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The Coach: Overview

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Introduction

The Coach is a software teaching tool whose main aim is to provide additional help to students on the Open University's introductory computing course M206, Computing: An Object-Oriented Approach. Students studying this course follow a series of practical programming activities in Smalltalk using the LearningWorks system [1]. The Coach provides additional help to students as they work through the practical activities particularly in the area of error reporting and error diagnostics.

LearningBooks

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 about what the activity aimed to illustrate. Further details are contained in [2].

The AESOP Recorder

The AESOP project [3], which is looking at how students learn to program, has produced a software component, the Recorder, which 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 message that the system provided, and information about the actions the student took following the error report.

The Coach aims to use the recorded information to provide improved error reports, information about the context in which the error was generated (synthesised from the recording) and links to appropriate additional information.

The AESOP Replayer

A separate, but related component of the AESOP project is a Replayer which 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. [3].

The learning context

Students of the Open University course M206, mainly study at home alone. The practical work within a LearningBook is designed to provide a structure within which a student can practice specific programming tasks to gain a thorough understanding of the concepts involved. However, should the student fail to understand the concepts, this will manifest itself in errors that the student fails to correct. We have analysed many student recordings and have direct evidence of the difficulties that some students have faced when trying to resolve an error. In some cases, it is quite clear that error messages can 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. This is not only frustrating for the student, but also fails to improve the student's learning.

Being on their own means that students do not have immediate access to their peers or teachers although they are encouraged to form self-help groups and contact their tutor by phone or email. This means that feedback on problems can be very 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. Even in 'conventional' laboratory-based teaching, the same problem arises: the novice is unlikely to recall accurately the steps that led up to a problem making it difficult for a teacher to respond adequately. At a distance, the difficulty is exacerbated by the likely lack of accurate documentary evidence. 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.

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 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 such as the Coach. The enrolment on M206 exceeds four thousand students annually, so the potential for gathering and analysing information about student behaviour is enormous and this is what the AESOP project seeks to do. The Coach system is part of an attempt to exploit the existence of a large corpus of information. By collecting information from more students, we aim to improve our knowledge of student behaviour and hence become better able to help new students. However, our intention is not to solve 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 that the student feels 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 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 containing practical activities. It runs in the background and can be accessed either from a diagnostic window or from a LearningBook. Figure 1 shows the interface to the LearningWorks environment that lists the currently available LearningBooks. In this figure, LB-45/46 contains practical activities, LB-50 is the Coach and OB-01 is a Replayer for the recordings.

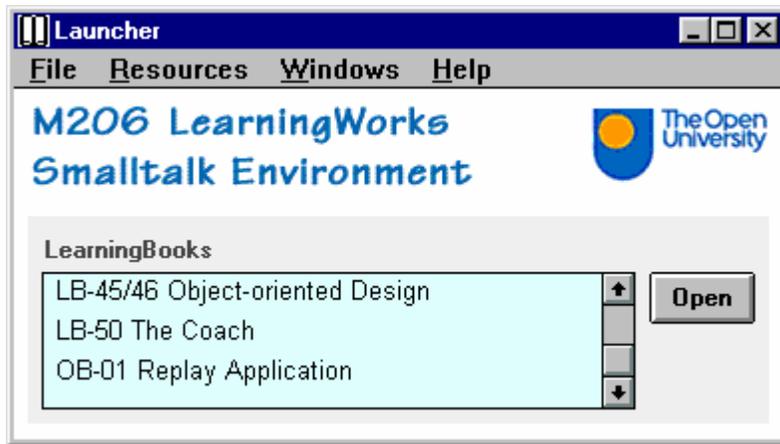


Figure 1 *The Coach implemented as a LearningBook*

Aims

The aim of the Coach is to utilise the information gathered by the AESOP Recorder to provide additional information to the student to resolve an error. In particular, the Coach system aims to gather information from all student recordings to produce a comprehensive database that can inform its responses to an individual student. In this way, the Coach will provide information to the student that is tailored to the specific error and the context in which the error was made.

It is not the intention to provide solutions to problems. Rather, it is to give pertinent information that students can use to resolve difficulties for themselves. The Coach is designed to be an aid to learning, not an automatic problem solver. Therefore, the Coach will have access to the following additional materials:

- a glossary of terms, to be used for discovering the meaning of unfamiliar terms (it can be the case that the technical terms used in error reports are unfamiliar to the students);
- the course teaching materials, to provide access to materials that are relevant to the problem in question.

(Both the glossary and the teaching materials have been captured electronically and can be integrated into the Coach.)

Finally, the Coach will offer a 'training' facility. Should the student request it, the Coach will provide a mechanism for learning about the programming constructs associated with the error.

System Overview

Figure 2 shows a component overview of the Coach system.

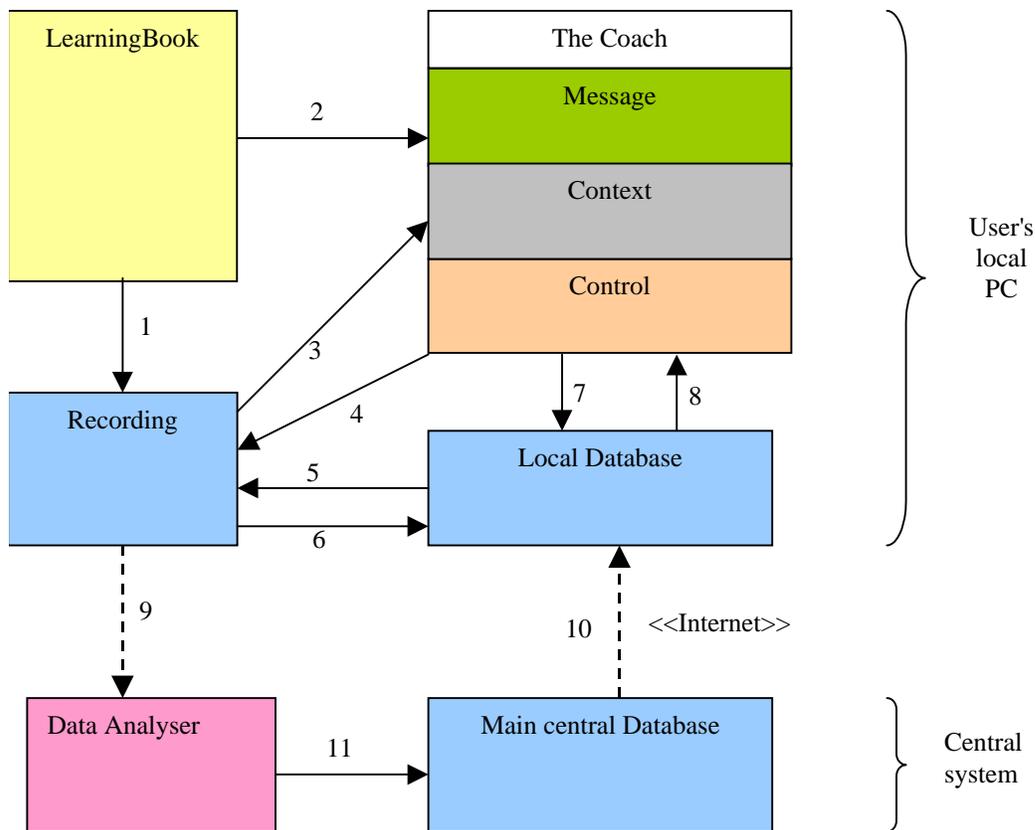


Figure 2 Coach components

The Coach is designed primarily for use by Open University students who will use it on their own PCs at home. Thus the Coach System is a distributed system with a copy of the Coach on each user's machine, and a central facility for processing data received from users (9). The main central database is used to update the user's local database (10).

Figure 2 shows a LearningBook being recorded (1) and invoking the Coach (2). The Coach uses data contained in the recording (3) and the local database (8). However, as the Coach is itself a LearningBook, the actions that the user takes when interacting with the Coach are also recorded (4).

The Coach has the ability to analyse the user's actions and hence update the local database (7).

Since the Recording is the means by which information is exchanged between a user's PC and the central system, new data added to the local database is added to the recording (5). Provision has also been made to transfer data from the recorder to the local database (6) as appropriate.

The figure also shows a central data analyser that processes each recording and updates the central database (11).

It is envisaged that prior to the use of the Coach the student would download information from the main central database to update the local database. On completion of the practical work in a LearningBook the student would upload the recording to the central data analyser.

A prototype user interface

Figure 2 also illustrates that the Coach itself consists of three main components: a message, its context and a control section. These areas are illustrated in more detail in Figure 3 where a prototype of the Coach's user interface is shown.

The aim has been to design an interface that is similar to the interface used for the LearningBooks.

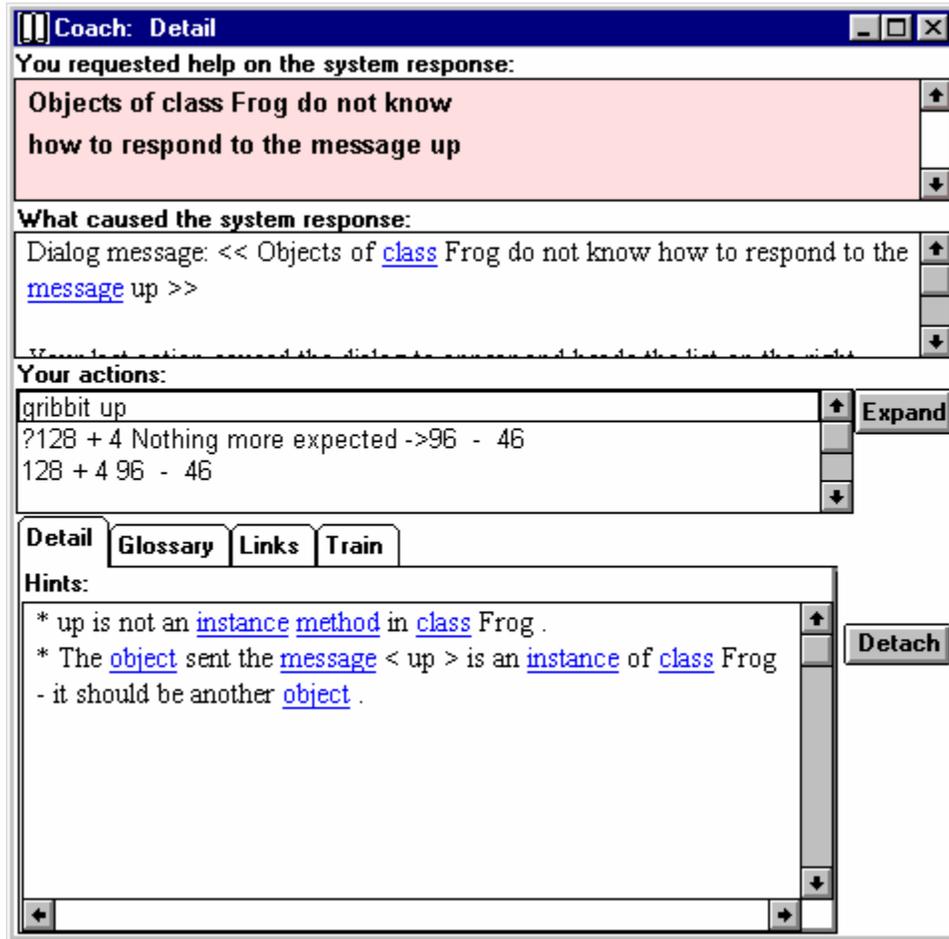


Figure 3 A prototype of the Coach's user interface

In Figure 3, the top scrollable area repeats the error message generated by the LearningWorks system. The second scrollable text area contains a more detailed explanation of the error.

The third scrollable area labelled 'Your actions' provides the context within which the error was made. This is information obtained directly from the recording.

The final section is a collection of tabbed areas:

- *Detail*: contains a list of possible reasons for the error. Each reason contains hyperlinks to the glossary.
- *Glossary*: a searchable glossary of terms used in the LearningBooks.
- *Links*: a set of hyperlinks to other information (such as course texts).
- *Train*: links to other LearningBooks that aim to provide training on the topics that relate to the error.

The Coach has two buttons labelled **Expand** and **Detach**. Clicking on the **Expand** button enlarges the scrollable area labelled 'Your actions:' to show more of the context. The **Detach** button creates a copy of the tabbed information area in a separate window so that it remains

visible on the user's screen whilst the user interacts with the LearningBook containing the practical work. The **Detach** button is a feature of the LearningBooks that students would be familiar with and corresponds to the metaphor of removing a page from a book while continuing to read the remainder of the book.

The Coach's interface with the LearningBooks

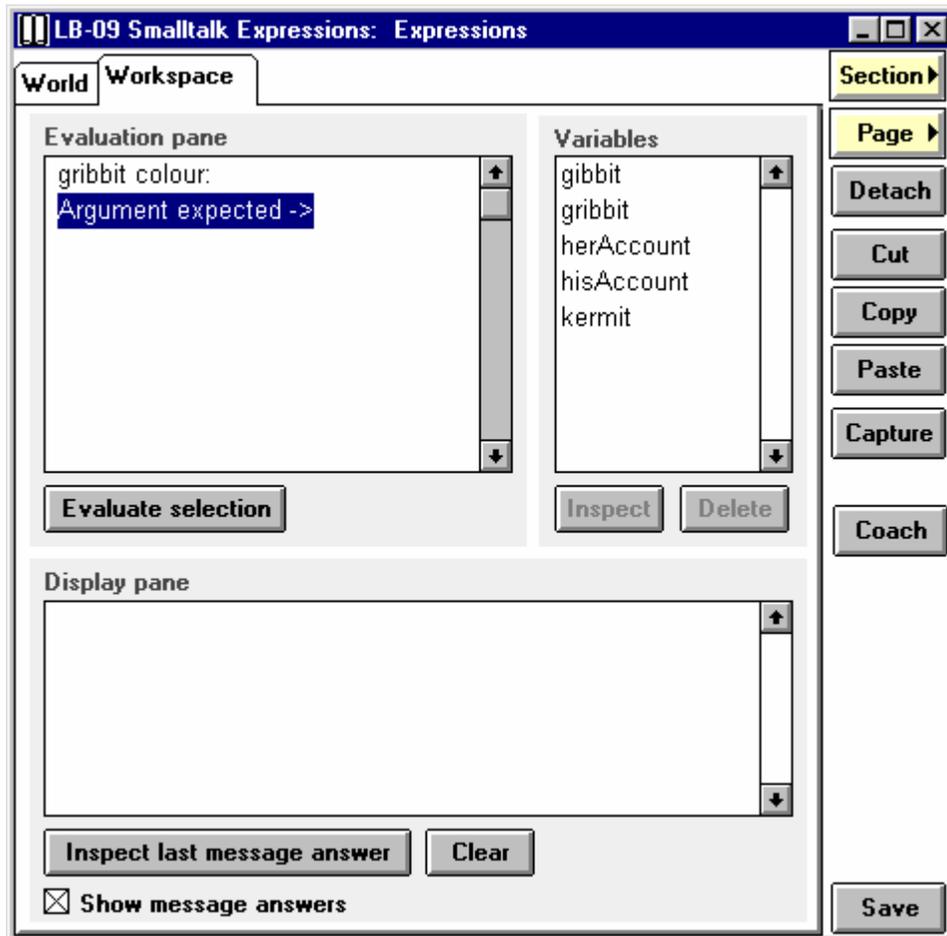


Figure 4 *The Coach interface with the LearningBooks*

Figure 4 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. The user is then able to use any of the facilities of the Coach apart from the fact that, as no error will have occurred, those parts of the Coach related to error reporting will be empty. However, if an error is made, the LearningWorks system will respond with a dialog box similar to the one shown in Figure 5.

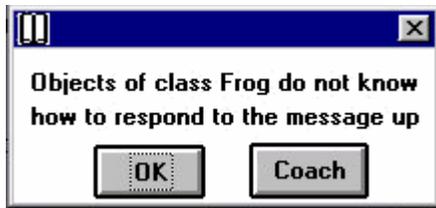


Figure 5 A typical error message from the LearningWorks system.

All such dialog boxes carry an additional button that invokes the Coach. This scheme means that, if the student feels that they require no further help, the Coach need not be invoked and there is no additional burden on the user in avoiding its use. In the example in Figure 5, the user must click on a button and can choose to invoke the Coach or continue with the LearningBook.

Ongoing Work

Current research is focusing on investigating the Coach prototype. An experiment to evaluate both the usability and the usefulness of the Coach is currently being designed. The experiment will be conducted with students on the next presentation of the M206 Computing course.

References

- [1] Goldberg, A., Abell, S., and Leibs, D. (1997) "The LearningWorks Delivery and Development Framework", *Communications of the ACM*, 40(10): 78–81.
- [2] MacGregor, M, Thomas, P.G., Woodman, M., (1999) "Recording and Analysing User Actions in a Smalltalk Programming Environment", *Proceedings of TOOLS '99, Technology of Object-Oriented Languages and Systems*, Santa Barbara, USA, August 1999.
- [3] Thomas, P.G., Martin, M., and Macgregor, M. (1998) "AESOP - An Electronic Student Observatory Project" *Frontiers in Education 98*, Phoenix, USA, November 1998