Computer Supported Educational Environment

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Abstract

Educational systems have been developed to apply computer abilities to various education domains and promote the activities of learners successively. However, the traditionally developed educational systems are not always designed to supply the knowledge handling process constructively to various education domains. When we look upon our educational activities as the knowledge management, it is necessary to design and implement the cooperative mechanism among individual phases of knowledge management.

In this paper, we address an architectural framework for educational activities of persons. In particular, we propose five-layers model, which is composed of educational environment, support system, person role, functionality and knowledge media. Our idea is to integrate them under the corresponding relationships among layers, and transform interpretatively the concepts in the upper layer into those in the lower layer. Concerning with this approach, our objective is to investigate knowledge handling mechanism from a viewpoint of person activity. The effectual results to be discussed are as follows: 1) framework of seamless personal activities among educational styles; and 2) framework to be supported practically by computers.

1. Introduction

Internet, which is currently one of typical telecommunication means, has been widely used as the most convenient data communication media. It is very wonderful that Internet has been applied year by year to various kinds of practical processing procedures. In particular, the application for educational activity is one of interesting topics: the evolutions of information technologies, which adapt information network systems (e.g. Internet II and its fundamental/application software products) as the platform for educational environment, has been continued anywhere and anytime.

The computer-supported educational systems have been developed as one motivation to apply computer abilities to various education domains and promote the activities of learners. However, the traditionally developed educational systems are not always designed to supply the knowledge handling process constructively to various education domains, but provide only question-answering facilities for exercises and/or explanations or tutoring facilities for individual instructions. When we look upon our educational activities as the knowledge management, it is necessary to design and implement the cooperative mechanism among individual phases of knowledge management[1].

I.Nonaka, et al. has proposed SECI model which promotes human knowledge management in the organization systematically[2,3]. SECI model encourages four kinds of knowledge-oriented activities under the transition mechanism between two different types of knowledge. Four kinds of knowledge-oriented activities are exclusively classified into the socialization, externalization, combination and internalization, and are defined distinctively in accordance with the growing-up process of knowledge forms/contents. Namely, the socialization is defined as the knowledge revision phase from tacit knowledge to tacit knowledge; the externalization does as the knowledge conversion phase from tacit knowledge to explicit knowledge; the combination does as the knowledge reorganization phase from explicit knowledge to explicit knowledge; and the internalization does as the knowledge re-discovery phase from explicit knowledge to tacit knowledge. SECI model can successfully explain the transition process of knowledge management for individuals in the organization, but is not always adaptable to specify the personal activity for knowledge management or the environment for personal knowledge handling. Namely, SECI model is useful to make human experience and skill powerful in the knowledge management process, pre-scheduled or pre-arranged to persons[4-6]. On the other hand, SECI model is not sufficient to specify personal activity without any predefined procedural framework, and is in short of the representative functionality for flexible and intentional activities, which has not been yet prepared in the organization.

In this paper, we address an architectural framework for educational activities of persons[7,8]. In particular, we propose five-layers model, which is composed of educational environment, support system, person role, functionality and knowledge media. Our idea is to integrate them under the corresponding relationships among

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layers, and transform interpretatively the concepts in the upper layer into those in the lower layer. Concerning with this approach, our objective is to investigate knowledge handling mechanism from a viewpoint of person activity. The effectual results to be discussed are as follows: 1) framework of seamless personal activities among educational styles; and 2) framework to be supported practically by computers.

2. Framework

The effective environment of knowledge management in the education must support various behaviors of individuals smartly without any operational differences because the personal activities are too strongly dependent on the personality and progressiveness of individuals but are not uniformly controlled under the organization. Of course, it is very difficult to attain this requirement sufficiently since ordinarily we are not always assisted well to our educational activities by man-to-man or by one-to-one relationship, but in many cases act in ourselves or are supported together by one-to-many relationship. Our educational support architecture is illustrated conceptually in Figure 1. This architecture is composed of five layers: educational environment, support system, person role, functionality and knowledge media. In our five layers, different modeling views are correspondingly mapped from the upper layer to the lower layer so that the modeling characteristics in the upper layer should be constructed interpretatively by the corresponding characteristics in the lower layer.

The educational environment points out distinguishable categories in our educational activities: private learning, group learning, group lecture and private lesson. These distinguishable categories are observed from our practically experienced education systems: the private learning is corresponding to our self-learning such as pre-learning and post-learning for school education; the group learning does to the discussions, meetings, exercises, etc.; the group lecture does to school lecture, public seminar, etc.; and the private lesson does to man-to-man lesson, private coaching, etc. Of course, these categorized activities are functionally established by means of any educational support systems such as CAL (Computer Assisted Learning) for private learning, CSCL (Computer Supported Collaborative Learning) for group learning, CAI (Computer Assisted Instruction) for group lecture and ITS (Intelligent Tutoring System) for private lesson. These educational support systems have been developed with a view to being apt respectively to individual education systems, which are currently organized as social structures/mechanisms. Of course, these support systems must be applicable to various types of users, who take roles to keep effectually instructional and conversational interactions. The person role makes the interactive- or functional-tasks of persons, who take plays actively or passively according to their situations and objectives in individual educational environments, explicit.

The function in the educational environment is interpretatively mapped into educational behaviors of persons and the educational environment is explicitly defined as the practical paradigm. The person roles can be looked upon as the features of users in the support systems, and student, teacher, tutor, coordinator, speaker, etc. are effectual roles. The educational environment in the top layer is individually categorized by educational characteristics of support systems and the categorized support systems are characterized by the roles of participated persons as actors. So, it is important for the educational environment to organize seamless activity fields in accordance with person roles and also construct the mechanism of making seamless activities possible among person roles. Of course, the person role is variant for individuals: the same person may take different roles in accordance with the motivations for educational activities.

The functionality defines operations for handling knowledge. Namely, the functionality makes the operational mechanism in the educational activity clear and is illustrated as knowledge manipulation facilities, such as knowledge acquisition, knowledge refinement, knowledge reproduction and knowledge presentation. These facilities may be implemented as role-dependent features and/or be sharable among person roles, associated with different educational environments. At least, seamless transition among these facilities must be powerfully supplied so as to make our educational activity effectual. On the other hand, the knowledge media indicates the information store assigned to subjective person of educational activity, and keeps the consistency in cooperation with knowledge handling facilities. So, the knowledge media accumulates the final/intermediate results, derived from knowledge handling process. In this case, the knowledge media is not only human brain, but also is regarded as his/her own educational field and its associated tools/means. This modeling viewpoint is very important to construct our educational environment of personal activity as an operationally system-supported mechanism, but not as a mental model.

3. Educational Activity

In the educational environment, the educational styles which we can distinguish in the real world are categorized into the private learning, group learning, group lecture and private lesson, as shown in Figure 2. These educational styles are distinguished in accordance with two factors: the number of students and the number of teachers. The number of students is 1 or n (n>=2), and the number of teachers is 0 or 1, respectively. Figure 3 locates such educational styles into two-dimensional space with respect to these two factors. Of course, we often observe the educational activity in which the teacher is a basic composite actor even on the group learning: in particular, in the large-scale group discussion which has not been associated with leaders, the teacher takes an important role as an advisor or a coordinator. Figure 3 does not define

the categorization for our educational activities of persons, but arranges the constructive relationship among different educational styles.

As for these educational styles, today the typical educational support systems, which are currently usable or proposed, are classified into four types of system configurations such as CAL, CSCL, CAI and ITS. These support systems are correspondingly consistent to four styles of educational activities. Figure 4 shows such a corresponding relationship between educational styles and educational support systems. Students are timely located to one of four types of educational support systems, according to their educational activities and pre-assigned schedules of learning. Thus, it is important that the seamless transition mechanism among different educational support systems should be implemented. Of course, these educational support systems are not adaptable to only students, but also must be applicable to persons such as teachers, advisers, instructors, etc., related closely to students. Table 1 arranges person roles for this discussion about extended support activities. In Table 1, the symbol "△" indicates that the person role is not always assured in the educational support system.

4. Seamless Transition among Educational Styles

Figure 5 illustrates the transitional relationships among different person roles in individual educational styles. Of course, all of these transitional relationships are not effectively established, but some transitions have to be selected as successive educational activities. Ideally, it is hopeful that the educational environment should support various styles of educational activities by the cooperative mechanism among different functions. The educational environment which can support the seamless sequence among various actions and reactions powerfully is better. We investigate the seamless activities in Figure 5 with respect to person roles. Figure 6 shows various types of transitive processes among different support systems with respect to the person role "student" for the traditional school education. The private learning is interpretatively looked upon as the pre-stage for other educational activities, and when one objective or successive behavior of personal plan is scheduled, a sequence of actions must be determined with educational activities, which were assigned in the private learning. In various educational styles, persons prepare their learning subjects to participate in pre-assigned educational styles. Of course, the person roles for participation are very changeable in accordance with occasional motivations. In this case, the private learning is a very simple and fundamental stage, and also is regarded as the pre-learning and post-learning phases for another educational style. Thus, the educational support system must always work cooperatively with each other so as to integrate various facilities and share data storage (or knowledge resources) accumulated by individual activities.

With a view to attaining effective seamless transition among various educational styles, it is important to keep the personal storage of educational activities continuously in addition to effective mode change mechanism of execution control among different educational styles. Although in Figure 6 the transition relationship under the mode change mechanism are specified between related educational styles, and the knowledge transparency in the personal workspace has to be established interchangeably. Namely, in order to enforce seamless transition among various educational styles, the functionality and representation structure of knowledge, which are supported in the fourth and fifth layers of our model, have to be powerfully investigated.

5. Knowledge Handling

It is not easy to investigate how is the knowledge manipulated in our brain, or how the knowledge structure is organized. Of course, some researchers have investigated these subjects interestingly. However, it is not always important for us to understand exactly the knowledge structure of our human beings, because our objective is to support the knowledge handling process of personal activity effectually or successfully with respect to a collection of externalized knowledge, but not to address the understanding mechanism of person directly or indirectly from a viewpoint of internal behavior. Thus, we assume that the knowledge is composed of collections of related frames or their networks in order to make the meaningful roles of knowledge handling functions clear. Namely, the knowledge is looked upon as a network structure of nodes and links, as a typical representation of our knowledge forms. Of course, even if this assumption was incorrect, the incorrect understanding for knowledge structure does not give any heavy drawbacks to us. This is because it is important to investigate different kinds of knowledge handling functions in the educational environment from a viewpoint of personal activity.

Figure 7 illustrates the functionality in our knowledge handling process conceptually. These actions are definitely distinguished in accordance with the educational activities of individuals, but do not reflect the system-supplied functions straightly. In Figure 7, the knowledge transactions are directly specified between internal and external worlds. The internal world represents the self-activity space, like our brain or our notebooks, associated directly or indirectly with each learner, and is abbreviated as *in-world*. Similarly, the external world indicates the interactive behavior space in which cannot be controlled by each learner effectively, and is called as *out-world*. Moreover, *in-world* is separated into *inside* and *outside*: *inside* indicates un-observable space, like our brain, which is regarded as the black-box from a viewpoint of knowledge handling process; and *outside* points out observable space, like our notebooks, memo-pads, scrap-files, etc., which can be directly manipulated.

On the other hand, the knowledge handling operations are categorized into four classes: acquisition,

refinement, reproduction and presentation.

1) Acquisition: the knowledge is transferred from *out-world* to *in-world* in order to generate, add and re-structure newly nodes or edges for existing ones. This phase is observable on learner's actions;
2) Refinement: the existing knowledge is transferred from *inside/outside* to *outside* so as to be modified for attributed values of nodes and/or edges, and can be reorganized in accordance with the relationships among individual nodes and/or edges. When this reorganization can be analytically categorized from a constructive point of view, the typical refinement functions are regarded as the generalization, specialization, aggregation, grouping, categorization, sorting, etc. Figure 8 illustrates the functional effects for knowledge segments in the typical refinement functions. This phase is observable for learner's actions, and must be supported by system-specific functions/tools;
3) Reproduction: the knowledge is transferred from *outside/inside* to *inside*: this class can be looked upon as the reverse function for refinement between *inside* and *outside*. All these functions such as expansion, creation and discovery generate new knowledge from currently predefined one. Figure 9 illustrates the difference among them conceptually, using the properties and domains of knowledge segments. The domain is loosely defined as the field, related to a main subject. While, the property is roughly corresponded to the attached procedure, fundamental mechanism or etc. The expansion is understandable as the change or improvement of property over the same domain. For example, in mathematics to derive new theorems over the same domain corresponds to this expansion. The creation is expressive as the change or generalization of domain: for example, the similarity estimation for unknown phenomena or events is a typical function. Finally, the discovery is the change or enlargement of both property and domain: the typical function is analogical inference. In general, these three knowledge handling functions can be taken as a kind of abduction. This phase is performed in the black-box. Thus, in this modeling viewpoint this phase cannot be well supported by any functions or as any tools;
4) Presentation: this function moves the knowledge from *in-world* to *out-world* with a view to arranging its own content or its relationship among related ones systematically. Of course, this phase is visible for learner's actions.

Outside of in-world is defined so that the knowledge structure or content should be managed clearly from educational support systems. However, the transition relationships among three different states denote explicitly the operational process of knowledge handling. Additionally, this framework made the system-specific mechanism clear. The framework in Figure 7 makes computer-supported mechanisms/facilities explicit under the cooperative interaction between human beings and computers/information-systems.

6. Conclusion

In this paper, we addressed an architectural framework for educational activities of persons. In particular, we proposed five-layers model, which is composed of educational environment, support system, person role, functionality and knowledge media. Our idea is to integrate them adjustably under the corresponding relationships among layers, and transform interpretatively the concepts in the upper layer to those in the lower layer. Concerning with this approach, our objective is to investigate knowledge handling mechanism from a viewpoint of person activity. The effectual results discussed in this paper are as follows:

1) framework of seamless personal activities among educational environments;
2) framework to be supported practically by computers.

Of course, currently these frameworks are not always sufficiently investigated: in particular, the integration of individual frameworks should be addressed strongly. Also, we should establish the educational knowledge handling paradigm and implement effectual educational support environment and functionality-oriented mechanism on our Internet world.

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References

[1]] P.M.Senge: " The Fifth Disciplines: The Art of Practice of The Learning Organization", *The Spieler Agency*(1990).
[2] I.Nonaka, K.Umemoto and D.Senno: "From Information Processing to Knowledge Creation", *Technology in Society*, Vol.18, No.2, pp.203-218(1996).
[3] I.Nonaka and H.Takeuchi: "The Knowledge-Creating Company", *Oxford University Press*(1995).
[4] T.Watanabe: "Education Support Paradigm as Knowledge Management", *Proc.of ED-MEDIA'01*, pp.2007-2008(2001).
[5] T.Watanabe: "Architecture of Education Support System, Based on Knowledge Management Paradigm", *Proc.of WebNet'01*, pp.1320-1321(2001).
[6] T.Watanabe: "Knowledge Management Architecture of Integrated Education Support", *Proc.of ICCE'01*, pp.1138-1141(2001).
[7] T.Watanabe: "A Framework for Managing Personal Knowledge Activity in Education", Proc.of E-Learn'02, pp.1006-1012(2002).
[8] T.Watanabe: "A Knowledge Handling Model in Educational Activity", Proc.of E-Learn'02, pp.2380-2383(2002).

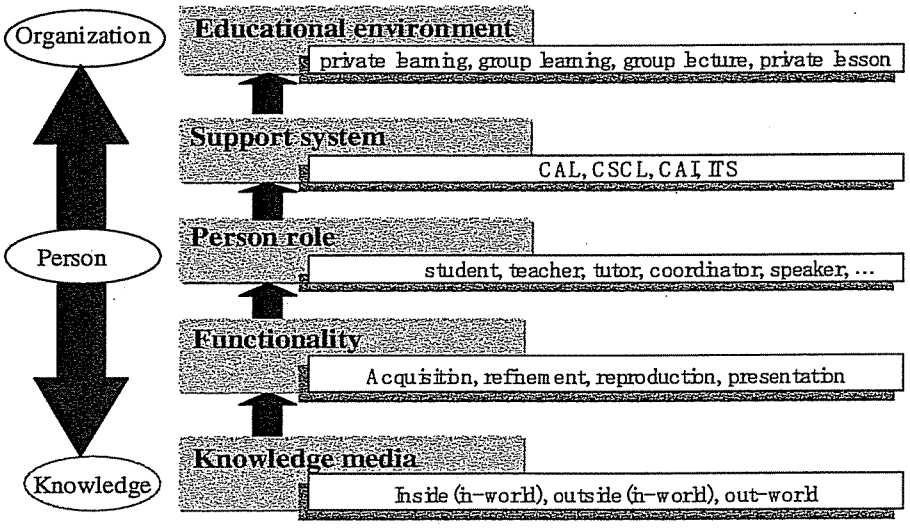

Figure 1: Educational support architecture

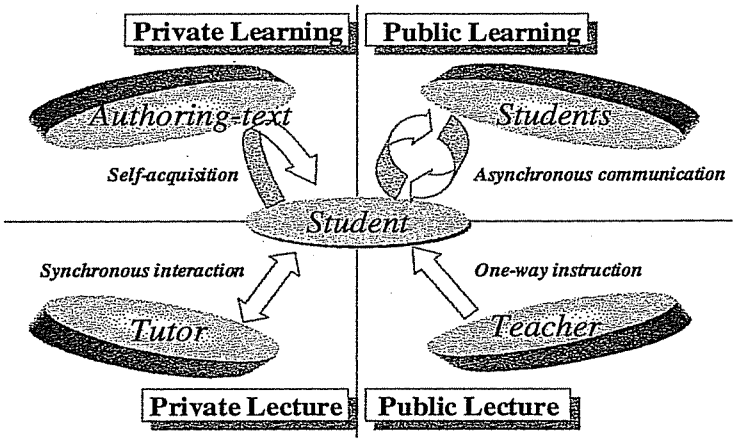

Figure 2: Educational style

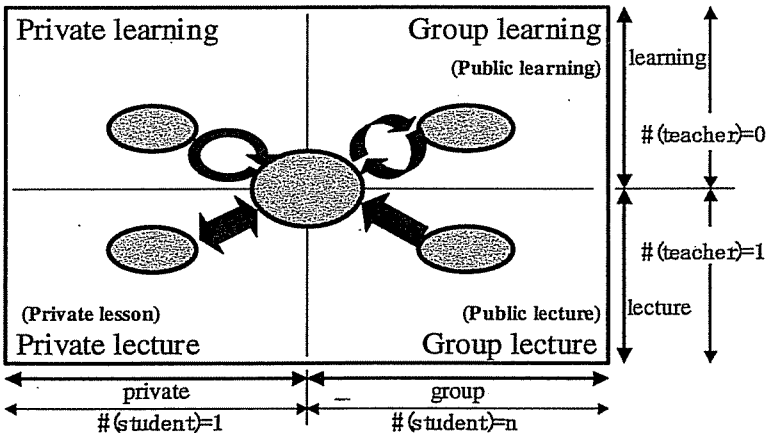

Figure 3: Classification of educational environment

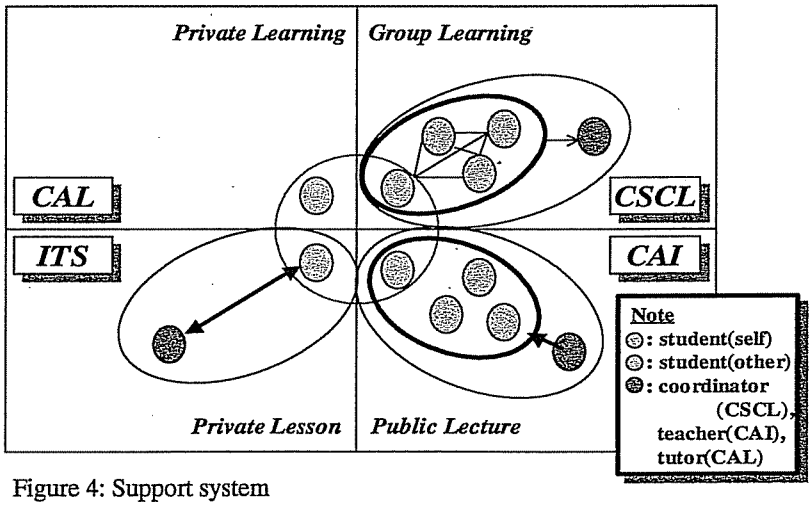

Figure 4: Support system

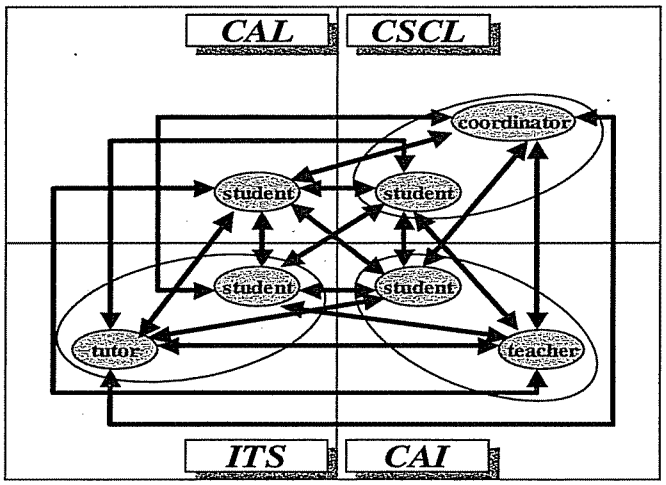

Figure 5: Transition relationships among different support systems

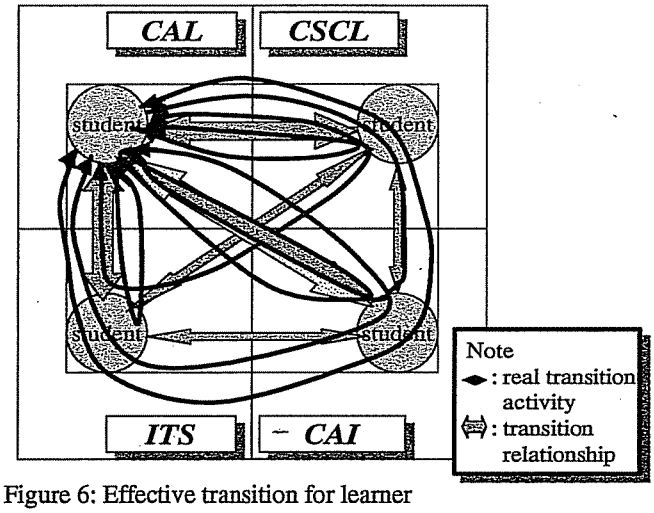

Figure 6: Effective transition for learner

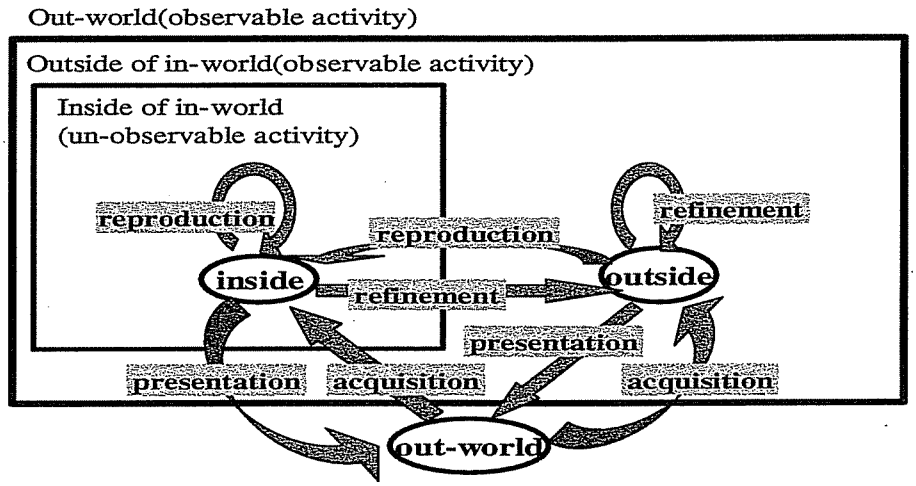

Figure 7: Mechanism of knowledge handling

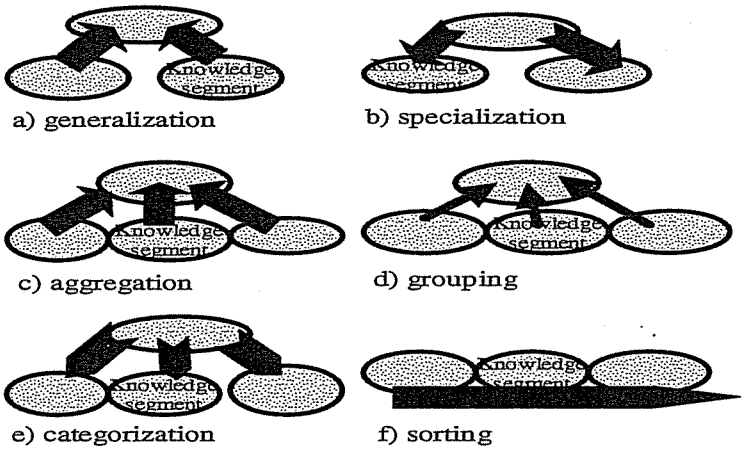

Figure 8: Refinement functions

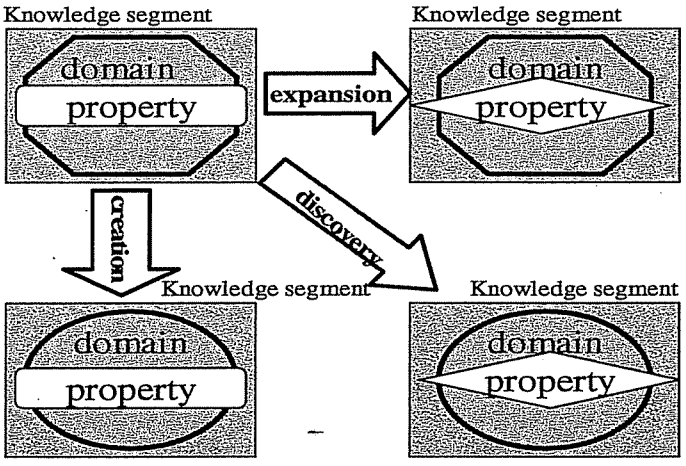

Figure 9: Reproduction functions

Table 1: Person role in support system

	CAL (private learning)	CSCL (group learning)	CAI (group lecture)	ITS (private lesson)
student(self)	○	○	○	○
student(other)		○	○	△
coordinator		△		
teacher			○	
tutor				○

[Note] ○: elements in inherent frame, △: elements in extended frame