Student Online Counseling Kernel System Based on Learning Behavior and Test Performance

Chakkrit Snae¹ and Michael Brückner²
Department of Computer Science and Information Technology, Naresuan University, Phitsanulok, Thailand, 65000
e-mail: ¹chakkrits@nu.ac.th, ²michaelb@nu.ac.th

Abstract - In this paper the authors use a design and create research approach to implement a system for student online counseling with adaptive feedback, the Student Online Counseling Kernel System (SOCKS). This system is based on observation of the learning behavior, i.e. the time spent for studying learning units and related test performance, and has a component to predict the learning outcomes of individual students during an online course and prior to final exams. The main objective of SOCKS is to give students an automatic and immediate response to monitored attendance and quiz/test results after having finished a learning unit composed of standardized learning objects. The prediction process is based on a statistical model of learning performance and test performance. The resulting response is an overview of student activities in various sections of the online course. The system not only monitors the learning behavior but also give comments and feedbacks to an individual student. It can deal with comprehensive as well as selective or topic driven tests based on random questions from a test repository. Results are given and discussed.

Keywords - Computer-assisted counseling, learning behavior, monitoring system, online course

I. INTRODUCTION

Many organizations and institutions that contribute to the standardization and development of e-learning and online learning systems including Learning Management Systems (LMS) and Learning Content Management Systems (LCMS), for an overview see (Learning Technology Standards Observatory, 2007); as is shown in (Siritongthaworn, Krairit, Dimmitt, & Paul, 2006), this is not only limited to the developed world but also true for the education systems in the developing world. Electronic learning, or e-learning, deals with both the technologies and associated methodologies in learning with the assistance of networked and/or multimedia technologies. Online learning is seen as a subset of e-learning and uses Web based teaching materials to leverage the Internet for the delivery of instructional materials. Other related areas are distance learning (or distance education) and mobile learning, often shortened to M-learning.

Whereas the technology and presentation tools for instructional domains are developing very fast, supporting activities, such as counseling, seem to fall behind and lack the assistance of comparably sophisticated tools. Counseling can be defined as a “relatively short-term, interpersonal, theory-based process of helping persons (…) resolve developmental and situational issues” (Gladding, 2003), and this process can be triggered by the person seeking help or by the counselor. In this definition the term “interpersonal” refers to face-to-face as well as computer-mediated communication (CMC) processes performed by humans. In an automated counseling system this does not hold any longer, since the counseling is carried out via the user interface of computer software based on neural network technology and individual student data. (Ranjan & Malik, 2007) describe a system that uses data min-
ing techniques to produce the basis for the subsequent counseling process. This process, however, is performed by faculty or staff, so it is not an automated process.

Figure 1 highlights some basic elements of e-learning systems. The individual student’s profile triggers the personal front-end, which records important data during the learning sessions. The personalization engine uses the monitored data to propose appropriate measures to review learning and improve individual skills and abilities. The learning units are based on Learning Objects leading to items (objects) that have to be learned during the sessions.

Web-based counseling systems are used in or developed for various areas, for example in health care (Lambert, 1989; Col, 2007) and health assistance (Snae & Brückner, 2007), physical activity (Pinto, Friedman, Marcus, & Tennstedt, 2002), and students’ counseling.

The benefits of Web-based counseling are manifold: shy and apprehensive people can seek help without being faced by a person rather than being asked questions without leaving their own settings; furthermore, people in rural or remote areas can benefit from a Web-based counseling process since they usually do not have access to nearby counselors. Web-based counseling can be carried out synchronously and face-to-face with the help of Webcams or asynchronously and text-based via e-mail or online. As the student counseling system framework presented here is advice-oriented rather than communication-oriented or even therapeutic, the Web-based approach is an appropriate approach.

E-learning and the automated counseling is seen not only as a means for assisting tutors in routine work but also for cost reduction of the associated activities, although this has not always been achieved. A review of related issues has been published by the OECD (OECD, 2005). Poppe and Breitner (2003) outline various aspects of business models for e-learning products and services, which may help to reduce the non-recurring costs for purchasing the e-learning system. Figure 2 shows the conceptual framework of an educational counseling system as it has been used in this research. The basic concepts taken into account here are people, data, methods, topics and time.

Figure 1 The e-learning process, adapted from (Stein, 2000)

In order to provide a basis for electronic counseling, many systems use a computer-based or electronic method of assessment. Electronic assessment, or e-assessment, has been defined as “the end-to-end electronic assessment processes where ICT [Information and Communications Technology, the authors] is used for the presentation of assessment activity and the recording of responses. This includes the end-in-end assessment process from the perspective of learners, tutors, learning establishments, awarding bodies and regulators, and the general public” (Joint Information Systems...
Electronic assessment can be achieved in various ways. The Student Online Counseling Kernel System (SOCKS) has been designed as a Web-based system triggered by the underlying Learning Management System (LMS) or the student, respectively, and based on the individual student’s learning behavior, i.e. time spent on learning units, and such learning results as the obtained points in the spectrum of the difficulty of the test/quiz questions.

This paper is organized as follows: after the introduction, Sect 2 shows a use case and basic requirements of the online counseling system. The next section presents the system framework of SOCKS, which is followed by a description of the important system modules, such as the online assessment module, the, the student and teacher modules (e.g., login statistics and student statistics). Finally, the results of the system evaluation by the users are presented and briefly discussed. In the last section conclusions are drawn and further work is outlined.

II. USE CASE AND BASIC SYSTEM REQUIREMENTS OF SOCKS

The elicitation of requirements for a Web-based counseling system is a rather complicated process, since many heterogeneous aspects have to be considered, such as test psychology, the difficulty of questions and topics of the learning domain, ergonomics of the user interface and data security as well as authorization and authentication aspects.

Let us consider a simple use case for SOCKS, which is outlined in the following. Student W is attending an online course on Software Engineering, which is almost finished regarding the last day the final test can be taken. The online course comprises 15 learning units overall and the time students are expected to spend in each unit varies from three to five hours. W has been studying all units and has taken all quizzes including the mid term test with varying results. The mid term test consisted of 25 questions and has been offered online. The questions covered all units of the first half of the online course and were designed with varying levels of difficulty. W has got more points than she expected before taking the test. Nevertheless, she is not sure whether she will pass the final and comprehensive test with a good grade. In this case, W can ask SOCKS for a consultation based on her time spent in every unit of the Software Engineering online course and on her points in the related quizzes plus the mid term test. SOCKS takes into account her individual data and calculates a predicted grade for the final grade as is. Furthermore, SOCKS will advise W on units that cover the spectrum of questions that W has answered with fewer points than average. With this advice W can then improve her studies by going back into specific learning units, and hopefully she will get a good grade in the final test.

In the following, the authors outline the four basic processes involved in SOCKS together with information security requirements. The basic processes are

- the process monitoring the students’ learning behavior,
- the prediction process for the student’s learning outcome
- the resulting counseling process, and
- the evaluation of the counseling process.

<table>
<thead>
<tr>
<th>TABLE 1</th>
<th>EXAMPLE OF THE LEARNING RECORD OF A STUDENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>LU</td>
<td>TST</td>
</tr>
<tr>
<td>1</td>
<td>65</td>
</tr>
<tr>
<td>2</td>
<td>75</td>
</tr>
<tr>
<td>3</td>
<td>58</td>
</tr>
<tr>
<td>4</td>
<td>77</td>
</tr>
</tbody>
</table>

As participants of an online course have to work through the learning materials, such as texts, graphical representations and instructional videos, their learning behavior regarding the time they spend on the materials can be measured and stored in an individual learning record. Table 1 shows an example learning record related to the time spent on different materials in the first four learning units (LU). TST, TSG and TSV refer to the time spent on texts, graphics and videos,
respectively. TSO is the overall time, i.e. TST+TSG+TSV. All data are given in minutes.

The participants are expected to take quizzes and tests regularly. The corresponding results are individually stored in the students' learning records. An example of this part of the learning record is shown in Table 2, which is enriched by the individual results of each quiz and test taken by the participant. The prediction process uses the enhanced learning records and takes into account the actual time spent in each learning unit against the average time spent and the learning results as has been gathered by the quiz and test results.

In all areas that deal with data records of individuals there are comprehensible concerns about the integrity and the security of data and information monitored, transferred, stored and retrieved. Primary issues within information security are the protection of data against unauthorized use as well as the authorization and the authentication process. The related system components have to be Web-based and should be based on standard interfaces and software.

**Table 2: Enhanced Learning Record of Student**

<table>
<thead>
<tr>
<th>LU</th>
<th>TSO</th>
<th>Q1</th>
<th>Q2</th>
<th>T1</th>
<th>T2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>87</td>
<td>76</td>
<td>69</td>
<td>72</td>
<td>74</td>
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<tr>
<td>2</td>
<td>91</td>
<td>79</td>
<td>72</td>
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<td>95</td>
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<td>68</td>
<td>67</td>
</tr>
<tr>
<td>4</td>
<td>105</td>
<td>59</td>
<td>67</td>
<td>73</td>
<td>79</td>
</tr>
</tbody>
</table>

**III. SYSTEM FRAMEWORK OF SOCKS**

In Figure 3 the system framework of the Student Online Counseling Kernel System (SOCKS) is presented. SOCKS uses (1) a database of students’ activities and assessments to advise students on their further studies and to provide immediate feedback after a quiz or test, and (2) a grade prediction component that takes the results of self-study activities (marks) of online assignments, quizzes, post-tests after finishing a study section, and mid-term tests to predict the final grade of the students.

Students can get assignments, or take post-tests, quizzes and mid-term tests only if they reach sufficient attendance during the course. Attendance is based on the students’ learning records (with a time counter).

**Figure 3: System framework of SOCKS**

**IV. USER INTERFACE DESIGN OF SOCKS**

User Interface Design of SOCKS contains two main parts (students and teachers) which are described below.

Students: Figure 4 illustrates the main menu for students interface. The main page contains:

- Change Password: is for changing student passwords which should be done every three months,
- Login Statistics: is for checking attendance of students in the course,
- Student Statistics: is for checking student behavior of learning course
- Suggestion-Feedback: is for giving feedback and suggestions to students or identifying what to consult or suggest and how,
- Assessment Result: is for assessing how much the student knows and how well and to decide where and how much help is needed,
- Logout from the system.

There are also learning subjects available for students, updating system, history of all stu-
students, exit from each lesson and log out from the system.

Login Statistics: Figure 5 illustrates checking attendance which a student must log in to the learning course by providing the student ID and password. The system recognizes the IP of the computer that a student uses for the first time and checks every time the student logs in. Thus, students must use the same computer for learning throughout the course.

**Figure 4** interface of SOCKS: student part

**Figure 5** interface of SOCKS: Login Statistic

ATT is for marking attendance, ST and FT are starting time and finishing time of learning respectively. TOTAL is for keeping the overall mark of attendance. The marks of attendance are based on time constrain, e.g., 1 means you log in and log out within the time limit (10:00 to 11:50) 0.5 means students are less than 30 minutes late (10:20) and get, and 0 means students are more than 30 minutes late (10:35) or absent. IP refers to the regular seat/computer that students must use for learning.

Assessment Result is to evaluate how well a student has done and to help students drawing conclusions for the learning improvement and purpose using appropriate response parameters as follows:

- **Very well**: no action
- **Well**: whenever get a chance, review related concepts
- **Not so well**: give exercises
- **Not well**: review concepts, exercises
- **Not at all**: teach
- **Forgotten**: review, no exercise

**Teachers**: Figure 6 shows the main interface for the teachers and the administrators of SOCKS. This page contains:

- **Change Password**: is for changing teacher passwords, which should be done every three months,
- **Student List**: is for checking the number of students attending the course,
- **Student Short Information**: checking necessary student information,
- **Inbox-Feedback List**: is for getting feedback and suggestions from students,
- **Assessment Result**: is for assessing how much the student knows (and how well) and to decide where and how much help is needed,
- **Message to Student**: is for creating and sending messages to students,
- **Student Statistics**: is for checking student behavior of learning course,
- **Logout from the system.**
- **Add Subjects, Add Chapters and Add Exam** are also on this page.

**Student Statistics**: Checking student behavior of learning in the course by providing the
time spent on TST-TSG, TSV, TSO, and quizzes that students have taken for each chapter (Figure 7). The system recognizes the lessons and chapters that a student has already studied during the course.

Figure 7 shows times that students spent and post-test after learning in each lesson. The threshold is up to check a minimum of time that student should spend in each chapter.

The minimum of time is computed by the average of times that all students spend in each chapter. If the student spend less time at the threshold and the marks of quizzes are less than standard then the students are advised to revise each lesson at the end of lesson otherwise they will not allow to take mid-term examination.

**REFERENCES**


