E-learning as a Vehicle for Knowledge Management

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Abstract. Nowadays, companies want to learn from their own experiences and to be able to enhance that experience with best principles and lessons learned from other companies. Companies emphasise the importance of knowledge management, particularly the relationship between knowledge and learning within an organisation. We feel that an e-learning environment may contribute to knowledge management on the one hand and to the learning need in companies on the other hand. In this paper, we report on the challenges in designing and implementing an e-learning environment. We identify the properties from a pedagogical view that should be supported by an e-learning environment. Then, we discuss the challenges in developing a system that includes these properties.

1 Introduction

An area of research that has seen a recent surge in organisations is knowledge management. Companies are showing an increasing interest in knowledge management. The goal of knowledge management is to preserve actively and systematically the knowledge that is available in an organisation. It is widely recognised that knowledge management is a key tool for the viability of an organisation, especially those that are for profit [1]. The implementation of knowledge management systems in companies requires tools and techniques from many disciplines, ranging from psychology to computer science.

In Baets [2], it has been pointed out that companies want to learn from their own experience and to be able to further enhance that experience with best principles and lessons learned from other companies. In these companies, knowledge management focuses on the relationship between knowledge and learning within an organisation. Raelin [3] states that in-company learning should merge theory with practice,

knowledge with experience. This approach differs from conventional learning in that it involves a conscious reflection on actual experience. Practitioners build theory as they consciously reflect on challenges of their practice; reiteratively engage in problem posing, data gathering, action, evaluation, and reflection; and then share the knowledge produced with others in practice. Knowledge creation within the company is thus depicted as the process by which individual experiences, which we may refer to as *implicit* knowledge, are transformed into shared knowledge that is *explicit*, especially through spirals of ongoing interaction between individuals, work teams, and organizations.

We feel that an e-learning environment may contribute to the knowledge management effort within companies, helping to support the dynamic learning process which Raelin advocates. Although we do not have a widely accepted definition for e-learning, we may describe an e-learning environment by a number of desired properties. First, an e-learning environment should focus on the needs of the learner, given his or her practical experience. Secondly, the environment should support a personalised learning process. In addition to these properties, an e-learning environment should also offer the users more than one learning method, e.g, a combination of a virtual classroom, collaborative tools, self-paced instruction, etc.

Our main research interest is focussed on the viability of e-learning as a tool for knowledge management. In this paper, we will report on the maturity of ICT technology to support the afore-mentioned e-learning properties. We have developed and implemented an e-learning prototype at the Nyenrode University. This prototype can be used by companies to train their employees as well as by educational institutes for teaching purposes. In order to judge the viability of an e-learning environment, we have used the prototype at our university in one of our MBA classes. We have evaluated the usefulness of our prototype. Although our evaluation result is preliminary, it appears to be promising in terms of learning objectives and student satisfaction (see Section 4).

Our experience is that in developing and applying an e-learning tool successfully, the technology to build an e-learning tool and the domain content stored in the tool are both of crucial importance. Technology is not only needed for fast user responses and an appropriate infrastructure, but also for keeping the content consistent and translating a user need expressed in natural language into a formal language that is understood by machines. Especially, the last task is a very tough one and research and development in this field is still in its infancy [4]. The quality of a response to an information/learning need is determined by the content in the tool. If the tool contains obsolete knowledge, the quality of responses may be low. Therefore, keeping the content up to date is an important issue in developing e-learning tools. For the time being, we have chosen practical solutions for this challenge, since our major goal is to investigate the viability of e-learning. Research directions facing these challenges will be discussed in Section 3 of this paper.

Another important issue related to the content of an e-learning environment is to preserve existing relationship between chunks of information, while storing them in a

computer system. Suppose that a user is learning about information systems with the help of an e-learning tool, which contains information about databases and knowledge systems. Then, the tool should make its users aware about this information and should make it accessible upon request to a user. In our prototype, we use hyperlinks to stress the relationships between chunks of information.

The remainder of the paper is organised as follows. In Section 3, we briefly discuss the architecture of our tool and implementation issues. Section 4 is devoted to a discussion of the results that we have obtained. In section 5, we sum up the main conclusions from the e-learning prototype that we have developed.

2 E-learning properties

We believe that an e-learning environment can serve as a complementary medium for knowledge management, helping learners to combine theory with practice and knowledge with experience. Although it is hard to find one universally accepted definition for e-learning, we may describe an e-learning environment by a number of desired properties. Let us focus on three main properties. First, an e-learning environment should focus on the needs of the learner, given his or her practical experience. Secondly, as a consequence of this approach the environment should support a personalised learning process, empowering the user to choose his / her own learning pathway. Thirdly, an e-learning environment should offer learners more than one learning method; e.g., a combination of a virtual classroom, collaborative tools, self-paced instruction, etc. As Jonassen, Mayes and McAleese (1993) [5] note, the environment should take the form of an open learning system which is "need driven, learner-initiated and conceptually and intellectually engaging".

This description departs from the traditional use of technology in course delivery, which has followed an 'instructor- centred' approach. Traditional computer-based learning environments are often driven by prescriptive programs that allow the learner to input information, however the responses to that input are prescribed and predetermined. In essence they are "*closed*" systems. A good example of this approach would be the placing courseware on a web server to be accessed by remote students, which would suit the prescriptive pattern of a taught course.
In our estimation, an e-learning environment should be "*open*"; that is to say it can be adapted by learners or trainers to the particular needs of learners, teams or groups of learners from different surroundings or cultures. It is modular in order to facilitate its adaptation, updating or its re-engineering.

Let us explore the e-learning properties, which we have identified, in further depth.

Needs-driven
An e-learning environment should fulfill an information or knowledge construction need of the learner. This should be based on the interests and experience of the user.

Jonassen, Mayes and McAleese (1993) describe this feature as a form of dialogue between the user and environment:

"Once a need is perceived, the learner will initiate a dialogue with the environment. To the degree that the environment is able to support the need, the learner's interactions will be engaging. That is, if the learner is seeking information to solve a problem or build a better understanding, then constructivistic environments, such as hypertext retrieval systems, should support that need and engage the learner." [6]

We see the needs-driven approach as an essential feature of e-learning, and view hypertext technology as a means by which individual users can interact effectively within an environment.

Personalised learning process

An e-learning system should support personalised learning trajectories, which take account of individual experiences and build on a learner's prior knowledge. This means that the environment supports the pro-activity of the learner in building knowledge, by taking account of individual characteristics and helping the learner to integrate available knowledge – transforming information into knowledge. An open system should encourage the development of knowledge and skills that will enable learners to search, find and process information adequately; it must facilitate the development of transfer abilities as well as a high level of autonomy in the learning process [6].

We view this property as a core feature of e-learning, delivering tailor-made learning pathways for users. This requires the technological design of the environment to deal effectively with subjectivity, providing scope for custom-built solutions for users.

Offer a variety of learning methods

An effective e-learning environment should also provide a variety of methods by which a user can pursue individual learning. We believe that the system should support the active involvement of users in their own learning, as well as providing an opportunity to observe peers engaging in related learning experiences. The system should also support interaction between individuals, allowing for collaborative work assignments. According to theorists such as Boud [8] a combination of learning styles will help students move from "mere access to information towards the internalization of concepts and ideas and the construction of knowledge".

Active learning: refers to the process by which learners take an active, constructive role in generating meaning for information by accessing and applying prior knowledge to new material.

Observational learning: refers to the process by which individuals observe others as they engage ideas and attempt to make meaning from them. This learning style is based on the assumption that students may learn a lot from observing other students who are experiencing and resolving difficulties. Technologies provide us with the option of capturing and compiling learning events and making them available to other learners.

Collaborative learning: refers to the collaborative construction of knowledge involving both instructors and student. Collaborative knowledge construction environments enable all members of a class or learning group the opportunity to contribute their interpretation.

We believe that personalised learning should lead to a choice of styles being made available to individual users, empowering users to select the most appropriate learning mode to match their needs. In our opinion, existing learning platforms perform best with regard to this last property. Consequently, for the purposes of the technological and pedagogical discussion in this paper, we will focus our attention on the first two properties - exploring how they may be operationalised in the design and delivery of an e-learning environment.

3 Towards an e-learning environment

This section is devoted to the technology requirements in order to support the so-called needs driven and personalised e-learning properties as discussed in Section 2. In Section 3.1, we discuss a framework to support e-learning and discuss to what extent this framework may be underpinned by the state of the art technology. Then, in Section 3.2, we will discuss the implementation of an e-learning prototype based on the available technology.

3.1 Framework

In order to be viable, an e-learning environment should consist of a number of components as depicted in Figure 1. It should be clear that an e-learning environment should offer its users an adequate user interface, in which a user may express its information need. Other important components are a document server, a meta database, and feature extractor. The document server actually contains educational material, e.g., a set of books from which parts may be selected that meet a user need. To speed up this selection process, a meta database stores data about the documents, e.g., key words, relationships between documents, etc. Suppose that a user is looking for information concerning birds, and if the meta database contains the locations of all documents that are relevant to birds in the document server, these documents can be quickly accessed and presented to the user. Whenever a new document is a candidate to be stored in the document server, a feature extractor derives relevant features concerning the document in order to store these feature in the meta database. In general feature extractors will be advanced computer programs. An example of a feature extractor might be a program that determines the describing key words of a document. Finally, an e-learning environment should contain a system dictionary, which contains all relevant information with regard to the system, for example when new documents are inserted or documents are deleted.

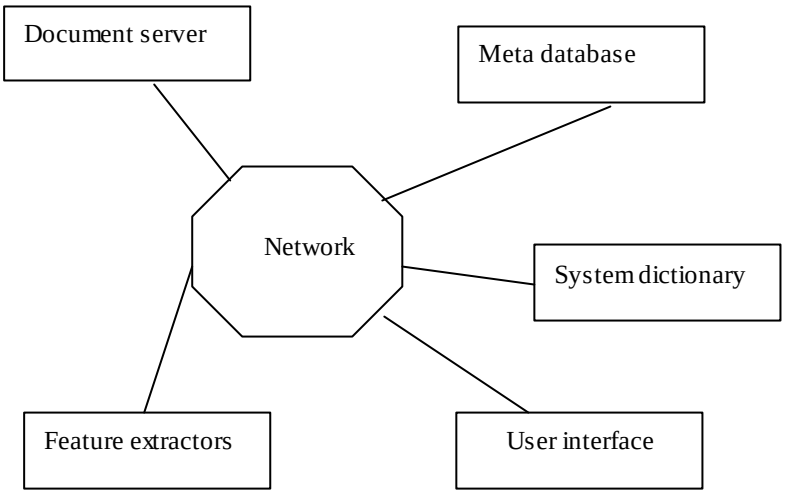

Figure 1: Components of an e-learning environment

To what extent the proposed framework meets the so-called needs driven and personalisation properties depends on the implemented query processing facilities and the content of the meta database. Suppose that a user tells the system that its information need is to learn about management information systems, then the system should not only consider documents that contain keywords management information systems, but also documents dealing with database systems, knowledge base systems, since these concepts are a part of information systems. So, the relationships between these concepts should be kept in the meta database. For example, this can be implemented by hyperlinks from one concept to another concept or by defining ontology schemes for notions. The main challenge is not to implement an ontology scheme or a hyperlink, but to determine the relationship between concepts. Feature extractors should accomplish this task.

Actually, a feature extractor should perform a mapping from a space that contains all possible ways to express a user need to a relatively small pre-defined space of concepts in the meta database. Once this mapping has been performed, the relevant documents can be located on the document server. This process is depicted in Figure 2.

Finding a suitable mapping function is, in general, a tough task. Therefore, the relationships between concepts are often manually established by human beings. However, for e-learning we feel that tools that support the establishment of relationships between concepts are of crucial importance. Especially, if we want to have the opportunity to include or delete documents, which is necessary to keep your e-learning environment up-to-date. Including a new document means that all relationships between the concepts appearing in the document to be added and the

already stored concepts should be established. Deleting a document means that the relationships between the concepts appearing in the document to be deleted and the remaining concepts in the system should be broken, for reasons of consistency.
It should be clear that the addition and deletion of a document is a tedious and error-prone process at best, when it is done manually. Therefore, there is practical need for tools that support these tasks.

To support the personalisation property in e-learning, the system should have a profile of a person. Such a profile can be obtained by gathering and processing the information concerning a person. Information can be gathered during a interactive session between the system and a person. In order to extract an adequate profile from the stored information, the system should be able to handle subjectivity, since the semantics of a concept might be different for various users. Even for the same user the semantic of a concept may evolve in time. A system should be able to anticipate on this dynamic behaviour. In the field of data mining, as an application of CRM, research and development is progressing on personalisation. It will be sensible to tailor these techniques in order to support our e-learning properties.

For the time being, we have chosen straightforward solutions for these challenges in our prototype.

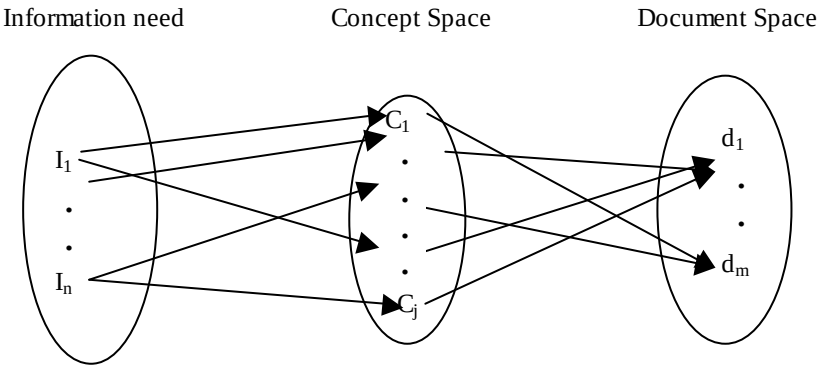

Figure 2: Mapping process

3.2 Implementation of an e-learning prototype

In this section, we describe the architecture of the e-learning environment as it is in use now. The implementation of our architecture is based on the so-called *Whizzdom* platform. This platform provides us with a general structure, administrative tools and reports on the learning of the users, as well as facilitating the easy addition of content. It also determines to a large extent the architecture as shown in Figure 3.

The central part of the architecture is formed by the database system (see Figure 3). This consists of a central database and a database management system, in this case MS Access dbms. This database is filled by the so called InWizard tool of the Whizzdom platform. This tool extracts content from an MS Word file and inserts it into the database. The database consists of two parts. One true database containing certain metadata and a hypertext library containing the actual, hyperlinked, content. There is, for instance, a table containing the text of a concept with the corresponding concept module, and course numbers (the three levels of content, roughly comparable to a paragraph, a chapter and a book). Other tables would contain the actual names of the course, module and concepts with their corresponding numbers.

The other part of the Whizzdom platform, the so-called OutWizard tool, extracts the information it needs from the database to build ASP (Active Server Page[1]) web pages. It formulates a query that extracts the appropriate elements from the database for building the ASP web pages. For instance a web page for one of the concepts mentioned above implies the formulation of a query that retrieves text and the corresponding course, module and concept name. Together with some scripts, the user web pages are personalised and delivered as output.

The content in our e-learning environment is added according to the following steps:
1. Raw input material
2. Structuring the material into an MS word file
3. Building a database from the material in the MS Word file
4. Building ASP (Active Server Page) pages from the database
5. Building the actual HTML page as viewed by the user

Steps 1 and 2 are done manually. Step 3 and 4 are done by the software of the learning platform and step 5 is done by the software on the server.

This architecture more or less supports all of the e-learning properties identified in section 2. The third e-learning property which we mentioned (offering a variety of learning methods) is supported the best, as was already remarked in that section. Properties 1 and 2 have been operationalised in our e-learning environment by offering the students extensive hyperlinks to concepts within the same course as well

[1] An Active Server Page (ASP) is an HTML page that includes one or more scripts (small embedded programs) that are processed on a Microsoft Web server before the page is sent to the user. The script in the Web page at the server can personalise the HTML pages by using input received as the result of the user's request for the page to access data from a database

as to cases and related concepts from other courses normally part of an MBA programme.

The biggest shortcoming in this respect is the fact that the hyperlinks have to be made manually. While this is made easy by the use of the Whizzdom platform, it is still a dreadful task since adding one concept means having to check all other concepts for possible links. One of the most pressing matters is therefore developing tools that support the updating of links.

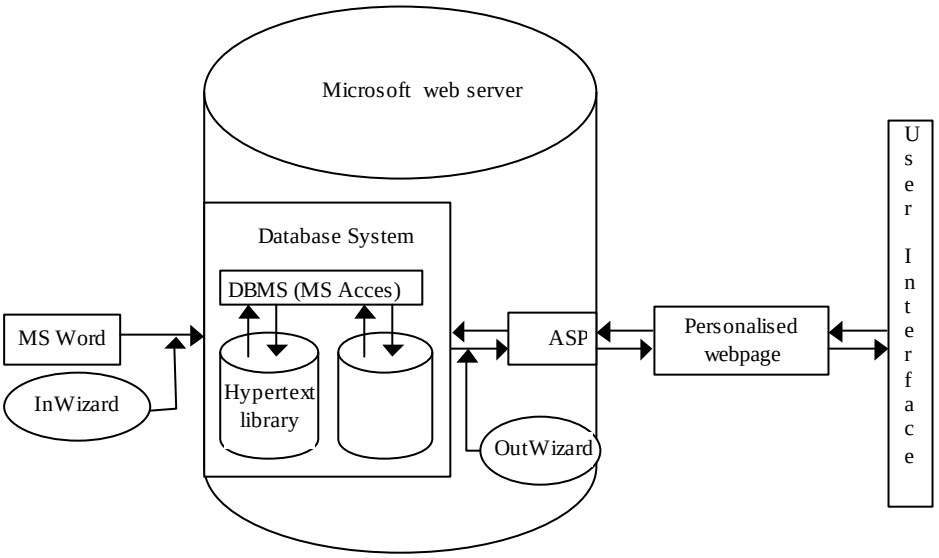

Figure 3: Architecture of the current e-learning environment

3.3 The e-learning environment

In the previous section we discussed the architecture of the current environment which we have been using. In this next section we will focus more on the environment itself and the design of the course [Management of Information Systems (MIS)] on which the preliminary evaluation in section 4 is based.

International MBA students following the 2000-2001 MIS course were presented with a combination of communication tools (NetMeeting, group bulletin boards) and learning materials on-line within the learning environment. The reading materials for the course were delivered in the form of hypertext-linked concepts and cases within this course, as well as outside the course, covering the full range of disciplines within the MBA programme of study (accounting, economics, finance, marketing etc.). Students were therefore able to follow their own exploration threads, following concepts links from MIS to all areas of the MBA curriculum within the virtual library.

This course was therefore designed to support a more needs-driven and personalised learning experience.

The environment was used to deliver a virtual learning component as part of the pre-course work (conducted off-campus) for the 2000-2001 MIS course. Students were encouraged to view the pre-course phase as the principal 'moment' for knowledge acquisition – a departure from traditional courses in which content is delivered in a lecture-style on campus.
The preparatory work was designed so that students acquired the concepts of the course following a process of research and reflective thinking, situating the theory of the course within each participant's own work environment. The rationale behind this design was to draw on student work experiences, creating a forum for ideas-sharing and knowledge-building during the pre-course phase of learning. It was anticipated that this would help students by exposing them to a variety of organisational experiences in MIS strategy, building a bridge between the theoretical and practical dimensions of the course.

Assignments were based on a four-stage learning process, along the following lines:
Assimilation, reflection and near transfer of the target concepts: application of the MIS concepts to the work environment – a preliminary organisational assessment, testing the student's ability to situate the new learning within the familiar environment of the organisational environment.
Reciprocal teaching and learning: students were asked to share their conclusions with a partner, exchanging work experiences and reflecting on the bigger picture.
Far transfer of the target concepts: a problem-solving exercise, conducted by peers, on a different organisational setting – requiring students to apply their learning to an unfamiliar case example.
Collaborative, group-learning stage: students reach a deeper level of understanding of the concepts by sharing their work experiences, and reflecting on the aggregate experiences acquired through dialogue and reflection with peers. The multiple perspectives should lead to a new set of conclusions on the effectiveness of MIS strategies, according to different organisational perspectives.

The pedagogical objectives for this design of activities were aimed at promoting active learning – encouraging students to explore and make sense of the concepts through their own efforts – using the organisational environment and the combined experiences of their peers as a framework for investigation. The four-stage process was designed to guide students in the learning process, helping them to build up their understanding of the concepts in an incremental fashion – moving from individual investigation and reflection to group-based conclusions.

4 Preliminary evaluations

Walker and Baets (2000) [9] have reported on an experimental course design for an international MBA class in Management Information Systems (1999-2000), where

students were encouraged to use a combination of synchronous and asynchronous communication tools to support their own learning. The 2000-2001 MIS course can be seen as a follow-up to this experiment. We will report on the 2000-2001 class's experiences using the Whizzdom environment as described above, in order to provide a case-example of the e-learning approach outlined in this paper.

It is important to note that prior to this MIS course, students had only limited experience of conducting their learning on-line. Half of the students had no previous experience of using chat boxes for pair discussion, with that figure rising to 62% for group discussion on-line, either conducted synchronously or asynchronously through the use of bulletin boards. The synchronous document-sharing capabilities of tools such as NetMeeting were therefore a new proposition for many students, who faced a steep learning curve in adopting IT tools to support their learning. Indeed, the vast majority of the class (95%) possessed no first-hand experience of using interactive course materials in on-line courses.

Given this limited degree of experience within the class, it was surprising to note the positive expectations of participants towards the virtual approach to learning which were recorded in a pre-course questionnaire. Over 60% of participants supported the view that online course delivery might offer a higher level of feedback for individual learning, as well as a higher level of knowledge-sharing in the pre-course phase of learning. Indeed they anticipated that this approach would enhance student learning, particularly cognition and understanding of key MIS concepts. Question marks were raised only over the quality of instruction which could be delivered on-line, with only 20% of students believing that this approach could support a closer and more effective relationship between students and the instructor.

Table 1 : Pre-course expectations regarding on-line course delivery

In comparison with traditional classroom instruction, online learning:

	RATING **SD** **D** **N** **A** **SA**
1. Supports ideas and experience sharing amongst students	5% 10% 20% 65% 0%
2. Facilitates individual learning, offering more guidance than traditional methods	0% 15% 25% 60% 5%
3. Supports a closer and more effective relationship between students and the instructor	15% 30% 35% 20% 0%

SD = strongly disagree; **D** = disagree; **N** = neutral; **A** = agree; **SA** =strongly agree

For the post-course analysis however, a similar pattern to the one recorded by Walker and Baets (2000) for the 1999-2000 class emerged amongst MBA students. An "adopter" segment of roughly a third of each class supported the learning experience,

viewing the switch to collaborative discussion-based activities as value-adding. Notably 41% of students believed that the course design helped improve cognitive skills – the capture, comprehension and retention of key concepts of the course. 31% believed that the course increased opportunities to utilize prior knowledge and experiences in the performance of the preparatory assignments. Participants from this adopter segment highlighted the "*commercial and exchange opportunities (rich / reach)*" and "*sharing of company practices*" as value-adding features of the collaborative learning process. However, an equal number of "traditionalists" were unconvinced by the experience, noting that there was no improvement in the levels of communication and interaction during the course, with only limited collaborative learning and ideas-sharing. Students in this segment of the class cast doubt over the cognitive and motivational benefits of conducting the pre-course work in this way.

Table 2 : Post-course attitudes towards on-line course delivery

Compared with traditional courses, online course delivery in the preparatory phase of this MIS course:

	RATING **SD** **D** **N** **A** **SA**
Improved cognitive skills (the capture, comprehension and retention of key concepts of the course).	0% 24% 35% 41% 0%
Provided an effective way of facilitating individual learning	17% 35% 18% 30% 0%

SD = strongly disagree; **D** = disagree; **N** = neutral; **A** = agree; **SA** =strongly agree

Similarly, the learner-centred pedagogical approach received a mixed reception by students. Some participants found the conversational dimension to the learning process to be value-adding, while others were overwhelmed by the shift in learning culture and the perceived increase in preparatory work prior to the commencement of the classes.

Students were in agreement though on a number of issues. There were strong criticisms over the way the course environment and IT tools were presented to students. Participants felt that the e-learning initiative represented a leap in learning culture, arguing for the early introduction of this method within the overall MBA programme in order to secure a wider acceptance amongst students.

In spite of these criticisms, students were able to separate their learning experiences for the MIS course from their opinions on the potential of computer mediated collaborative learning. Participants responded positively regarding the potential of virtual course design and delivery, confirming that computer technology can contribute to new ways of teaching and learning as well as enrich the learning

process. The conditions in which courses are designed, delivered and positioned within an MBA programme, were deemed to be critical however.

Table 3 : Post-course attitudes towards computer technology and its suitability in management programmes

The use of computer technology in management education:

	RATING **SD D N A SA**
1. Is relevant and value-adding for students	0% 18% 18% 41% 23%
2. Enriches the learning process	0% 19% 37% 44% 0%

SD = strongly disagree; **D** = disagree; **N** = neutral; **A** = agree; **SA** =strongly agree

The findings from this MIS course are insightful in highlighting a range of student expectations towards virtual course delivery. From the evidence of the course it appears that the socialisation process – helping learners to accept changes in course design and delivery – represents a key responsibility for course providers. The successful adoption of the "learner-centred" conversational model also rests on the level of orientation and guidance that students receive during the preliminary stages of the course. The freedom that this method offers to individuals, particularly the choice over content and learning style, can appear quite daunting to students at first. Guidance and follow-up tutorial support therefore appear to be necessary to help individuals function effectively within an "open" learning environment.

5 Conclusions

In many companies knowledge management focuses on the relationship between knowledge and learning. Learning should merge theory with practice, knowledge with experience. In this paper, we have reported on the challenges in building an e-learning environment. We have identified the pedagogical properties that should be supported by an e-learning tool. Then, we have also discussed to what extent these properties can be met, given the state of the art technology in computer science. Although there are a number of problems to be solved in order to build an adequate e-learning environment, we were able to build an e-learning prototype. We have chosen straightforward solutions for the problems, and therefore our prototype is not scalable. Experiments with our prototype have indicated however, that e-learning environments can make a contribution in supporting knowledge management, enriching the learning process.

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