LMS, LCMS and E-Learning Environments: where did the didactics go?

paper prepared for the 11th EDiNEB Conference
JUNE 16-18, 2004, Maastricht, the Netherlands

First author: Marjolein C.J.Caniëls (corresponding author)¹
Second author: Anke H.J. Smeets-Verstraeten²

version: 10 juni 2004

¹Open University of the Netherlands (OUNL), Faculty of Management Sciences (MW),
P.O. Box 2960, 6401 DL Heerlen, the Netherlands. Tel: +31 45 572724; Fax: +31 45 5762103.
E-mail: marjolein.caniels@ou.nl

²Open University of the Netherlands (OUNL), Faculty of Management Sciences (MW),
P.O. Box 2960, 6401 DL Heerlen, the Netherlands. Tel: +31 45 572459; Fax: +31 45 5762103.
E-mail: anke.smeets@ou.nl
Abstract
Most of the existing e-learning environments are applications in which the teacher will upload study materials that students will download. This approach to e-learning discards many didactic principles that e-learning tools could support and enhance. This paper demonstrates how didactical principles successfully can be integrated in an e-learning environment. Furthermore, the paper addresses the fact that current e-learning software only offer point solutions. There is a clear need for one unifying system to make the entire range of educational processes more efficient and effective. We use a newly developed e-learning environment to give a practical illustration of an all-in-one application that integrates didactical principles and supports all educational processes.

Keywords:
On-line education, distance education, electronic learning environment, didactical principles, learning content management systems.
1. Introduction

Web-based education is very popular. Research of the American Ministry of Education showed that 56 percent of American universities offer their education (partly) by means of distance education via the internet. Students seem to be very enthusiastic about e-learning, since the number of students applying for online lectures is growing explosively (Tabs, 2003).

Educational institutes use a variety of software tools to deliver web-based education to students. Broadly three groups of software systems can be distinguished: (1) Learning Management Systems (LMS); (2) Learning Content Management Systems (LCMS) or authoring tools; (3) e-learning environments. Each of these systems offers a specific kind of electronic support to educational institutions: a LMS provides assistance with the organisation of the education and offers administrative support, a LCMS provides authoring tools for educational materials and an e-learning environment is the virtual place where students and teachers interact.

Although a crucial requirement for successful implementation of e-learning is the careful integration of didactic principles, most software producers intentionally distance themselves from didactical issues. They often are indifferent to didactical principles that should underpin their software systems (Govindasamy, 2002). Firidiyek (1999) argues that there is a serious mismatch between the abundance of features in LMS and the lack or total absence of explanation on the didactic principles underlying the inclusion of these tools. As Govindasamy puts it "most LMS providers perceive themselves as mere providers of technology. Consequently, while every technologically possible feature is included in LMS, there is an absence of overt pedagogical integration" (2002, p. 288).

In this paper, we report our design and implementation of a web-based e-learning system that was developed as an answer to the shortcomings of the existing software tools for distance education. The system is specifically designed to incorporate various didactic principles. In addition, the system supports the entire range of required educational processes and all the actors involved in them. It provides an all-in-one solution, in the sense that all three of the above named processes are integrated in one software system, i.e. authoring tools as well as administrative tools are integrated with an e-learning environment in which students and teachers interact. The system is currently named Sophia, and is the fruit of a project funded by the Digital University of the Netherlands1.

The general objective of this paper is to contribute to the knowledge about electronic learning systems, by showing ways in which didactical principles can be integrated in an e-learning system. Second, the paper will point out how the various issues that should be addressed by e-learning software can be incorporated in one overall system. We will use the newly developed e-learning system Sophia to describe how these two issues can be tackled.

The organisation of the paper is as follows. In Section 2 we will go into the fourth generation of distance education and elaborate on the different processes involved in the organisation of education. We show how the software packages that are currently on the market only partly fulfil the needs of educational institutions. Furthermore, we will show in this section that it is impossible to translate classroom education to web-based education without paying close attention to the accompanying shift in didactics. In section 3, we map out the different didactical scenarios that underpin web-based teaching in our newly developed application. In section 4, we illustrate how all relevant educational processes can be supported in an all-in-one system. Section 5 presents preliminary conclusions.

2. Web-based education: where did the didactics go?

Web-based education constitutes the fourth generation of distance education. In first generation distance education the interaction between students and the educational institution took place solely by means of written educational materials and mail. This form is also called "correspondence education" (Passerini and Granger, 2000; Spooner et al., 1998). The second generation distance education is characterized by the use of radio and television broadcasts, audio and video tapes in addition to written materials. This kind of distance education was popular in the beginning of the 70s. Ten years hereafter, CD-roms and other multimedia products entered distance education (the third generation). Presently, e-learning environments prevail. Recent developments in telecommunication technology and, most importantly, the growth of internet have led to the need for a completely new didactical approach to distance education. While former generations of distance education were teacher-led, the specific educational needs of individual students are now put center stage (Downes, 2002; Vermunt, 1992). In fourth generation distance education systems students should be able to determine their knowledge gaps themselves (for instance by means of a diagnostic test). They should have the
possibility to study or gather knowledge at the exact moment they need it (Al-Nuaimy, Zhang and Noble 2001; Collis, 1998). Moreover, students should be enabled to decide for themselves the amount of practice materials they need before taking the final test that will be graded.

We argue that current e-learning systems have two prominent drawbacks that hinder the development of efficient fourth generation distance education systems. First, didactic underpinnings are neglected. It is striking that most of the existing e-learning environments are places where the teacher will upload study materials that students will download, thereby discarding the many didactic principles that could be supported and enhanced by using e-learning tools. Important didactic principles such as just-in-time learning, competence-based learning and learning aimed at a practical application of theoretical insights are not supported by such systems. Instead, current systems tend to focus almost entirely on the management of the learning process (Ismail, 2002). "They add little or no value to the learning process. Furthermore, they do not provide any means to support internal content production processes, relying instead on commercial courseware" (Ibid., p. 330). In the currently existing e-learning environments information and communication technology is used to create a one-on-one translation of classroom teaching to web-based teaching. Leidner and Jarvenpaa (1995) have shown that "initial attempts to bring information technology to management education follow a classic story of automating rather than transforming. IT is primarily used to automate the information delivery function in classrooms. In absence of fundamental changes to the teaching and learning process, such classrooms may do little than speed up ineffective processes and methods of teaching", (1995, p. 265). As a result e-learning tools are not student-centred as they should be, but they are still very much teacher-led. In this way a traditional classroom setting is mimicked and no advantage is taken of the large educational potential of fourth generation distance education systems.

The second shortcoming of current systems is closely related to the first and has to do with the fact that current software tools only offer point solutions to specific needs. Providing fourth generation distance education calls for the organisation of a wide range of educational processes. Each of the current systems provides software solutions for only a subset of these processes. There is no system that supports the entire range. The processes that play a role in the education of students vary from authoring of educational materials; the design of courses and allocation of students and teachers to these; providing study and communication facilities for students; and supervision, evaluation and grading by teachers. Broadly speaking three sets of processes can be distinguished: (1) processes concerning the authoring and managing educational materials on the task level; (2) processes related to the design and management of information on the course level; and (3) processes connected with the teaching itself (see Table 1). The third column in Table 1 shows some well-known systems that offer software solutions for a particular subset of educational processes.

Educational institutions are under a constant pressure to work in a cost-efficient way (Moonen, 1994). E-learning tools can help reaching goals of efficiency by attuning the workflow of all actors involved in the education process. However, this is only possible when one integrated system is used. Until now the creation of e-learning tools has been driven by technology instead of the needs of the learning process itself. Most software tool developers do not recognise that web-based teaching requires an integrated tool, rather they have focused on providing a solution for a specific subset of educational processes.

We conclude that (1) there is a need to integrate didactical concepts and strategies into the e-learning environment; and (2) there is a clear need for one unifying system to make the entire range of educational processes more efficient and effective (see also Parikh and Verma, 2002). In the remainder of this paper we present our prototype for a multimedia e-learning environment, called Sophia, and we will show how the above challenges can be met in practice.

3. Didactics integrated in an e-learning environment

The central objective of developing Sophia was to design an e-learning environment firmly rooted in a number of didactic principles. These are operationalised into several different instructional strategies. An instructional strategy contains a didactical scenario on how to teach students specific competencies or knowledge. The instructional strategies provide the core of the application around which several other supportive facilities are designed.
The learning process of students contains different stages from mastering basic and essential concepts and methods to applying this knowledge in practical situations (González-Castaño et al., 2001). Sophia provides on-line functionality supporting all these stages, i.e. via the internet one can (a) diagnose the knowledge the student already possesses; (b) provide the student with activities that will help him fill his knowledge gaps; (c) provide the student with assignments on real-life case(s) and let the student apply the theoretical knowledge to a real-life problem; (d) test whether the student possesses the required level of knowledge or competence.

All instructional strategies cover one or more learning stages (see Table 1). Note that strategies do not always cover all stages, thereby opening possibilities for blended learning. It is possible for an organisation to make a deliberate choice about the way in which each learning phase is supported, either by web-based teaching or by offline methods. For example, some organisations might prefer to take the examination in a classroom environment, while all other learning phases take place online.

Note that while some instructional strategies cover an identical set of learning stages, they differ in the adopted didactic scenario. For example, instruction strategies 2, 7 and 9 all provide e-learning materials for processes (a), (b) and (d). Below we will explain the distinct didactical principles guiding each task type.4

Task types 1 and 2 contain the idea of providing knowledge to students on exactly those areas where they experience gaps. These task types are used to identify the knowledge level of students by means of sophisticated multiple choice questions.5 After completing the test the student receives an advice for further study that is conditional on the mistakes made in the test. One will usually employ tasks of type 1 at the beginning of a course. Based on the knowledge gaps, the students are directed towards tasks (of another instructional strategy) that will provide them with knowledge, insights, skills and attitude on specific subjects. Tasks of type 1 can be used in combination with a real-life exam in a classroom, while tasks of type 2 are specifically designed to online evaluate students on their level of knowledge and competence. Type 2 tasks are typically used as a conclusion to an entire course.

Task types 3 to 8 are firmly rooted in constructivist ideas on just-in-time learning (Schoening, 1998). After detecting and filling the knowledge gaps, the student starts out with a problem relevant for a specific firm. The assignment will lead the student to both, relevant theory on this problem and background information on the firm. It is up to the student which information to use for solving the assignment. Students are immersed in a real world context and discover how to use certain theoretical concepts and methods. Theoretical insights are gathered on the exact moment they are needed to solve the assignment (just-in-time). Type 3 tasks provide on-line facilities for all phases in the learning process, whereas tasks of types 4 to 8 leave room for fulfilling one or several learning stages offline.

Finally, tasks types 9 and 10 find their origin in problem based learning (Birch, 1986; Norman, 1988; Dolmans et al., 1994) and project based learning (Blumenfeld et al., 1991) respectively.6 Project based learning differs from problem based learning in several ways. An important difference is that problem based learning is directed more towards acquiring knowledge, while project based learning strongly emphasises the application of knowledge (Leroy and van den Bosch, 2001, p. 10).

In the problem based tasks (type 9) students typically start with an on-line discussion on a specific case description which is designed to seduce students into the investigation of problems. Students ask and refine questions and debate on ideas for possible solutions. This stage is concluded with identifying the lacks in the collective knowledge and setting learning objectives. In a subsequent session (usually in a classroom), students will communicate their ideas and findings to each other and ask new questions until finally all learning objectives have been reached to full satisfaction of all students. In Sophia this task-type is concluded with an individual assignment for each student which will be graded by the teacher. The project based tasks (type 10) follow a similar approach. The point of departure is an online project-assignment which leads to an on-line discussion among students on how to manage the project. The final goal is to produce a certain artefact (e.g. a model, a report, a videotape or computer program) in a group effort. The final artefact is handed in online to a teacher who grades the end result.

From the perspective of a learning content developer, a course usually contains several tasks. A developer of e-learning materials starts out by choosing an instruction strategy suitable for the specific objective he wants to reach with a certain task. As we have seen above, there are at least two sides to
this. First, one has to choose which phases of the learning process will be supported online and which will be provided in another way (by classroom lectures, books, videos et cetera). Second, one has to choose a suitable didactical approach. Once chosen, Sophia will make sure that the didactical scenario of the chosen instruction strategy is closely followed. It does this by providing the building blocks (components) for the task, which have to be filled with content materials by the developer. This means that the electronic environment ensures the didactical quality of the produced tasks.

We can conclude that on the task level students are treated as active agents in the learning process, instead of passive recipients of knowledge. In addition, the system provides an intake assessment. In this way the entire course (and even the entire programme) can be exactly matched to the educational needs of students. Intake assessments can test either knowledge or competencies. Sophia provides knowledge assessments on several levels and in various areas, e.g. history, mathematics and English. Competencies are assessed with the "Intake Assessment for Competencies" (IAC), which contains three phases, self assessment, portfolio and interview. The self-assessment describes first of all the competencies that will be assessed. This is followed by a survey, based on the well-known STARR method (Situation, Task, Action, Result, Reflection), which consists of statements relevant for the specific competency. The student ticks off his level of skill for each statement, which is then checked against the minimum required level of skill for the specific competence. In the portfolio phase of the IAC the student provides documents that provide evidence of his personal skills. These can be certificates of qualifications or descriptions of situations in which the student had to use a specific skill. An assessor will evaluate the quality of the provided documents and if they prove to be convincing the assessor will schedule an interview with the student. The interview creates the opportunity to check whether the student is as competent as was indicated by the self-assessment and the portfolio. Based on the interview the assessor decides whether the student will be enrolled for the education programme at all, and if so, which courses and tasks will be suitable.

4. One integrated system

An important shortcoming of current software systems is that they provide solutions for only a limited set of educational processes. Sophia was designed to join all educational processes in one system. In this way tasks and student information can be easily accessed by all actors involved in the education of students. Moreover, one integrated system facilitates the managing of educational processes and increases the specialisation of actors, thereby enhancing efficiency.

In Section 2 we argued that educational processes can be divided into three groups: (1) processes concerning the authoring and managing educational materials on the task level (usually organised by an LCMS); (2) processes related to the design and management of information on the course level (usually supported by an LMS); and (3) processes connected with the teaching itself (e-learning environment). Our newly developed system provides support for all these groups of processes. It distinguishes different roles in each group. Each role gives the user of the system access to specific possibilities. In addition, each role defines several responsibilities for the user.

**LCMS**

The author role takes a prominent place in the LCMS counterpart of our system. Authors are responsible for the creation of tasks and the storing of learning objects in the library. As already mentioned in Section 3, Sophia provides an author with a limited set of building blocks to construct a task. The building blocks ensure a sensible didactic approach and pave the way for a further specialisation in the authoring process. Several blocks do not require expert content knowledge in order to be filled, e.g., the inclusion of web sites that are relevant for cases. This work can be executed by a (low wage) student assistant. This specialisation within the authoring process opens many possibilities for cost efficient content production, since easy tasks can be directed to lower wage content developers. Content experts can focus on filling those building blocks that require expert knowledge.

[INSERT FIGURE 1 ABOUT HERE]

Figure 1 presents a screenshot of the workspace of the author. The dark blocks on the right hand side of the screen correspond to the building blocks for a task. In this screenshot the building blocks
for a task of type 3 (combination+). In this specific view, only one of the building blocks is unfolded, namely the one in which the assignments can be designed.

As soon as authors co-operate digitally and tasks are re-used, a content management system becomes vital to manage different versions of educational materials. Updating and revising learning objects introduces the danger of having different versions of the same object operational simultaneously. A content management system assures that tasks used by students cannot be altered or removed unintentionally by other actors in the system. Sophia introduces a life-cycle for tasks to tackle this problem. Tasks can only be edited by legitimate authors during certain phases of the life-cycle of a task.

A task is subject to five phases. In the upper left of Figure 1 the five life cycle phases are visible. As can be seen from the slightly darker colour of the "concept" button, the author is currently working in the draft phase. In this phase the author develops a task. As soon as the development of a task is completed, the author will give the task the predicate “ready-for-use”. The task now enters the second phase of its life-cycle. An author is allowed to withdraw the task from this phase, as long as the task has not yet been added to a course by the supervisor. The third phase in the task life-cycle is called “active”. Active tasks have been added to a learning path and therefore cannot be altered by authors. An addendum function allows supervisors and authors to add recent information to the tasks in this stage of the life-cycle. All students using these tasks will immediately be notified of this additional information. Large revisions of active tasks are only possible by copying an active task to the draft phase in which the task can be revised. Once the task is revised it will be declared “ready-for-use” by the author and hence it can be included in new courses by the supervisor. However, in this example the unrevised tasks remain in circulation. To remove an outdated task, the author can “block” it, and thereby the task will reach its fourth stage in its life-cycle. Active learning paths containing a blocked task will still be operational. However, a supervisor cannot include blocked tasks in new learning paths. Only “ready-for-use” and “active” tasks are available for the creation of new learning paths. Blocked tasks, that are not used in any course, automatically enter the final phase of their life-cycle. These so-called “closed” tasks are obsolete and may be deleted from the system by the author.

An efficient LCMS is characterised by many possibilities for re-use of objects. Objects can be (a) resources, (b) tasks and even (c) entire courses (learning paths). One of the facilities that enable re-usability of resources is the library. In the library authors can store all kinds of learning objects, e.g. images, cases, web-sites and text files. Other authors can be granted access to certain libraries, thereby enabling them to re-use materials developed earlier by other authors. A glossary is another facility enabling the re-use of objects. In this case an object is a specific glossary term, accompanied by a description and a study advise about where to find a more elaborate discussion of the term in the literature. Not only a single glossary item can be re-used, but entire glossaries pertaining to specific content fields can be re-used as well. Conditional access protects content objects in Sophia against being overwritten unintentionally. Editing of objects is only allowed for authors within one content group (authoring in a specific content field). Authors of other content groups may be granted use of existing resources, but the only way for them to make adaptations is to copy the original objects to their own resource library before editing it.

LMS
The functionality that is usually provided by an LMS is accommodated by the supervisor role and an administrative role.

In the supervisor role one is responsible for composing the educational programme (i.e. the course, or the learning path). Furthermore, the supervisor monitors the progress of all students in the learning paths created by himself. When the course period is over, he closes the learning path by sending students their final grade. To compose a course the supervisor can either (a) choose an instruction strategy (or mix of strategies) that is considered useful for the course, and subsequently instruct authors to make tasks of this type; or (b) create a learning path with already existing tasks (created by authors for another course). The latter is called re-use.

Tasks can be (re-)used in an unlimited amount of courses. This is sensible because a task is a learning object which is created to fulfil a specific educational objective. One specific task could very well be useful in several different courses. A supervisor is able to compose different courses by (re)combining tasks. All tasks designed by authors within a certain content group can be used freely in
learning paths. A content management system protects tasks for being rewritten. Moreover, entire learning paths can be re-used as well (for instance for another group of students).12

A common function of an LMS is the administration of students and teachers. Sophia distinguishes a separate administrator role, in which one can add or remove users. An administrator can also design homepages for general use. These contain information on the educational institution or the company that offers the courses. In addition, the administrator can provide role-specific information which will be displayed in the system. For instance, students are welcomed to the training facility and are instructed about the use of the system. Similarly, authors are instructed about the process of creating educational materials with the application.

E-learning environment
The e-learning environment in Sophia provides a virtual space where students and teachers work and interact. The student role is quite straightforward. A student visits the Sophia website and logs in with a unique and personal login name and password. The learning paths will direct the student to his/her tasks on different subjects. Questions on the tasks can be posed to the mentor. Usually, learning paths are concluded with tasks testing the competencies of the student.13 Assessors will grade these tasks and subsequently the supervisor will grade the overall performance in the learning path. A student is still able to access his study materials after his assignments have been graded, but obviously he is not allowed to make changes.

Figure 2 shows the workspace of the student. In this particular view a student sees the first assignment of a combination task. In the box below the assignment the student can type his analysis of the problem. Note the two hyperlinks in the assignment that lead the student to (1) the theory about the marketing mix (the link has been clicked and the small window in the lower part of the figure resulted) and (2) the case specific information about the firm Center Parcs. The button “Toon feedback” in the middle of the screen gives instant feedback on the assignment to the student. The upper right of the screen shows the mailbox of the mentor. By following this link the student can pose a question to the mentor of the course.

The teacher role is divided into several sub-roles. The mentor supports students by answering questions on the education material and uses facilities such as email and a FAQ (Frequently Asked Questions). A mentor has access to progress overviews of the students, which enables him to focus on students that need assistance. Assessors are responsible for grading tasks of students. Sophia supports assessors in a number of ways. First, assessors can make use of answer models, describing the essential elements that a correct answer contains. Second, the system assures objectivity across assessors in the grading of the same assignments for different students. Depending on the task type, assessors have access to an overview of the grading behaviour (and rationale) of other assessors for a specific assignment. The moderator role is created for instructional strategies that incorporate discussion groups related to a certain subject. The moderator monitors the discussion groups, deletes improper contributions and undertakes action against contributors who abuse the system.

In the above we have tried to allocate each role to one of the three subsystems identified in Section 2. It becomes clear that it nearly impossible to make such a clear demarcation of LCMS, LMS and the e-learning environment. Actors in all the subsystems co-operate and communicate. This is underlined by Figure 3. This figure shows how the Learning Content Management System (LCMS), the Learning Management System (LMS) and the e-learning environment are related and integrated within one system.

The tasks published by authors are used in courses (learning paths) designed by the supervisor. The supervisor allocates students and teachers to the course and monitors the progress of students and the behaviour of teachers. Students communicate with other students, the teacher (in case of questions about learning content) and the supervisor (in case of planning problems). The teacher controls the progress of his students on detail level (by motivating them in absence of progress) and he coaches them as they are working on the assignments. Eventually, the teacher grades the work of the student.
This grade is instantly visible for the supervisor. In the case that additional offline assignments exists, the supervisor inserts the grades for these offline assignments into the system and finalises the course for the student. The grade will now be instantly visible for the student.

The various overviews in the system provide valuable information to all the users. For instance, supervisors that want to design a course have an instantly updated overview of all tasks that are marked ready-for-use by the authors. This is only possible because of the integrated system that couples the LCMS to the LMS. Additionally, supervisors can instantly see, whether teachers have graded the student assignments in time. The integrated system makes sure that information generated by the e-learning environment is always immediately visible within the LMS.

The system is currently used by real students in real courses. The first preliminary evaluations of the implementation of Sophia indicate that the system meets all expectations. Sophia is fast and can be accessed easily through the internet. The system is easy to use for students as well as teachers and managers of educational institutions. They highly appreciate the didactic principles incorporated. The system proves to be very effective in organising educational processes such as the development of educational materials (especially by large teams of authors), the distribution of materials to students, and the maintenance of content.

5. Conclusions
The fourth generation of distance education calls for (a) the integration of didactical principles in an e-learning application; and (b) the development of one unified system that supports all actors involved in educational processes. Practical applications that tackle both issues are scarce. This paper demonstrated the design of an all in one system called Sophia. It showed how such a system can support the various educational processes that are usually separately attended to in an LCMS, LMS and an electronic learning environment. Furthermore, it showed that it is very well possible to integrate didactic principles in an e-learning application. Moreover, it gave a practical illustration of how the instructional strategies can support teachers to translate classroom education into web based education, thereby adopting and joining several distinct didactic principles.

The underlying study is based on a field study and is explorative in nature. Further research will be directed towards a detailed evaluation of the system. Different groups of users will be systematically questioned on different aspects such as ease of use, usefulness, timeliness of response, convenience, format and layout, accuracy, conformance to the knowledge gap and satisfaction.

Acknowledgements
The authors thank Iwan Wopereis for valuable comments on earlier versions of this paper. The usual disclaimer applies.

References


### Table 1: Sets of educational processes and typical software solutions

<table>
<thead>
<tr>
<th>Categories of educational processes</th>
<th>Processes</th>
<th>Examples of current systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Authoring (LCMS)</td>
<td>- developing content (tasks)</td>
<td>Macromedia Authorware, TotalLCMS, WebPublisher&lt;sup&gt;14&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>- storing and managing content</td>
<td></td>
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<tr>
<td>2. Management (LMS)</td>
<td>- designing courses (packaging content into courses)</td>
<td>Blackboard, Lotus LearningSpace, Docent, WebCT&lt;sup&gt;15&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>- allocating students and teachers to courses</td>
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<td></td>
<td>- evaluation of students</td>
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<tr>
<td>3. E-learning environment</td>
<td>- studying (student-centred)</td>
<td>BSCW (Basic Support for Co-operative Work)</td>
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<tr>
<td></td>
<td>- teacher - student interaction (student support)</td>
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<tr>
<td></td>
<td>- grading of tasks</td>
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</tbody>
</table>

### Table 2: Overview of instructional strategies in Sophia

<table>
<thead>
<tr>
<th>Instruction strategies</th>
<th>Learning stages</th>
<th>(a) Detection of knowledge or competence gaps</th>
<th>(b) Acquisition of knowledge or competencies</th>
<th>(c) Practice the application of knowledge or competencies</th>
<th>(d) Examination</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Diagnose</td>
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<td>X</td>
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<td>2. Diagnose and test</td>
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<td>X</td>
<td>X</td>
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<td>X</td>
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<tr>
<td>3. Combination +</td>
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<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>4. Combination</td>
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<td>X</td>
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<td>5. Practice +</td>
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<td>X</td>
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<tr>
<td>6. Practice</td>
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<tr>
<td>7. Exam +</td>
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<tr>
<td>8. Exam</td>
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<tr>
<td>9. Discussion</td>
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<td>X</td>
<td>X</td>
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<td>10. Project</td>
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</table>
Figure 1: Screenshot of the workspace of the author

Figure 2: Screenshot of the workspace of the student
Figure 2: Organisation of the education in Sophia

LCMS functionality

- author
  - developing content

LMS functionality

- supervisor
  - creating learning paths / monitoring progress

E-learning environment functionality

- student
  - studying / making tasks

- teacher
  - coaching and grading

→ content / tasks
← communication
Notes

1 The Dutch Digital University was founded in 2001. This joint initiative of ten Dutch universities (of both master and bachelor degree) aims at developing e-learning content and tools and disseminating them among the Dutch universities.

2 Parikh and Verma (2002) note that "a strong opinion has recently emerged that the current practice of using Internet in teaching has not lived up to the high initial expectations and it even leads to sub-standard education" (p. 28). They believe that appropriate teaching methods and instructional material to support learning activities is a key to improve web-based learning.

3 In accordance with Ulrich et al. (1995) we define competence as a student's ability to handle real-life situations in a professional way by integrating and applying knowledge, skills, insights and attitude and to reflect on the chosen approach.

4 In the design of e-learning materials authors can choose to develop a task which adopts a certain instruction strategy. Therefore instruction strategies are also called task types.

5 To provide sophisticated multiple choice questions Sophia is partly integrated with Question Mark Perception (QMP). QMP is a computer assisted assessment system which allows several distinct forms of multiple choice questions and incorporates several mechanisms for differentiated feedback. Empirical evidence indicates that simply showing students the correct answer has less effect on learning than providing an elaborate feedback on the correct and incorrect elements of the given answer (Dempsey, Driscoll and Swindell, 1993). Moreover, the motivation of students is positively influenced when feedback is given that is tailor made to the answer of the student (Ross and Morrison, 1993).

6 For a detailed description of the benefits of project based learning we refer to Blumenfeld et al., 1991, pp. 372-372.

7 The STARR method stems from behavioural interviewing and is based on the idea that past performance is the best predictor of future performance in a similar situation. If a student is able to describe a positive experience in which he demonstrated leadership skills in the past, it is likely that this student can duplicate this behaviour in the future (Janz, 1986; Janz et al., 1989).

8 A portfolio can be defined as “a collection of evidence, usually in written form, of both the products and processes of learning. It attests top achievement and personal development, by providing critical analysis of its contents” (McMullan et al., 2003).

9 “Ready-for-use” corresponds to “gereed” in Dutch, see Figure 1.

10 The supervisor role will be discussed under the heading “LMS”. It is obvious though that the activities of supervisors have an influence on the environment of authors. Therefore, in practice it is impossible to make a strict demarcation between the LCMS and the LMS.

11 “Closed” corresponds to “in afronding” in Dutch, see Figure 1.

12 Learning paths undergo a somewhat different, though similar life cycle to tasks. The life cycle of a learning paths has the following phases: draft, active and closed.

13 This is not to deny the possibility for blended learning in the system that enables a choice for off-line examination.

14 See http://www.clueful.com.au/cgi-bin/cmsdirectory/browse/Products%3aCommercial%20systems for a broad overview of CMS systems.

15 See http://www.nettskolen.com/in_english/webedusite/used_lms.html for a broad overview of LMS systems.