DEFINING AND SUPPORTING PERSONALIZED LEARNING PROCESSES

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ABSTRACT: Personalized learning can take many forms. It can be individually driven or instructor driven. In either case, systems must be customized to the selected learning process. Such customization can sometimes be onerous making systems difficult to use. This paper proposes a general support system for personalized learning to assist users to setup learning spaces that match the learning process. It combines collaborative systems, agent systems and learning models into an integrated environment to facilitate personalized learning. It describes software agents that can be used to provide such support. It first defines the various ways for supporting personalized learning. It then defines learning spaces that must be set up to support these ways and how agents can be used to do so.

KEY WORDS: Learning spaces, Learning objects, Software agents, Constructivist learning.

1 Introduction

Personalized learning is now becoming increasingly important both in educational institutions and in business. Students are increasingly demanding that courses be customized to their needs. In industry there is greater demand for just-in-time learning so that they can learn specific material related to their current work. A common approach to personalized learning is to set up learning space, which will include the people involved in the learning process, the documents and materials needed and support learning, and for personal interactions within the learning space. There are many ways to classify personalized learning and consequently the way learning spaces are setup and administered. These depend on factors such as, who is driving the process, who will take responsibility for the process, and how will learning be supported. However, a range of support usually requires users to set up complex learning spaces. Learning spaces can take many forms, as for example defined by the IEEE standard [1] for learning objects. Personalized learning spaces include the roles of people in learning as well as the learning methods that satisfy personalized needs. A support system must cater for a range of situations if it is to be viable and allow learners to easily setup learning spaces to satisfy their learning goals.

Current services provided by most learning management systems center on content distribution, notification schemes and discussion boards. The services for constructivist learning differ from current services in a number of ways. They must:

- support individual learners to develop their own learning plans, and follow their own learning processes using their preferred learning styles,
- take into account the learners current knowledge and background when assisting them to create and follow their plans,
- customize technology application to their preferred way to study, and
- build up learner profiles as they construct their knowledge to adapt the system to their changing profile.

This in turn requires that knowledge content be organized in a more granular way that is currently the case. This will enable learners to pass through the same material in different ways. The paper describes processes followed by learners and ways to support them.

2 Learning Processes

Personalized learning is primarily based on the ideas of constructivist learning. The most important requirement is to provide an environment conducive to constructivist learning. Suggestions here include setting thick problems [2] that are ill-structured and exhibit complexity and choice, and support for learning in a social context. Jonassen [3] stresses the need for project based learning using constructivist approaches within a context and also notes [4] that there must be supporting culture for group learning in the teaching institution. Working in teams provides the opportunity to discuss and try ideas to build on their knowledge through a continuous and guided process of identifying learning project goals, and record outcomes in their learning outputs. Hence any support system should allow learners to setup up group learning arrangements. The role of instructors changes more to that of a guide with students...
being apprentices. Such processes can also emphasize competency based learning [5], which is also becoming more important in practical environments.

2.1 What are the learning processes?

Our first approach was to develop ways to support groups. This was reported earlier [6]. The process followed here is shown in Figure 1. A learning process is made up of a number of activities, shown as black circles in Figure 1.

![Diagram of learning process](image)

Figure 1 – Process for Supporting Learner Groups

The process starts with the teacher setting up guidelines for the construction of a learning plan. The plan that is predefined but students are allowed some discretion in changing the content of the steps. The plan is made up of a number of steps each of which is commenced once the previous step is completed. The agents monitor progress and create workspaces for the steps as required. The steps provide the materials and environment needed to complete the step. They can assist the group to manage their documents, set up their group interaction and assign responsibilities to group members if needed.

2.2 Personalized systems

The process used in personalized learning is illustrated in Figure 2. It has two main parts, namely:

- Defining the goal and setting a learning plan, followed by
- Managing progress through the plan.

![Diagram of personalized learning process](image)

Figure 2 – Process for Supporting Personalized Learning

The approach here is that the learner defines their learning goal. This is then used by the software agents to select alternate plans to achieve the goal. The plans are made up of a number of activities, here called units of learning (UOL). A unit of learning includes the materials, tools and services needed to carry out the activity together with links to people that may wish to collaborate with the learner. These may them form a group if they so wish.

2.3 Services required by Personalized Learning

We have approached this goal by taking a service oriented approach. However, we have gone beyond the range of services [7] commonly found in current learning management system to provide services that guide learners through the learning process. These include:

- developing a way of structuring knowledge by working towards a learning process specification language (LPSL) based on an earlier EML specification language [8]. LPSL describe the learning activities and processes in terms of units of learning (UOL), which differ from the current methods by providing optional learning paths within and between each UOL. Currently UOLs are defined using XML.
- defining agents to support the planning and learning process. Our agents are process agents that assist learners to proceed throughout a learning process. The agents here are different from other work. They differ from pedagogical agents [9, 10], where the pedagogical agents take on a role as a tutor, motivator or mentor in a learning process to help learners study. They also differ from intelligent tutoring systems as they have no domain knowledge. Our agents promote learning not by playing a role in a learning process, but rather by helping a learner to construct their knowledge through following a learning process supported by a broad range of services. Process agents do not need to understand the knowledge of a particular domain as pedagogical agents do because they aim to guide learners to get through a learning process rather than providing domain-specific assistances. Such domain
knowledge is included in the UOL, which includes various hints and choices.
Developing a broad range of services, focused mainly on assisting learners to get through each UOL by providing with the necessary material and tools. They are provided through an agent supported leaning system (ASLS). These services go beyond simply delivering course materials, answering FAQ relevant to a course, presenting an easy-used user interface, but provide a wider range of services especially hints and access to experts to facilitate the learning process.

At a more detailed level questions arise on what interactions are needed? These include prompts to represent apprenticeship elements and check lists. Support systems must allow learners to vary the problem. Workspaces should then allow group members to clearly define roles, such as for example the teacher being the legitimator of expertise rather than director of activities. We see the main requirements as support for teamwork and the tools made available to teams. Jonassen and Rohere-Murphy [11] also suggest the following requirements to encourage constructivist learning based on activity theory. In summary the requirements are:

- It should be possible to easily create workspaces for teams and to assign responsibilities to team members,
- Such workspaces should include conversational tools to support interactivity,
- There should be support for reflection to provide insight into learning,
- There should be a context and that includes thick problems that exhibit complexity and choice,
- It should be possible to access subject material and information resources relevant to the study goal,
- There should be related cases provided as examples that are easily accessible, These are part of UOLs,
- There should be cognitive tools to help structure thinking and knowledge building. Includes representation (visualization), dynamic modeling, semantic organization, interpretation of information as well as help using these tools.

![Figure 3 - Setting up the learning plan](image)

3 The ASLS System
The majority of these goals have been implemented by developing the ASLS system. This has been developed by using the collaborative services provided by our LiveNet system [12], which is a generalized groupware system based on a collaborative metamodel [13]. We now describe the way a learner proceeds through the system. More detail can be found in [14]. The ASSL system is divided into three parts, namely, developing the learning...
3.1 Developing the Learning Plan

Figure 3 illustrates the first step, namely developing the learning plan. The learner here states their goal, the system uses the learner profile to select suitable plans, and presents them to the learner with guidelines for selection.

3.2 Following the plan

This involves two parts. One is simply presenting the learner with materials. The other is making suggestions for proceeding through the plan. The kinds of activities here are shown in Figure 4. The learner can carry out the actions suggested in the UOL and the agents observe the outcomes and can make suggestions of what actions the learner can take following evaluation.

3.3 Offering Suggestions

One of the ASLS features is to suggest ways for students to carry out their learning. Figure 5 illustrates some such options.
prompts and provide prompts to assist learners. The agents perceive the progress of learning activities and provide where necessary create their learning plans. These agents can either be interface or navigational agents. This paper proposes a third class of agents, namely process agents. Process agents guide learners throughout a process and do not contain domain knowledge but simply assist learners to proceed throughout the learning process. They assist learners to get access to learning materials, and where necessary create their learning plans. These agents perceive the progress of learning activities and provide prompts and provide prompts to assist learners. The following agents have been developed for this purpose:

- **Learner agents** are the agents for individual learners. Each learner is assigned an agent while the learner is logged into the system. It acts as a personal assistant for the learner. It continuously observes the behaviors and actions of its master learner in order to maintain a profile for him. The profile covers many facets that can be relevant in the process of knowledge construction. The agent updates the profile as the learning progresses, and provides this information to other agents while being requested.

- **Learning plan agent** is an agent responsible for assisting learners to develop personalized learning plans for a UOL. Its tasks include locating learning content, determining learning activities and conduct sequences, selecting evaluation method, etc. All of these are accomplished based on the practical learning scenarios and the specific learning characteristics of individual learners. The learning plan agent identifies times to commence activities. It perceives the state of each learning task and suggests times to start the next. The learning activity agent monitors the progress of each activity. It perceives changes to key documents and interactions between users. The agents coordinate their work. Figure 4 illustrates the agents identified and the multi-agent structure.

- **UOL agents** are responsible for managing learning processes. Each of the objectives in a UOL has its own agent, i.e. a UOL agent. It delegates work to learning activities by creating a learning space for each learning activity and an agent for that activity. The UOL agent perceives the progress of the learning activity task for the UOL and provides assistance for learners to revise learning plan accordingly. It includes monitoring the submission of the artifact file for the UOL, evaluating the artifact file, or asking a subject expert to evaluate it and then receiving the evaluation result from the expert.

These agents are generally rule-based. They are being designed to undertake the tasks of actively providing suggestions or advices for learners according to the real learning progress and learner styles. Agents observe and monitor the learning environments and make suggestions what should be done for individual learners. Learning progress is evaluated through evaluating the detected events. The learner profiles are built and timely updated through collecting the detected events and inducing by them. The agents take the practical learning scenarios and the learner styles as input and generate suggestions or advices for learners. This is implemented based on some event-condition-action rules and with the help of the UOL database developed through careful learning designs.

There is a specific agent, administration agent, responsible for the administration of all the agents in the system. Every agent sends a register message to it while joining the system and sends a un-register message to it before quitting the system. The administration agent maintains the information of all the individual agents currently in the system, including their ID, types, and actions. It also provides various intermediate services for communications between the agents in the system. A task agent is a specialized agent designed to undertake a particular task, for example to develop a learning plan, to evaluate an artifact, to manage a learning space, etc. The third class agents, administration agents, are the ones responsible for the administrating the agents in the architecture and for providing various intermediate services for other agents.

The detailed definition of the agents can be found elsewhere [16].
5 Conclusion

This paper outlined the need for greater flexibility in learning systems. It suggested a trend to systems that provide greater learning flexibility where learners can select what they want to learn and how they want to learn it. The paper suggested that such a trend can be best met by adopting learning methods that emphasize the constructivist approach and in context learning. The paper outlined the limitations of current learning management systems in supporting this approach and identified the kind of services that systems should provide. It concentrated on services that support group learning and suggested that such services be enhanced with software agents. The agents should have the capabilities needed both to monitor and facilitate progress through a learning plan, and support the evolution of learning plans. The paper then proposed that such support should include the ability to create customized support systems for personalized goals and outlined a way of defining such goals and constructing support systems.

References