

Using Computers to Support Formative Assessment of Assignments

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Abstract: It is generally acknowledged that using formative assessment properly can significantly improve student learning. Computers can be used in a number of ways to assist formative assessment. Unfortunately, currently available Computer Assisted Assessment applications and e-learning technologies do not support formative assessment of open-ended assignments tasks very well. This paper presents the results of a requirements analysis for transferring paper-based assessment skills into an e-learning environment to support formative assessment of electronically submitted assignments. A software system which satisfies the most important of these requirements is introduced.

1 Introduction

Despite the positive impact of formative assessment on student learning, two major obstacles prevent the wide-spread use of formative assessment. Firstly, teachers need to develop the ability to apply formative assessment properly over a period of time as claimed by Black and Wiliam (1998). Secondly, the pressures on education, especially the increasing workload of teachers, obstruct the use of formative assessment (Yorke, 2003).

Current e-learning technologies provide opportunities for transferring the assessment theories into practice. Contemporary computer technology, with its powerful abilities of data processing, storage, and transfer, can be used to assist assessment in various areas (Freeman and Lewis, 1998). However, most of the available Computer Assisted Assessment applications only deal with objective test questions whose correct answers are predetermined (such as multiple-choice or fill-in-the-blank questions) and are only capable of providing students with some predefined feedback (Bull and McKenna, 2004).

Based on the review of the formative assessment literature and the current situation of using computers to assist assessment, we set out to develop a new way to combine well-established paper-based assessment skills with current computer technologies to support formative assessment of assignments. We concentrated our efforts on usability, effectiveness, efficiency, and security. This paper presents the results of our research work. It begins with the requirements we proposed for using computers to support formative assessment. This is followed by the introduction of a software system (the MarkTool system) we developed based on these requirements. This paper concludes with a review and a discussion of future work. In this paper, the term “assignment” refers to all types of student work that can be submitted electronically and are in printable formats, i.e. these assignments only consist of printable symbols (letters, digits, graphics, and images). Therefore, assignments containing hypertext and audio/video components are beyond the scope of our system.

2 Requirements for Using Computers to Support Formative Assessment of Assignments

As required by formative assessment theories and the “conversational framework” theory which was developed by Laurillard (1993) and claims that the dialogue between teachers and students is central to learning, assessment of assignments needs to include a sequence of activities; as are illustrated in Figure 1.

We propose that the goal of using computers to assist formative assessment of assignments can be reached only when all the activities included in Figure 1 are supported in an effective, reliable, and secure way. The remaining content of this section presents in detail the requirements for supporting these activities.

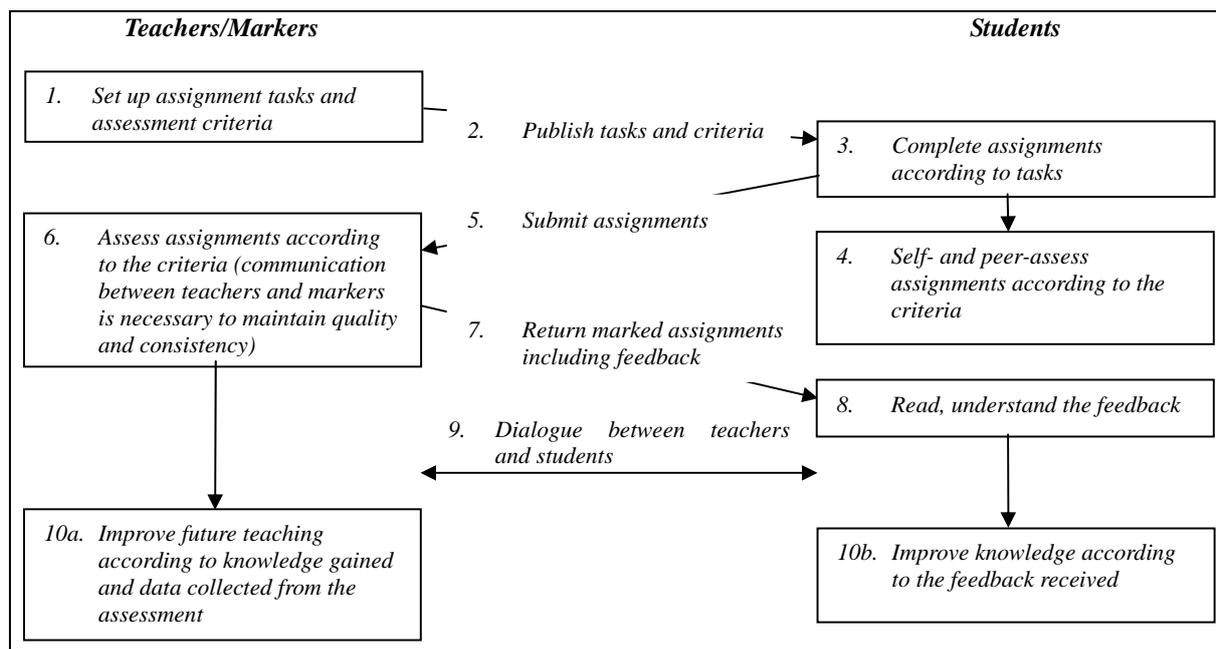


Figure 1: Assignment assessment life cycle

2.1 Setting up and Publishing Assignment Tasks and Assessment Criteria

The tool which enables teachers to create a document consisting of the descriptions about the task and a set of assessment criteria (each criterion is associated with a different aspect of the assignment) for a specific assignment has to be provided. As assessment theories suggest that feedback needs to be associated with assessment criteria, the created document has to be saved in a special format so that each individual comment on the assignment can be linked with its corresponding criterion by using the marking tool discussed later. The mechanism for publishing this document via a computer network needs to be created so that the other markers and students can receive it in a timely manner.

2.2 Submitting Assignments

Students need to be provided with the means of submitting assignments via a computer network. Furthermore, students should be allowed to use any printable document type to submit their assignments. This requirement is based on the facts that 1) assignments of different disciplines may require different document types and 2) different students may write the assignments for the same topic in different document types due to the availability of software and students' preferences.

The submission process and the submitted assignments need to be managed in a reliable and secure way. This requires the provision of functionalities to set the deadline for the submission, to record students' submission status, to ensure that the assignments are submitted to the correct teachers, to associate each individual assignment with the corresponding assessment criteria against which it is assessed, and to allocate assignments to different markers.

2.3 Assessing Assignments by Teachers/Markers

Since current computer technologies are not sophisticated enough to understand the complex contents of assignments from various disciplines and students' thinking patterns reflected in their assignments, it is not possible to automate the generation of detailed and relevant feedback respecting each individual student's particular approach in the assignments. Therefore, into the foreseeable future human markers are still needed to understand students' work and construct feedback conducive to learning (Heinrich and Lawn, 2004). This requires the development of an onscreen marking tool which presents electronically submitted assignments to human markers. With the help of this marking tool, the markers read and assess assignments by the means of adding some comments and numeric marks

to the displayed document.

To assist human markers to assess assignments efficiently, we propose that an onscreen marking tool should possess the following features:

- To provide a solution for supporting formative assessment of assignments from a wide spectrum of disciplines and the freedom of students to use their preferred applications to complete the assignments, the marking tool should be able to handle all printable document types. It is impracticable to develop a tool which is capable of presenting all these document types directly. This requires that the marking tool converts all the assignments to a specific document type and this conversion must preserve the contents and presentation effects (page setup, layout, font size, etc.) of the original assignment documents.
- The proposed marking tool should enable human markers to use their paper-based assignment assessment skills to assess the assignments onscreen. Markers should not need extra training and students should be presented with results in a familiar format. This leads to the requirement for the marking tool that users should be able to create annotations on the displayed assignment document, and each of these annotations consists of two kind of components – a graphic component which users can draw on any part of the assignment; one or more textual comments which are linked with the graphic component and are input by the users via the keyboard. That an annotation may have more than one textual comment is important to support self- and peer-assessment and will be discussed later.
- Each textual comment needs to be linked with the relevant assessment criterion predefined by teachers, as demanded by formative assessment theories (Freeman and Lewis, 1998).
- Markers should be able to place some numbers on the displayed document as the marks of the assignment. This requirement is based on the fact that the assessment of assignments is often both formative and summative – on the one hand, teachers can provide students with formative feedback in the format of textual comments on their assignments; on the other hand, teachers need to allocate numeric marks to the assignments since these marks contribute to the students' final grades.
- To assist students to grasp feedback quickly, the proposed marking tool should be able to generate a summary sheet for each assessed assignment, as suggested by assessment theories (Brown and Knight, 1994). This summary sheet needs to group all the annotations under different entries of the assessment criteria against which the assignment was assessed.
- Black and Wiliam (1998) argue that summative assessment may negatively affect performance. To avoid this negative impact on learning, we propose that the numeric marks should be separated from the textual annotations. For example, these marks can be restricted to appear only in the summary sheets.
- The proposed marking tool should save the feedback (including annotations and the associated criteria, numeric marks, and summary sheets) separately from original assignment documents. This enables a full control on the feedback and is important for the quality and consistency control of feedback, analysis of assessment results, and support for self- and peer-assessment (Heinrich and Lawn, 2004).

As demanded by assessment theories, quality and consistency of feedback must be maintained (Brown and Knight, 1994; Freeman and Lewis, 1998). To achieve this goal, several ways are suggested by researchers, for example, training markers using samples, discussions with other markers, or double marking by teachers. These methods require a document exchange and communication channel among teachers and markers to distribute the assessment samples to markers, to carry out discussions among teachers and markers, and to enable teachers to collect assessment results from markers.

2.4 Returning Marked Assignments to Students

A mechanism for sending back the marked assignment including feedback to students electronically via a computer network needs to be created. This mechanism must ensure that teachers can return marked assignments to students in a managed, secure, and efficient way. The process of returning marked assignments needs to be controlled by teachers. For example, teachers should be able to determine which marked assignments can be returned and at which point-of-time these assignments are returned. It is important that the marked assignments are returned to student securely. Each individual assignment with the feedback must be returned to the student who submitted it.

2.5 Reading Feedback

Assessment theories reveal that formative assessment can be effective only when students read, understand and act

on the feedback (Black and Wiliam, 1998). Researchers also argue that the dialogue about the feedback between teachers and students is necessary not only to help students understand the feedback on their assignments but also to remind students to take actions to improve learning. This means a tool is required to present marked assignments including feedback to students and this tool should be able to facilitate the communication between teachers and students. The onscreen marking tool proposed in Section 2.3 is a possible solution for this tool, provided the required communication functionalities are added. One example of the communication functionalities could be that a student is able to send a question message to the teacher in respect to a specific comment on his/her assignment.

2.6 Self-assessment and Peer-assessment

During self-assessment or peer-assessment, students not teachers or markers need to provide formative feedback on their own or their colleagues' work. From this point of view, self-/peer-assessment are nothing other than two special formats of formative assessment and all the formative assessment principles (explicit assessment criteria, association between feedback and criteria, etc.) also apply to self-/peer-assessment (Freeman and Lewis, 1998). This means the same onscreen marking tool as proposed in Section 2.3 can be used by students to carry out self-/peer-assessment. It is important that the proposed marking tool should be facilitated by a document and message exchange mechanism so that teachers can distribute assessment samples to students and the dialogue between teachers and students can be conducted, since it is argued by researchers that self-assessment and peer-assessment are skills that need to be learned by students with a certain amount of training and a great deal of practice accompanied by feedback from their teachers (Brown and Knight, 1994). As we suggested in Section 2.3, the proposed marking tool should allow an annotation to have more than one textual component. This feature enables teachers to provide feedback on the feedback created by students during self-/peer-assessment.

2.7 Analysing Assessment Results

Formative assessment is beneficial not only to learning but also to teaching. The analysis of assessment results can help teachers review the effectiveness of their teaching and make adjustment accordingly (Freeman and Lewis, 1998). To support this kind of data analysis, a tool is required to extract feedback from marked assignments and perform some statistic work on the extracted feedback.

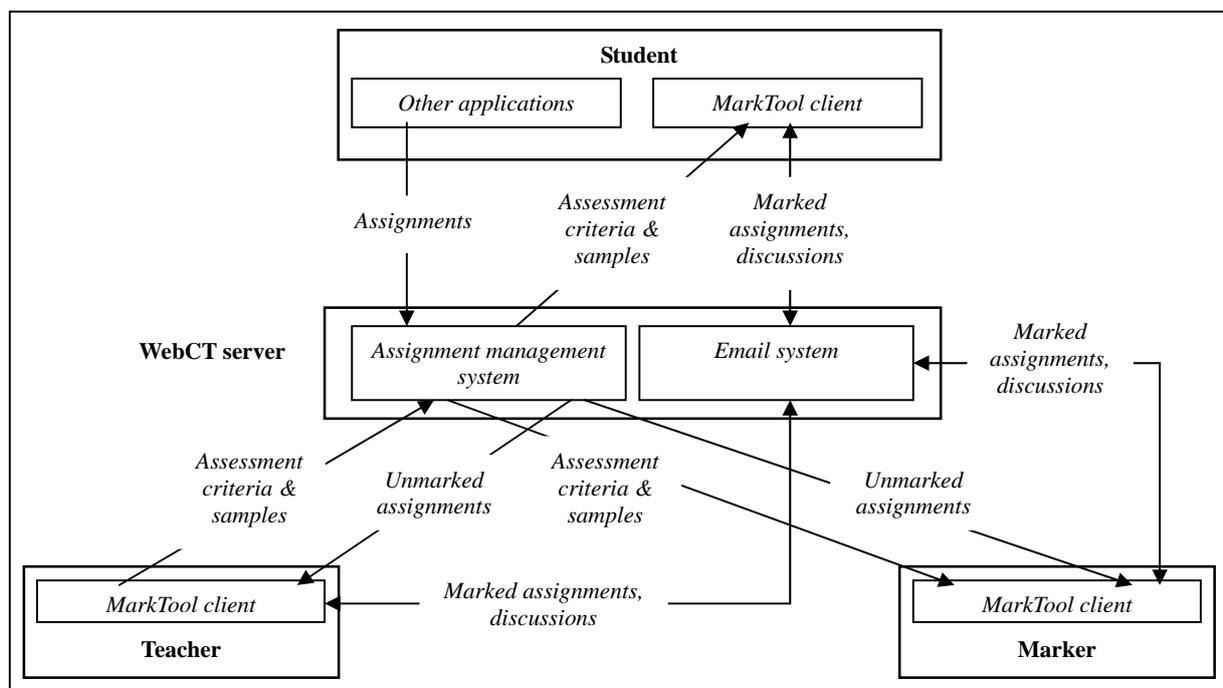


Figure 2: The MarkTool system

3 The MarkTool System

This section introduces the MarkTool system we developed based on the requirements analysis for using computers to support formative assessment of assignments.

As discussed earlier in Section 2, any system aiming to support formative assessment of assignments needs to provide 1) functionalities around assessing assignments; 2) communication channels among teachers, markers, and students; and 3) management functionalities. This requires the MarkTool system to be designed with client/server architecture – the client end sits on the computers of teachers, markers, or students and provides the assignment assessment functions; the server end sits on a central server computer and is in charge of the management and acts as the bridge for the communication between different users. The remainder of this section presents briefly the design strategies of the MarkTool system and introduces the implementation of its client end.

3.1 Design of the MarkTool system

Instead of developing its own server end application, we decided to use the WebCT service installed by Massey University as the server end of the MarkTool system. This is based on the following considerations: 1) The security, reliability, and effectiveness of WebCT are guaranteed by the vendor and maintained by university's technical support staff; 2) WebCT provides various student and assignment management functions which the MarkTool system can take advantage of; and 3) The internal email system and document uploading/downloading mechanisms of WebCT can be used as the communication channel among teachers, markers, and students.

We designed the client end of the MarkTool system to provide the functions for setting up assessment criteria, assessing assignments according to assessment criteria, analysing assessment results, and connecting to the Massey WebCT server to upload/download documents to/from the Massey WebCT server or to send/receive email to/from the internal email system of the Massey WebCT system. The core part of the client end of the MarkTool system is the onscreen marking function and we decided to develop this part based on the MarkTool application developed by Heinrich and Lawn (2004) which is able to present PDF documents and add annotations on the displayed document. This leads to the requirement for the client end of the MarkTool system to be capable of converting any printable document into a PDF file.

Figure 2 shows how we designed the MarkTool system to be used to support formative assessment of assignments. In short, the steps involved in using the MarkTool system are as follows:

1. A teacher sets up the assessment criteria for an assignment and uploads the criteria with the assessment samples to the WebCT server.
2. Students and markers download the assessment criteria and the samples from the WebCT server. If markers and students have questions on the assessment criteria, they can communicate with teachers via WebCT's internal email system in respect to the questioned criterion.
3. Students complete the assignments using their preferred applications and upload the assignments to the WebCT server.
4. The teacher downloads the submitted assignments. If other markers are involved, the teacher needs to communicate with these markers via WebCT's internal email system to allocate the assignments to different markers.
5. Teacher and markers assess the assignments according to the assessment criteria. The communication between teachers and markers is necessary in this stage to guarantee quality and consistency of assessment.
6. The teacher collects the marked assignments from other markers and students (should self-/peer-assessment are involved) via WebCT's email system and checks the feedback. In the case of self/peer-assessment, the teacher needs to provide feedback on the comments created by students.
7. The teacher returns the marked assignments to student via WebCT's internal email system.
8. Students read the feedback on their assignments. Students can discuss specific comments with their teachers via WebCT's internal email system to help them understand the feedback.
9. The teacher analyses the assessment results.

As the server end of the MarkTool system is designed to take advantage of the Massey WebCT server, the implementation of the MarkTool is reduced to only the programming of its client end. The next section will introduce what we have completed for the client end of the MarkTool system.

3.2 Implementation of the Client End of the MarkTool system

Currently, we have implemented partially the client end of the MarkTool system by three separate applications – the MarkTool application which is based on the original onscreen marking tool with the same name described by Heinrich and Lawn (2004), the WebCTConnect application, and the Analyzer application.

Users can use the MarkTool application to create a marking scheme (which consists of a set of criteria and each criterion is associated with a different colour) for a specific assignment topic and save this scheme as an XML document. The core feature of the MarkTool application is that users can use it to add annotations on the displayed assignment documents (in PDF format). Each annotation has a graphical component and one or more textual comments which are associated with the corresponding assessment criteria. The annotations are saved separately from the assignment as an XML document.

The WebCTConnect application was developed to demonstrate how to connect to WebCT. By using this application, users can login to WebCT, retrieve student and assignment lists of a specific course, and send emails which are delivered via WebCT's internal email system to students. The marked assignments are returned to students as the attachments of these emails.

The Analyzer application was developed to demonstrate how to help teachers analyse assessment results. It extracts the textual comments from the XML documents and presents these comments to users in the order of assessment criteria or markers who created the comments. In the Analyzer application, each comment is hyperlinked with the context in which it was created, i.e. selecting a comment in the Analyzer application will activate the MarkTool application to present the relevant assignment to the user with the selected comment highlighted.

4 Conclusions and Future Work

In this paper we have discussed the requirements we propose for using computers to support formative assessment of assignments. We have introduced the MarkTool system we have developed. The MarkTool system takes advantage of the WebCT services and satisfies the most important requirements for supporting formative assessment.

The future work mainly falls into three categories. First is the further implementation of the client end of the MarkTool system. A number of functionalities should be added to the current implementation (for example, the automatic downloading of the assignments from the WebCT server using the WebCTConnect application, and further analysis features of the Analyzer application). Second is the further development of the assessment practices, for example to increase the quality of feedback through the pre-release monitoring supported by the Analyzer application. Third is the evaluation of the effectiveness of the MarkTool system by colleagues. So far we have tested the system by using the MarkTool application to mark the assignments of a software engineering course on data modelling and using the WebCTConnect application to return the marked assignments to students.

5 References

- Black, P., Wiliam, D. (1998) Inside the Black Box: Raising Standards through Classroom Assessment. *Phi Delta Kappan*, Oct 1998, Vol. 80, Issue 2, pp139-149.
- Bull, J., McKenna, C. (2004) *Blueprint for Computer-Assisted Assessment*. RoutledgeFalmer, London, UK.
- Brown, S., Knight, P. (1994) *Assessing Learners in Higher Education* in Stephenson, J (Ed) *Teaching and Learning in Higher Education*. Kogan Page Ltd., London, UK.
- Freeman, R., Lewis, R. (1998) *Planning and Implementing ASSESSMENT*. Kogan Page Ltd., London, UK.
- Heinrich, E., Lawn, A. (2004) Onscreen Marking Support for Formative Assessment. *Proceedings of Ed-Media2004 World Conference on Educational Multimedia, Hypermedia & Telecommunications*. L. Cantoni, C. McLoughlin (Eds.), Association for the Advancement of Computing in Education, Norfolk, USA, pp1985 – 1992.
- Laurillard, D. (1993) *Rethinking University Teaching: a framework for the effective use of educational technology*. Routledge, London, UK.
- Yorke, M. (2003). Formative assessment in higher education: Moves towards theory and the enhancement of pedagogic practice. *Higher Education*, Jan 2003, Vol. 45, Issue 4, pp. 477-501.