e-Learning service process. With combining the difference of culture and knowledge among members in learning team, and knowledge abstract degree of learning content, to build reasonable trust policy for cooperative learning, we can effectively select reasonable learning member for e-learning process to control and schedule the cooperative learning process of team. Learners and advisers learners and advisers can effectively complete innovative team study and complex computation study with the proposed platform.



- Figure 5. e-Learning Process Cooperative Mechanism Based on Workflow Enactment and Trust Strategies

IV. CONCLUSION

This paper proposes a model, namely el-PCDA, for overall lifecycle process management on e-Learning service by considering learner's behaviours during e-learning services and scheduling and monitoring of learning activities. Process modeling for e-Learning services can be taken according to the study ordering of the knowledge points by using workflow modeling and enactment mechanism. Overall lifecycle process management of Knowledge is addressed by combining credit polices of members in research team, knowledge product modeling and knowledge resource modeling, as well as considering trust value of learners, advisers and providers in e-Learning services. The proposed method can be used to

support the sustainable development of e-Learning services from planning, development, checking to improvement of e-learning process, and it also support learners and advisers to effectively complete innovative team study and complex computation study.

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