

The Coach - Supporting students in the area of error reports

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Abstract

AESOP, An Electronic Student Observatory Project, is a collection of computer-based data collection and analysis tools for instruction and research in Computer Science education. AESOP is based on a system for recording, replaying and analysing user actions in LearningWorks, a Smalltalk programming environment for distance education students.

Over the past 2 years the AESOP Recorder has been used to gather information from students studying object-oriented programming to investigate how students learn to program (in Smalltalk) and to develop software tools to help the teaching and learning process.

The existence of this collection of recordings provides a great deal of information about the kinds of errors that students make and how students go about solving problems for themselves. The recordings provide a substantial wealth of data that can be exploited by a suitable software tool. This paper introduces the AESOP Coach - a software tool which utilises this information to provide additional help to students, particularly in the area of error reporting and error diagnostics.

Field trials of the Coach with students are currently underway to evaluate both the usability and usefulness of the tool and this paper discusses the nature of the trials and emergent issues.

Introduction

The Open University

The Open University is a large, distance learning institution. Students study at home from primarily printed materials and may have occasional face to face and telephone access to a tutor, but most communication is by e-mail and computer conferencing via the Internet. Consequently there is limited opportunity for person to person interaction among students and between students and staff.

M206 and the LearningWorks environment

AESOP is associated with the Open University (OU) course M206, Computing: An Object-oriented Approach (The Open University, 1998). M206 is a combination of print, computer-based text and practical work. The practical work for the course is performed in Smalltalk using the LearningWorks (Woodman et al. 1999, Goldberg et al. 1997) environment.

The LearningWorks environment contains a number of LearningBooks, each one of which provides the student with access to one or more microworlds (Smalltalk applications) on which the practical activities are based.

Each LearningBook specifies a sequence of practical activities that the student is expected to carry out to learn about object-oriented programming and the Smalltalk programming language. Having completed a practical activity the student can access a discussion of what the activity aimed to illustrate. Further details are contained in (MacGregor et al., 1999).

AESOP Software

AESOP consists of four major software components:

- *The AESOP Recorder*

This records a student's use of a LearningBook. A recording consists of the sequence of actions that a student performed when attempting the various tasks specified in the practical activities of a LearningBook. Included in a recorded sequence of actions (known as significant events) is information about the errors, if any, that the student made (as indicated by the LearningWorks system). Thus, a recording contains information about the actions that the student took prior to an error, the error report that the system provided, and information about the actions the student took following the error report.

- *The AESOP Replayer*

This is a separate, but related component of the AESOP project. The Replayer recreates, on screen, from recordings, the complete set of actions performed by the student when interacting with a LearningBook. The Replayer can be used by tutors to view a student's work with a view to recommending remedial action should the student get into difficulties with the practical activities (Thomas et al., 1998).

- *The AESOP Analyser*

This is a search engine for examining recordings. It enables the investigator to search for patterns of behaviour across sets of recordings. A wide variety of possible analyses have been identified, and several implemented (Thomas & Paine 2000a, Thomas & Paine 2000b).

- *The AESOP Coach*

This is a software component, implemented as a LearningBook, which runs concurrently with the Recorder and the LearningBooks. The Coach will be discussed further in this paper.

The AESOP Coach

Introduction and Aims

The fact that students on the M206 course study at home alone means that they do not have immediate access to their peers or tutors. In this situation feedback on problems can be slow and the information provided by the student about the problem is often lacking or incorrect. It can be very difficult to respond to requests for help when there is inadequate information about the problem. Also, the turn-round time to providing an answer to a problem faced by a remote student is likely to be such that the student will have forgotten what the problem was by the time a response is received.

Therefore, a system that provides a quicker and more accurate response to problems is required. Recording the actions that a student performs addresses the accuracy issue and it is possible for a tutor to replay the recording and hence provide appropriate feedback. However, there is still the problem of extensive turn-round time. The aim of the Coach therefore is to automate the diagnostic function and provide instant focused help.

The existence of recordings provides a wealth of data about the kinds of errors that students make and how students go about solving problems for themselves that can be exploited by a suitable software tool such as the Coach. Many student recordings have been analysed and we have direct evidence of the difficulties that some students have faced when trying to resolve an error. Error reports provided by the LearningWorks system have been seen to be entirely misleading and can set the student off on a course that diverges markedly from a path that would lead to a successful solution of the underlying problem.

Our intention is not to solve student problems, but to provide additional support that will steer the student in the right direction and enable the student to solve the problem. The Coach is to be viewed as a support mechanism, not an automatic problem solver.

To complete the system, we want to be able to offer the student focused reinforcement of concepts. It may be the case that the Coach can help the student solve a problem but the student may feel unsure about the process and would like further information about the concepts being used. Therefore, the Coach has been integrated with the primary teaching materials on the course in order that the student can (re-)visit the relevant teaching.

The Coach interface

The integration of the Coach into the LearningWorks system

The Coach is a software component, implemented as a LearningBook, which runs concurrently with the Recorder and the LearningBooks. The Coach can be accessed in one of two ways when a LearningBook is open:

- *From a dialog box*

Any error that results in an error dialog box contains the additional option of clicking 'Coach'. See Figure 1. Students can choose to invoke the Coach or continue with the LearningBook.

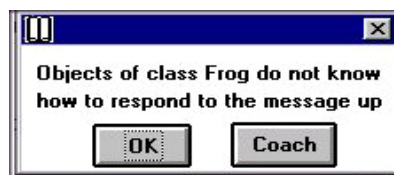


Figure 1 - A typical error report from the

- *From a LearningBook*

All LearningBook pages contain the additional option of clicking 'Coach'. Figure 2 shows a typical page from a LearningBook in which a variety of buttons appear down the right hand side of the window. A new button labelled Coach has been added which, when pressed, invokes the Coach. This method of invoking the Coach is useful when error indicators are embedded in the program code.

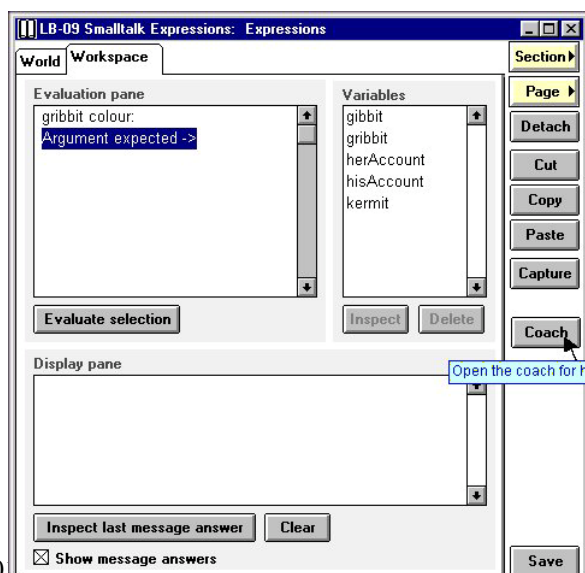


Figure 2 - The Coach interface with the LearningBooks

The Coach can be invoked by a student at any time, but it is intended primarily for use whenever an error report occurs. When the Coach is launched, it becomes the active window on the screen.

Description of the Coach interface

Figure 3 shows the Coach interface. Our aim was to design an interface that is consistent with the interface already used by the students in the M206 LearningBooks. This was for reasons of Learnability (and Predictability), to allow students to understand how to use the interface initially and to attain a maximum level of performance (Dix et al., 1998). We also felt that if a student felt the Coach was too obscure they would not use it.

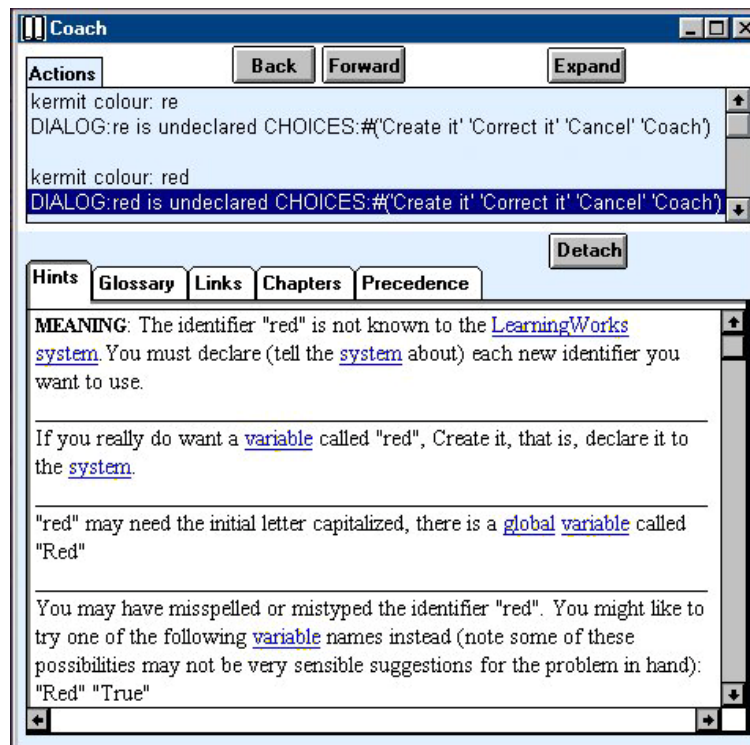


Figure 3 - The Coach

As can be seen from Figure 3 the Coach window has an upper section and a lower section. The main areas of the Coach are described below.

The upper section of the Coach contains a scrollable pane labelled 'Actions'. Actions include something a student has carried out in a LearningBook (for example, an evaluation, a method creation / alteration) and any error report generated by the LearningWorks system. Actions are taken from the recording and appear in chronological order.

The aim is to provide students with a record of what actions they have recently performed in an easily accessible form. In particular, to make the error report visible (errors in the LearningWorks system are often reported via a modal dialog box which disappears when the user selects another action, and the student has no record of the content of the error report). The actions pane also allows the student to review their actions that led up to the error.

The lower pane of the Coach window contains a five separate pages, accessed by clicking on its corresponding tab: 'Hints', 'Links', 'Chapters', 'Glossary' and 'Precedence'. The Coach allows a student to see more than one of these pages at a time by using the Detach button to detach the page currently selected from the lower section. The detached page is displayed in a separate window.

- *Hints page*

The Hints page is selected by default and can be seen in the lower section of the Coach in Figure 3. This page consists of one scrollable pane that contains a list of ‘possible solutions’. The first item in the list of hints labelled **MEANING** is an explanation of the error report and should be enough to explain the nature of the error. The remaining hints are possible solutions to the problem that caused the error. The hints are in a hypertext form, and when clicked on will open a new window with a definition from the M206 Glossary (see Glossary page below) for that term.

In the current version of the Coach the hints have been developed from AESOP Recordings from previous presentations of the course. The hints were constructed by interpreting the results of an automatic analysis of the errors in a substantial collection of recordings. The intention is to supplement the current set of hints with further data collected automatically (i.e. without human intervention).

- *Links page*

The Links page is shown in Figure 4. The scrollable pane labelled ‘References’ includes hyperlinks to contextually relevant sections in LearningBooks, the M206 Glossary (see Glossary page below) and in the printed text (see Chapters page below).

At the bottom of the page is an email link to the AESOP team to enable students to provide the AESOP team with feedback on the Coach as they interact with it.

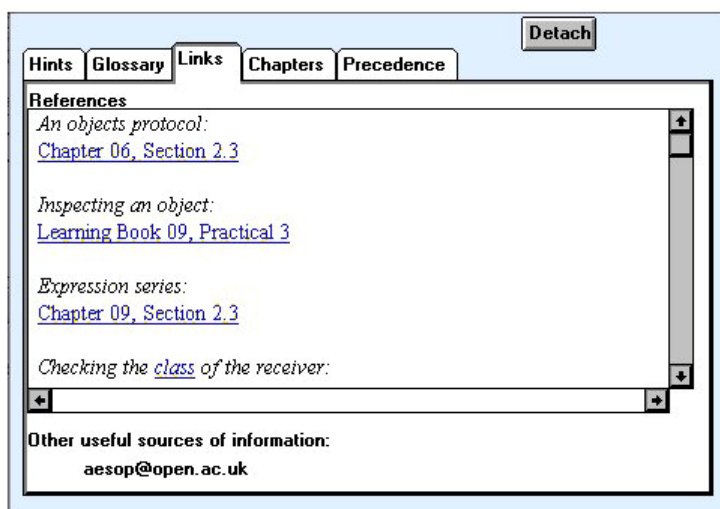


Figure 4 - The Links Page

- *Chapters page*

The Chapters page allows students to navigate to html versions of the M206 course materials (a collection of ‘chapters’).

- *Glossary page*

This page contains the M206 Glossary students are provided with on the M206 course.

- *Precedence page*

The M206 Course Team developed a tool to illustrate how the LearningWorks system applies its set of precedence rules to specific expressions. The Coach includes this tool for messages whose order of evaluation students wish to see.

The current project

A prototype of the Coach with the above-mentioned pages has been delivered to a group of student volunteers in order to investigate issues of usability and usefulness. At this stage, we are interested in how students react to the existence of the Coach. Four tutor groups are participating in the project, which provides us with access to around 80 students. All volunteer students have been provided with two additional LearningBooks, each containing a small number of exercises related to the work of earlier LearningBooks. The exercises ask the student to evaluate a simple expression, which will result in an error, and to attempt to rectify the error.

Our aim is to compare the actions of students who use the Coach with those who do not. Therefore, each tutor group of students was 'split' into two sub-groups. One group was given the additional LearningBooks and the AESOP Recorder and Coach software. The other group was given the additional LearningBooks and the AESOP Recorder software (without the Coach software).

Students were assigned to sub-groups on the basis of a pre questionnaire aimed at controlling variables related to gender and age. We chose to divide each tutor group in order that the two groups received equivalent support from the same tutor.

Remote Evaluation

A low cost remote evaluation¹ method was used to test the usefulness and usability of the Coach.

As well as the students interaction with the LearningBooks being recorded their interaction with the Coach is also recorded. The recordings provide us with an objective remote evaluation.

We also wanted to collect users' subjective experiences as they used the Coach.

Developer-user-contextual-inquiry (DUCE) sessions involve users interacting with an interface in real life scenarios whilst verbalising their experience.

A 'write-along DUCE' approach (Dunckley et al., 2000) collected subjective accounts of student interactions with the Coach. As part of a remote evaluation package students were given a detailed evaluation form. The evaluation form consisted of questions modified from those prepared by Dunckley, Taylor, Storey & Smith (2000) for scenario based design, which were structured under Norman's seven stages of action model (Norman, 1988).

The students were given four tasks to carry out in the LearningBook (these tasks related to the first four exercises in one of the additional LearningBooks). With each task a number of questions were provided which student were asked to answer while carrying out the task. Students were given the evaluation form as a word document to complete online. An example task and selection of questions are shown below:

Task 1

After evaluating the expression `kermit colour: red` in *Exercise 1 in LearningBook Test-09*

Examine the Expressions window:

How did the screen help you know that the Coach was available?

Examine the Coach window:

What appears to be the most useful information visible in the Coach window when it is launched?

Having completed the two additional LearningBooks, the students were asked to fill in a very short questionnaire and send the recordings of their work to us via email. Students in both subgroups completed a questionnaire about the usefulness of the additional LearningBooks. Students with the

¹ A usability evaluation where evaluators are separated in space and time from their users.

Coach software completed an additional number of questions about the usefulness and usability of the Coach.

Summary and work in progress

We have designed and developed a Coach - a software tool to provide additional help to students in the area of error reporting. We have developed a suitable trial to investigate both the user interface and the functionality of the Coach. Some preliminary tests of the Coach with colleagues have been carried out and we are now at the stage of field trials with students. A number of students studying M206 have a version of the Coach and the collection of data from recordings and questionnaires is currently underway. The analysis of the collected data will begin shortly. The results of the trial will be available in the spring 2001.

Future Work

It is envisaged the Coach system will become 'customised' to individual students with their use of the tool. In other words, the Coach will be able to provide information to a student that is tailored to a specific error and the context in which the error was made.

Future additions to the Coach will include the idea of a training page. This page would provide a student with access to additional practical activities. The aim being for a student to carry out practical work in order to develop their understanding of a specific concept that they may have trouble with.

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