Design Concept of e-Learning System based on Cybernetics

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Abstract: The importance of e-Learning, which supports to study anywhere and anytime, has been pointed out for improving education. There have been various research papers on e-Learning system for educations. Most of literatures have focused on guiding the student or measuring understanding their level etc. Design method of e-Learning system has not been discussed based on structure and analysis of the class. In this paper, scheme of the class is proposed by analyzing and structuring class, then design method of e-Learning system is discussed based on it.

Keywords: e-Learning, Support system, Cybernetics, Education model, Reapperance of Lesson, Distance Learning, Synchronization

1. INTRODUCTION

Construction of the new teaching-materials distribution and study environment called e-Learning using the Internet and Web technology is progressing splendidly on a world-wide scale [6], [12]. It goes up to 193 affairs that the related paper to e-Learning reported in the Journal of the educational system information society in the past five years [7]. Yano et.al. [7] showed that classification arrangement of the related research field was carried out at (1) new systems development / evaluation, (2) theory, and a cognitive consideration (3) practice report, (1) accounts for 53.8% of the whole, and (3) and (2) 37.3% and 9.8%, respectively. Furthermore, while they pointed out the importance of the viewpoint about the educational system design which utilizes the Internet technology, and its employment method, they mentioned the following problems in the design to the success sake of future e-Learning.

1. Standardization of e-Learning technology
2. Uniformity of the quality of educational service, and coexistence of individual educational service
3. Symbiosis of internationalization and education/study culture unique to Japan
4. Examination of the mutual complement relation between the classroom environment of a facing lesson system, and study by e-Learning
5. Examination of a role assignment of a teacher and e-Learning

In fact, the e-Learning system design theory which can actually solve these design subjects is presently untreated in the the literatur [10]. It is cited as a cause of such situation that the practical use range of an e-Learning system is very broad and profound, such as continuing education and lifelong learning, the education in a company, high education, or elementary secondary education. Also the practical use know-how of e-Learning differs remarkably about items such that, a response to the question, the diagnosis and the evaluation of a study implement, an achievement and the comprehension, the study contents and materials that support positive achievement of study targets. Moreover, e-Learning is a self-study place where the flexibility is high, that is, there is not much restrictive conditions about a place or time. So, this situation may originate in various forms for e-Learning.

Now, from a different viewpoint, various examples also notice that e-Learning system is a machine system which performs mutual transfer and accumulation of information, knowledge, and wisdom, or supports study activities. That have been just human - machine system. To date, there have been several important activities of the research and development putting the chief aim on life support by carrying out collection analysis of human's action from the viewpoint that a machine system approaches human. However, the framework of human behaviour, understanding of action, and action support based on this have not been proposed. For this, we built scheme of a human action conformity type life support model by catching various life/action support with human - machine system which contains people in a system, and performing analysis of the task and information inside the system according to the concept of cybernetics [4]. And the design theory of an life supporting information system based on this scheme was proposed, and the application to the design of a healthy life support system [1], [3] or to the support system for detection of irregular life behavior has been considered [2]. From this viewpoint, the education and learning are activities of human life, so the design theory of education / study support system can build in a similar approach as life support system.

In this study, the tasks that the teacher and student carry out in the traditional simultaneous lesson are analyzed, with which the time and the place in educational facilities were appointed. Then, after analyzing the information exchanged between teacher and student, the concept of cybernetics are used for a new expression of an educational model. And the subject and functions required of the e-Learning system are further detailed using the obtained educational model. Finally, we shows the standard design scheme and development of one of the e-Learning system as the example of concrete composition.

2. ADAPTIVE INDIVIDUAL LIFE SUPPORT MODEL

People's life behavior is performed for a certain purpose execution, and it is constituted as a combination of some life action. The execution result of the action plan generated based on knowledge is life behavior, and the influence of a mind-and-body state cannot be disregarded for it. Moreover, people have an individual difference and a state difference, and even if it is the same person, life action and behavior may change according to state change of their own inside or the exterior. For this reason, it is required that the support equipment which can ask for cooperation with man should suit change of an individual mind-and-body condition and change of life action / behavior, and a target of operation should be attained.

Then, the modeling technology expressing a life action / behavior and mind-and-body state, and the observation technology of them are indispensable for design of such a support equipment. By considering that life support technology is the assistant technology for operation (action) in which people work on an object to meet the target value which was able to be given, an life support system can be expressed as the system which carries out intension of the people, from a viewpoint of cybernetics.(shown in Fig.1)
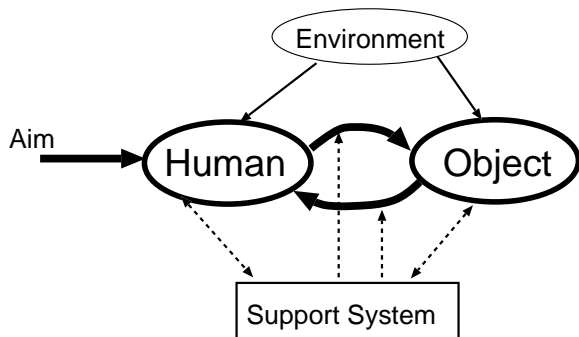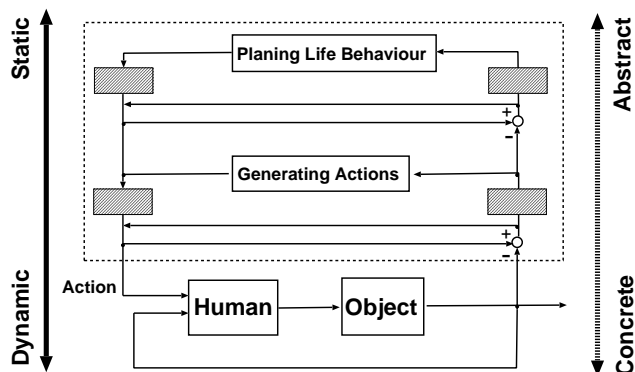

Fig.1 Life support system

Fig.2 Life support system model with multi-layer structure

Although behavior of human and many of actions are real-time control operation aiming at error correction with the target and object, decision of an action plan is performed by off-line processing rather than real- time processing, in many cases. Moreover, the plan determined with the broader view serves as a basis of each action plan. Therefore, an life support system is asked for the ability of not only support of real-time control operation type individual action but support of the determination of a fundamental plan and support of decision of an action plan to be offered. Then, we have proposed expressing by the model which has a hierarchical multi-layer as shown in Fig. 2 [4].

Now, let consider action of both education and study as life action. In this case, Human in Fig.1 is Teacher, and Object serves as Student. If based on these model figures, it can be considered that an educational support system is what performs support of the joint function between an Educator block and Student blocks or between them and a higher rank layer block. The joint function during blocks is the task generation and communication of information to a subordinate block. Therefore, in order to build the life support model, the task and information which are included in life action need to be analyzed.

3. TASK AND INFORMATION ON EDUCATIONAL STUDY ACTIVITIES

Then, it argues about the task and information which are included in education / study activities in school education. First, analysis of a task and information is tried from the view point of teacher. In school education, generally, the school held up the total educational policy which makes the basis of all educational activities, and has set up the educational target and curriculum based on it. The teacher in charge of the subject set as the curriculum draws up a lesson plan bearing in mind positioning in the curriculum of an educational policy, an educational target. And for the subject in its duty, he/she may create required teaching materials. Moreover, after setting up the attainment target of the contents or a level which a student is made to understand for every lesson, the teacher explains concrete knowledge in a lesson. Although these teachers' activities have a difference of time continuity each other, it turns out that feedback of the information from a student is performed aiming at achievement of an educational target. For example, an educational policy, an educational target, and the decision cycle of a curriculum are usually dozens of years from several. The cycles of correction of the lesson plan which a teacher draws up separately are several months - one year, and change in the middle of a term is not usually carried out. However, about the contents of a lesson, the feedback and the correction will be made day by day according to the degree-of-comprehension measurement result of the student obtained by the report subject etc. Furthermore, by observing continuously the attendance attitude represented by the reply situation over a student's question, an educator grasps a student's state of mind and transmits knowledge efficiently by continuous feedback in real-time. Therefore, if the long educational activities of a cycle are arranged to the class of a higher rank, each activity shown above will be arranged from a higher rank in following order to a low rank. (1) An educational idea, (2) educational targets, (3) curriculums, (4) annual lesson plan, (5)the determination of the contents of lessons, (6) lessons.

Next, consider a student's task and information. A student sets up a study attainment target based on the educational policy, an educational target, and a curriculum that a school holds up. Moreover, a student performs preparation and self-study (review) of a lesson while forming a study plan for an annual lesson plan (syllabus) to reference. Being in spontaneous study activities variously, the data investigation using the reference book etc. and repeated practice of an exercise problem are the typical example. When a question arises in relation to the contents of a lesson during attendance or after attendance, a student may ask a teacher the question directly. Moreover, students may answer to an examination of the achievement and a self-valuation of the understanding level may be carried out.

Table 1 is obtained by arranging the information delivered their own tasks of a educator and a student based on the above considerations.

4. MODEL OF EDUCATIONAL ACTIVITIES

Consider describing the educational model in the educational activities by the simultaneous lesson system according to the expression method of a human action conformity type life support model based on the concept of cybernetics shown with Section 2

Table 1 The task and information on education / study activities

Event	Task of Educator	Task of Student	Information
Scheduling	A setup of an educational plan	A setup of a study plan	Syllabus
Lesson preparation	· Formulation of an annual lesson plan · Teaching-materials creation	Attendance preparation · Formulation of a study plan · Bibliography investigation	Lesson schedule

Lesson	· Oral explanation
	· Gesture
	· Data presentation
	   Arrangement of notes/key point to
	   a blackboard etc.
	   Printed matter distribution
	· Test implementation aiming at
	   knowledge fixing and degree-of-
	   comprehension measurement
	· The reply to a question
		Attendance to a lesson
		· Creation of a lesson note
		· Question
			Attendance record

Examination	· Creation of a test question and a model answer · Grading	· An answer and self-evaluation · Review	An answer, Scores
Discussion	The reply to the student's question	The question	A lesson note, Data results of an investigation, An exercise problem answer A report

based on the result which arranged the task and information in educational activities in the foregoing paragraph. An educational goals, a syllabus, and a curriculum belong to a higher rank class, and the feedback combination with the educator as a controller and the student as a candidate for control belongs to the class of the low rank in which communication of information and processing of a task are performed in real-time. (Fig.3)

Here, when two or more person number is assumed, change has neither a teacher block nor a student block in the model structure of this education, and it is only that the quantity of a task and information increases.

5. FUNCTION OF E-LEARNING SYSTEM

In this research, the e-Learning system means the study support system which added the function it not only to form the feedback system expressed by the education/study model (Fig.3), but to release a student from time restrictions of a study opportunity by using IT, even when a student separates from an educator in distance. Distance and time rupture of a educator and a student means cutting of the transfer course between the teacher block and student block showed in Fig.3, and it can be considered that construction of an e-Learning system is reservation and functional restoration of such a transfer course. Moreover, the demand to e-Learning does not only remain in functional restoration, but it is also strengthening of a function. That is, the support function which an e-Learning system should hold is the following six items.

[The function required of an e-Learning system]

1. Share support of time and space
2. Interaction function between student and educator
3. Synchronization with explanation of knowledge and data presentation
4. Accumulation of lesson related data
5. Accumulation of a question and a reply
6. Analysis of Understanding level

An e-Learning system is built by application of Internet Technology(IT), in order to realize these functions. Next, the realization method of each above-mentioned function is explained in full detail.

5.1. Shared time and space over Internet Technology

By combining the image and sound which recorded description of the educator in a facing lesson on videotape, and the distributed materials in the lesson, the teaching materials reproducing a lesson are created and it transmits to a student via the Internet using information communication technology. At this time, since an equivalent state is acquired with having participated in the facing lesson, a student will share a lesson opportunity across time and space.

5.2. Support system for interactive communication

We make interactive communication between each other when we have a class. So, it is important for e-learning system to have specialized software to transmit information to each other. Also, responsibility of software should be high and load should be low. We have several choices of the software such as chat on Internet can be adopted.

5.3. Synchronization between each element that constitutes education

A learner will not be able to understand what educator is going to teach when his gesture and his speech are not synchronized. Similarly, educator will waste of labor when his explanation and educational materials presenting system are not synchronized. To overcome this problem, we will adopt streaming technique, which has special function to distribute animation and sound [5], [10], [11], [12]. Using this technique, latency caused by downloading amount of data is decreased. Also realizing live relay broadcast can be achieved easily. Also, to collaborate streaming technique and XML, we can make synchronization between each element that
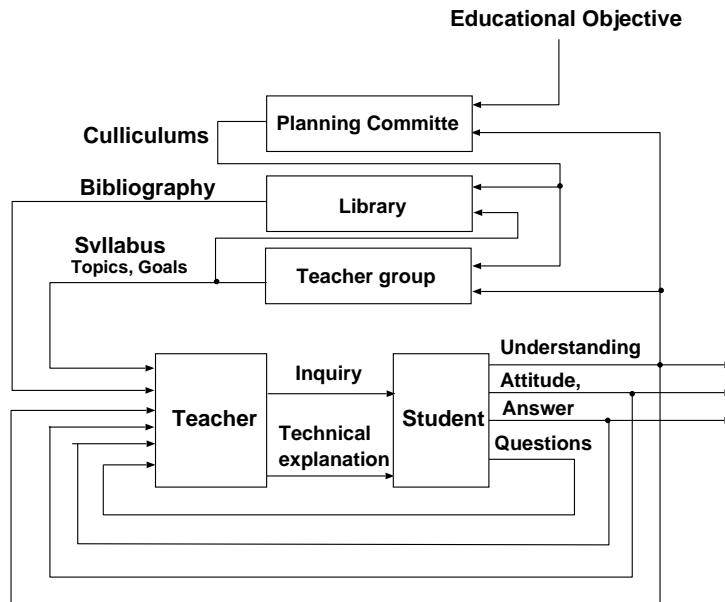
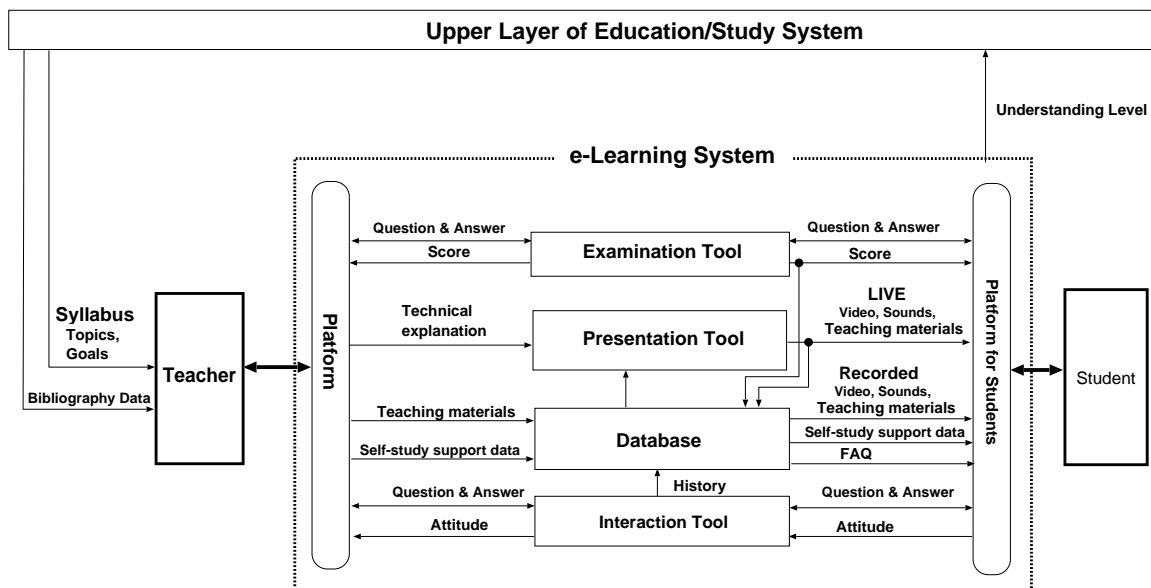Fig.3 Multi-layer type education/study model

Fig.4 Structure of e-Learning system

constitutes education.

5.4. Accumulate the streaming video and its exhibition

The distributed animation and sound using streaming technique will be accumulated on Internet server. Then these data will be exhibited for any one cannot have the class on time.

5.5. Constructing of FAQ

All question asked by learner and reply will be accumulated. Then, the question is classified into several groups. Finally, we can search the question and reply for it quickly.

Based on these considerations, the structure of such an e-Learning system can be given as shown in Fig.4.

6. DEVELOPMENT OF THE PRESENTATION TOOL WITH INTERACTION

6.1. Details of functions for e-Learning system

The concrete realization method is examined for the function of (1) - (3) shown in the preceding section. First, the function of (2) and (3) are detailed further as follows.

[Interaction function between a teacher and a student]

1. The function which supports discussion with two or more students and a one teacher
2. The function in which a student can take out a question to an educator
3. The function which an educator can choose about to which the reply to the question from a student shall be distributed between a questioner and the whole student

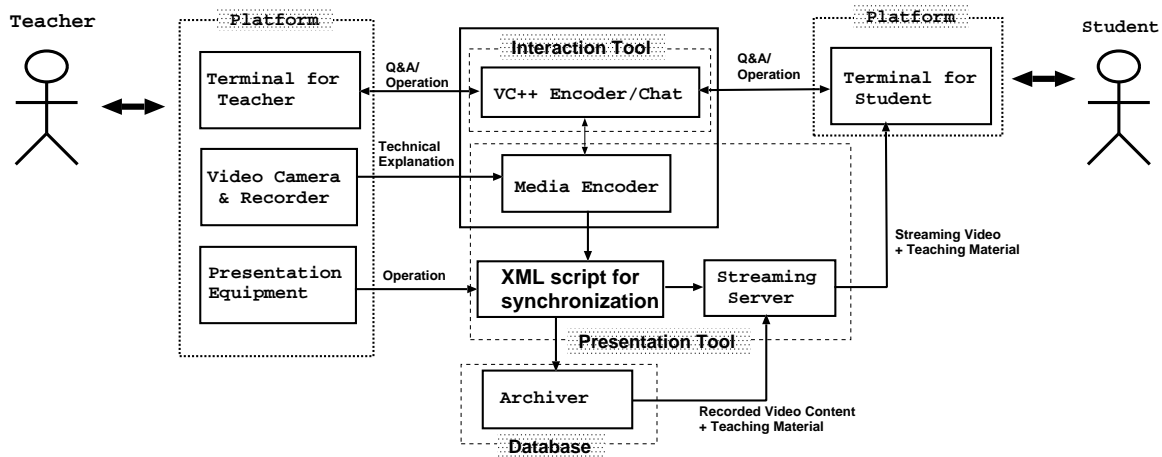[Explanation and teaching-materials presentation]

Fig.5 Development of interaction tool and presentation tool with synchronization for e-Learning

1. The function which enables live relay of the remote lecture using distribution of a movie.
2. The function which the Web page presented by the teacher in the lesson is synchronized with video and distributes it to a student
3. The function which the teaching materials created in advance are synchronized with an animation, and distributes them to a student

[Record of a lesson]

1. The function to carry out digital computerization of the contents of a lecture used as the live image, and to compress and save it.
2. The function whose distribution is possible according to the demand from a student

6.2. Concrete development of e-Learning functions based on education/study model

The systems development example which has the above-mentioned function is shown in this paragraph.

Development environment :

- Visual C++ and XML

  It is used in order to carry out synchronous distribution of streaming data and the teaching materials of the HTML form created by the educator. And, in order to give the function of the interaction between an individual and large number of people, the Chat enviroment is provided.

- Visual Basic Script

  It is used for creation of the response by server program and the terminal both of a teacher and a student.

A system configuration is shown in Fig. 5. The VC++ Encoder can not only provide the Chat environment as interaction tool but also control for Media Encoder which can encoding video and sounds data. Resulting video and sound data is combined for synchronization with the teaching contents written in HTML by use of the XML script. Then the synchronized presentation contents can be distributed to a student through a Streaming Server and INTERNET. As a result, the student can receive the lesson through the Internet at the almost same time in the distance place via the Platform for student. And, since the reappearance data of lesson is archived in Database, it is also possible to repeat and receive the same lesson afterwards.

7. DISCUSSION AND CONCLUSION

In this paper, we have prooposed the new model of class by considering the teacher and student as a controller and controlled object, respectively. Also we have showed the functions which e-Learning system should have. And the concrete development of e-Learning functions based on education/study model has been attempted. The resulting system maintains the functions (1) $\sim$ (4) among six functions required for e-Learning system shown in section 5. The remaining function are two functions, namely (5) is the accumlation of Q&A and (6) is the analysis of understanding level for student, respectively. Toward to provide these functions, it seems that the some kind of artificial intelligence technology has to be applied such as an Intelligent Tutoring System(ITS) [8], Individual Learning, collaborative learning [9] and the combination with them.

In further study, we will design software with the full-functions taking into account the application of the above-mentioned relating conventional technologies and implement it to e-Learning system server and evaluate its effectiveness.

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