Analysis of Feedback Authoring Possibilities in Web-based Learning Systems

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Abstract: This paper surveys and analyses the feedback authoring possibilities in online assessment modules of the most popular Learning Management Systems (LMS) including Moodle, Sakai, and Blackboard. We consider the problem of authoring and support of tailored and personalized feedback and demonstrate how it has been (or could be potentially) addressed in these systems.

Introduction

Developers of modern WBLS put a lot of effort in the creation of user-friendly and effective authoring tools. Their main intentions are to enhance the teacher's work in managing e-learning applications and to produce useful and efficient learning materials. The WBLS authoring tools are aimed at helping: (1) to decrease the effort (time, cost, and/or resources) for making learning courses, (2) to decrease the skill threshold for designing learning applications, (3) to help the teacher to articulate or organize his/her domain or pedagogical knowledge, (4) to support good design principles (in pedagogy, user interfaces, etc), and (5) to enable rapid prototyping of learning courses design (Murray, 1999).

Among the whole learning system's functionality feedback is the one that gives the student the response from the system. It occurs during interaction with different components of WBLS (assessment, navigation through the learning materials, communication and collaboration, etc.) and performs many functions – feedback informs, motivates, corrects, evaluates the student, keeps his/her attention, and provides additional comments and explanations. Therefore, the study and design of feedback provided by the system and feedback authoring tools are crucial aspects of the educational applications development. In (Vasilyeva et al., 2007) we overviewed a state-of-the-art of feedback in WBLS and outlined the main problems of the feedback design in WBLS.

In this paper we are focusing on analysis of the feedback that is presented during online assessment in WBLS. Online assessment components of LMS are actively used nowadays not only in e-learning, but also within blended learning, as part of the learning process for self-evaluation and for "real" exams. Authoring and delivering of feedback is one of the important tasks of the online assessment components.

The increasing number of users of WBLS as well as the existence of different types of feedback and the ways of its presentation emphasises the necessity of the feedback personalization. The same feedback could have different power for different students. Tailoring of feedback offers possibilities to deliver feedback that is the most effective for the student and is the most appropriate for the user's expertise and cognitive abilities in general and, in particular, adapted to the user's performance, current mood and attentiveness. In our recent research we experimentally demonstrated feasibility and effectiveness of immediate feedback personalization during online assessment in WBLS (Vasilyeva et al., 2008a; Vasilyeva et al., 2008b).

To the best of our knowledge none of the existing WBLS currently supports possibilities for tailoring of feedback in online assessment (except the possibility of tailoring of feedback to the response correctness). In this paper we analyze how this limitation can be overcome and present our approach of introducing feedback tailoring functionality to WBLS which was implemented as a proof of concept in the Moodle LMS.

The remainder of this paper is organized as follows. First, we review and summarize feedback authoring possibilities supported by three most popular WBLS: Moodle, Sakai and Blackboard. Then we focus on the issues related to feedback tailoring in WBLS. After that we discuss possible modification of WBLS on the example of Moodle to support feedback personalization during online assessment. We conclude the paper with a summary and outline the directions for further research.

Feedback Authoring Possibilities in major WBLS

In this section we present an overview of the functional possibilities of the most popular WBLS such as Moodle, Sakai, and Blackboard with regard to feedback authoring in their assessment modules. Moodle, Sakai and Blackboard are designed using sound pedagogical principles and support online individual and collaborative learning through a number of features and activities including course management, creating learning content and document distribution, forums, chats, wikis, online testing, etc. We focus our analysis on the feedback that is supported by online assessment components of these systems.

Moodle (http://www.moodle.org) is a free, open source WBLS used in more than 180 countries. Besides the powerful course management system, Moodle includes a quiz module that allows the teacher to design and implement quiz tests, consisting of multiple-choice, true-false, short answer questions etc.

Moodle supports the following types of feedback in its assessment module: immediate, summative and delayed feedback. Immediate feedback may include knowledge of the response (KR), knowledge of correct (KCR) and/or elaborated feedback (EF) to the question as a whole, to the variants of the answers, to the multiple-choice questions being answered correctly, incorrectly, or partially correctly. Summative feedback can include the grade for the test and general comments on the student's performance based on his/her score. Delayed (until after all questions have been answered) feedback may include an overview of all the questions, the student's responses to those questions, highlighted correct responses and EF (explanations). Delayed feedback could be presented either directly after answering to the whole test or when the test is closed (typically when the end-time of the exam is reached). Moodle's quiz authoring tool allows setting the listed above types of feedback presentation.

Sakai (http://www.sakaiproject.org) is actively developing WBLS that has been recently becoming widely used. It is also a free, open-source educational software platform used for teaching, research and collaboration. Sakai is currently being used at over 150 institutions and being piloted by over 100 more. Sakai includes an assessment manager (SAMigo) that supports online assessment through online tests/quizzes, homework questions, problem sets, self-study questions, compositions, projects, language drills, and surveys. SAMigo assessment tasks can include the following types of questions: multiple choice, survey, short answer/essay, true/false, fill in the blank, file upload, and audio recording.

The types of feedback which can be presented in SAMigo are: immediate and delayed feedback (the time when feedback should be presented can be set), KR, KCR and EF (to the question, to the variants of answers). The EF can be separately specified for the question in case it is answered correctly and in case it is answered incorrectly. The feedback can also include the statistics of answering to the questions of the certain test.

Blackboard (http://www.blackboard.com) is the popular commercial WBLS which is being used in over 2200 education institutions in more than 60 countries. Its features include course management, a customizable open architecture, and a scalable design. Blackboard has an online assessment unit that allows creating tests and surveys and supports different types of questions (multiple-choice, true/false, matching, ordering, etc).

For each of the questions the author can specify the necessity of providing the KR and/or KCR feedback. Blackboard also gives instructors the possibilities to specify different types of formative instructional feedback for multiple-choice questions. The authors can specify EF for the each possible variant of the answer, for the correct response and for the incorrect response to the question.

In Table 1 we present a summary of the feedback functionality supported by Moodle, Sakai and Blackboard. For this analysis we used the taxonomy of feedback suggested in (Vasilyeva et al., 2007).

Table 1. Feedback-related functionality in Online Assessment Components of LMS

Time of occurrence:	Moodle	Sakai	Blackboard
- Immediate Feedback;	yes	yes	yes
• possibility to specify what to include to the immediate feedback: responses, correct answers, scores, elaborated feedback;	no	yes	yes
- Delayed Feedback:			
• After completing the attempt,	yes	yes	yes
• After the quiz is closed,	yes	no	no
• At the specific date.	no	yes	no
• possibility to specify what to include to the delayed feedback: responses, correct answers, scores, elaborated feedback	yes	yes	yes

Complexity of feedback:			
- Knowledge of response feedback;	yes	yes	yes
- Knowledge of result feedback;	yes	yes	yes
- Knowledge of correct response feedback;	yes	yes	yes
- Elaborated feedback:			
• for correct response;	yes	yes	yes
• for incorrect response;	yes	yes	yes
• for partially correct response;	yes	no	no
• for the question as the whole;			
• for each variant of the answer.	yes	yes	yes
	yes	yes	yes
Way of occurrence:			
- Textual;	yes	yes	yes
- Graphical;	no*	yes	yes
- Animated;	no*	yes	yes
- Auditory.	no*	no*	no*
Progress Coverage:			
- Immediate (grade for the question);	yes	no	yes
- Continuous (intermediate grade);	no	no	no
- Summative (total grade).	yes	yes	yes
Timing Info (when time for the test is limited):			
- timer (time left);	yes	yes	yes
- time recommended for answering to the question;	no	no	no
- expected time needed to answer to the rest questions of the test.	no	no	no

* - in these cases a good knowledge of html and/or at least some programming skills are required for authoring of the feedback.

Although LMS offer a wide range of functionality for feedback authoring, it is still not possible to vary the type of feedback presented for the questions within the test depending on the student's responses (besides having EF for correct/incorrect/partially correct responses), the performed task and individual characteristics of the student.

In the following sections we address the problem of tailoring of feedback and suggest a way of adding this functionality on the example of the Moodle LMS.

Tailoring of Feedback in WBLS: Problems and Tasks

Different types of feedback carry out different functions and thus they can be differently effective in terms of learning and interaction and can even be disturbing or annoying to the student and have negative influence on the learning and interaction processes (Hatie & Timperley, 2007). The analysis of different feedback studies suggests that trying to design a so-called "one size fits all" feedback is a rather meaningless approach in general. Instead, the efforts can be directed towards studying the problem of how to enable authoring and adaptation of the most suitable feedback to a student, tailoring it to the student's personality, the performed task(s) and environment (Mory, 2004).

The development of the personalized feedback requires having answers to at least the following questions: (1) what can be personalized in the feedback; (2) to which user or performance characteristics feedback should feedback be personalized; (3) how should personalization of feedback and authoring of the personalized feedback be organized.

In our recent studies we tried to answer to these questions. During the 2006-2007 and 2007-2008 academic years we have conducted a series of online assessments of students (as integral parts of several bachelor and master courses) and have studied the possibilities of tailoring the feedback (presented to a student as a result of his/her response to the multiple-choice questions of an online test) taking into account the individual learning styles (LS), certainty in the concept studied by the corresponding question, certitude in a response and correctness of this response (Vasilyeva et al., 2008a, Vasilyeva et al., 2008b). We introduced feedback personalization/recommendation functionality to Moodle LMS and demonstrated the feasibility and benefits of designing adaptive feedback (with respect to the characteristics of an individual student) in online multiple-choice tests.

In the next section we describe a technical changes that we introduced to Moodle LMS to facilitate feedback personalization personality.

Feedback Personalization in Moodle

The Moodle Quiz Module allows authoring of different types of feedback (Tab. 1). This allows introducing the possibilities of feedback tailoring without developing feedback functionality itself. We have introduced a number of changes to Moodle Quiz module and Moodle's database architecture throughout the series of the experiments to support discrimination between several types of feedback (KR, KCR and several types of EF) and personalization/recommendation of feedback.

Our approach is based on the traditional user modeling approach in adaptive hypermedia (Brusilovsky, 2001). In our study we used a simple user model that includes information about student's LS, certitude and correctness of the current response. Other individual characteristics can be added easily of course, however we tried to focus our study on a particular set of characteristics that allows us to verify our findings from preceding experiments as well as to verify the feasibility of the EF adaptation approaches and to make some new observations. Besides the user model, another important component is a feedback adaptation unit that has to include a knowledge base containing the adaptation rules that associate user (task, environment) characteristics with certain feedback parameters from the feedback repository.

In the Appendix we present the list of changes introduced to Moodle database and quiz module to support feedback personalization functionality.

Conclusions

Feedback is an important feature of the online assessment components of WBLS. In this paper we overviewed feedback-related functionality of the most popular WBLS – Moodle, Sakai and Blackboard. Our analysis demonstrated that although a wide number of the types and ways of feedback presentations are supported, authoring and presentation of the personalized feedback is still not possible. Tailoring of feedback to the individual characteristics of students and their learning needs is a promising direction of WBLS development that can be beneficial for enhancement of WBLS in terms of efficiency and effectiveness of interaction and learning processes.

In this paper we also stressed that it is relatively easy to extend the WBLS functionality by altering the code and introducing some changes into the database on example of the Moodle LMS. In our work feedback personalization was hard-coded. However, there are no serious obstacles in providing authoring tools for adaptation within WBLS. Authoring of personalization rules is supported in existing adaptive systems. For example, AHA! provides both high-level (Graph Editor) and low-level (Concept Editor) authoring tools which can be used for creation and editing of the personalization rules (De Bra et al, 2007).

Our ongoing and future research is focused on incorporating adaptation (including feedback adaptation) supported by AHA! adaptive system into existing LMS. This is one of the main goals of the EU FP7 STREP project GRAPPLE.

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Appendix [1]
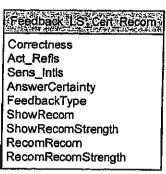
Moodle Database Modification

The Moodle database was modified in order to store (1) additional information in the user profile, (2) personalization/recommendation rules, and, (3) additional systems settings. We introduce the following main changes to the database architecture of Moodle:

1) The field "adaptivefeedbackflag" was added to the quiz properties table (mdl_quiz) to enable/disable feedback personalization in the certain quiz.
2) Additional fields for the multiple-choice questions table (mdl_question_multichoice) were added:
   - question_concept – to store information about the concept studied by the certain question;
   - question_adapttype – to store the information about the feedback adaptation strategy used for EF personalization/recommendation;
   - feedback_theory – to store theory-based EF for the question;
   - feedback_example – to store example-based EF for the question.
   - feedback_url – to store 'pointing' EF for the question.
3) Fields to store the student's learning style characteristics (active/reflective, sensing/intuitive, visual/verbal, global/sequential) were added to the user profile's table (mdl_user).
4) Fields to store feedback-related events and more data about the test were added to Moodle question states table (mdl_question_states table):
   - answ_cert – to store student's certainty in the response for each response,
   - answ_check – to store information about requests of KR feedback,
   - answ_check_time – to store the time of KR feedback request,
   - time_start – to record the time when the student receives a new question,
   - time_feedback1_start – to record the time when the student start reviewing first type of EF;
   - time_feedback2_start – to record the time when the student start reviewing second type of EF;
   - feedback_pref – to store information about immediate and/or delayed feedback requests;
   - feedback_pref_type – to record types of EF visited by the student.
5) A new table to store user's ratings of the feedback usefulness and student's comments about the questions and explanations was created. (mdl_feedback_rating) (Fig 1a.)
6) New tables to store feedback recommendation/personalization rules were introduced (mdl_feedb_recom, mdl_feedback1):
   a. feedback recommendation/personalization rules based on certainty in the concept, response certainty and response correctness (Fig 1b.)
   b. feedback recommendation/personalization rules based on active/reflective and sensitive/intuitive LS, response Certainty and response Correctness (Fig 1c.).

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[1] In case you plan to introduce the similar changes to your Moodle server, please request more details from the first author of this paper. A script on automatic update of the Moodle server can be also made available on request.

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Figure 1. New tables introduced to Moodle Database

Moodle Quiz Module Modification

We used the "adaptive testing" mode supported by Moodle Quiz Module as the base for introducing feedback personalization/recommendation possibilities. In this mode the students are allowed to check their answer and to give multiple responses to a question even within the same attempt at the quiz. In adaptive mode an additional *Submit* button is shown for each question. If the student presses this button then the response to that particular question is submitted to be scored and the mark achieved is displayed to the student together with the feedback.

The following changes were introduced to Moodle's Quiz Module:
1) The possibilities to answer to the question several times were disabled;
2) *Submit* button was replaced with *Check Answer* or *Get Explanations* button;
3) Navigation between the questions was removed so that the students should answer to the questions one after another and finish the test after answering to the last question of the quiz;
4) Possibilities of authoring of the concept related to the question, time recommended to use for answering the question, different types of elaborated feedback were added to the question editing tools;
5) Besides the timer counting the time left before closing the test, we also presented to the student the time recommended for answering the current question and the time that was recommended to answer for the following still unanswered questions of the test. The additional functionality to show/hide each of those timing information elements was introduced;
6) The possibility to separate KR from KCR + EF was provided for some of our experiments: after pressing *Check Answer* button the student first received KR feedback like "Your answer is correct!" and after that the student could get KCR+EF, choosing between the types of EF;
7) KCR feedback remained as it was in Moodle – the correct responses were highlighted. KCR and KR feedback information was hidden for some of the experiments so that the student did not receive knowledge of result information after pressing "Get explanations" button and correct answers were not highlighted when the question and the variants of the answer together with EF were presented.
8) The choice of the types of EF available in the system was added. Corresponding possibilities were added into the quiz module's authoring tool. The teacher could provide different types of EF for each question: theory-based, example-based, general feedback, and, 'pointing' feedback with a link to corresponding learning materials. During the test the student could get the buttons listed available types of EF;
9) EF selected by the student was presented below the question and its answer variants. If another type of EF was available the student could request it by pressing the corresponding button (placed after the received type of EF);
10) The recommendation of the available types of EF was added. The images with the stars (highlighted or not) were used – placed next to the buttons directing to the certain types of EF;
11) The personalization strategy based on the feedback recommendation/personalization rules stored in the database was implemented. The system analyzed user's LS stored in the database, collected response certainty and correctness and depending on the corresponding adaptation rule either recommended (with certain strength – number of highlighted stars) or presented directly the certain type of EF.

All listed above changes were introduced into the appropriate php scripts responsible for the multiple-choice test functionality (/moodle/question/type/multiple-choice/) and for the quiz module functionality in general (/moodle/mod/quiz/).