What People Learn from Exploratory Device Learning

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Abstract

The empirical investigations outlined in this paper are concerned with identifying what people do during exploratory learning and what they learn whilst they conduct it. The results have been used to develop a framework within which to model exploration. Implementation of the framework is proposed in order to test a number of predictions and to help explain and support findings from further empirical studies

Keywords: Human-Computer Interaction, Exploratory Learning, COGENT, ACT-R

Introduction

Exploratory Learning People often learn a novel device or software application by actually trying to use it, drawing on a combination of prior knowledge, information from the interface itself, and problem solving skills. We describe this phenomenon as exploratory learning. Rieman (1996) showed that in a real world situation, people prefer to learn by exploration in the context of a real task they need to perform, rather than taking time out to experiment with it or work through the documentation in a task-independent manner. Exploratory learning also occurs in situations when training or documentation is not available and in the case of walk-up-and-use devices

Device and Task Oriented Knowledge Before describing the work investigating exploratory learning, it is necessary to clarify the distinction between device-oriented and task-oriented knowledge. Device-oriented knowledge usually consists of a collection of facts about what the device as a whole (or parts of it) do. When a user is trying to learn about a new device, one of his goals, for example, will be to find out what each button does. Task-oriented knowledge, on the other hand, is knowledge about how to complete a task using a particular device. When learning about a novel device, a user may need to acquire both device knowledge and task knowledge, e.g., 'what does the button labelled on do?' and also 'how do I set this video-recorder to record my favourite programme while I'm out?'

Trudel & Payne 1995 Trudel & Payne (1995) carried out a series of investigations into reflection and goal management in exploratory learning. In their initial study, they compared the performance of three groups of participants on tests of declarative and procedural knowledge. They presented their participants with a simulation of a digital watch and asked them to explore it with a view to being tested afterwards. The participants either had 20 minutes in which to do this, or a limit of 250 keystrokes, or were given a list of 7 tasks to complete

Their manipulations yielded dramatic results. They found that the keystroke-limited group did significantly better than the other two groups on the tests for declarative knowledge and procedural knowledge, despite actually spending less time exploring it. They concluded that the imposition of the keystroke limit had made the keystrokes a precious resource and had forced the participants to reflect more fully on each action.

Thesis Research Summary

Study 1 and Initial modeling in ACT-R Following the work of Trudel & Payne, 1995, it was decided to conduct a partial replication of their first experiment using a different, less-moded device to ensure generalisability. Participants explored a simulated central heating timer in one of two conditions. Those in the unstructured exploration condition had 15 minutes in which to learn how to use the device while those in the mouseclick limited group had 100 mouseclicks or 15 minutes, which ever finished sooner.

The results suggested that the imposition of a mouseclick limit did not automatically improve performance. Two reasons for this non-replication were suggested. Firstly, that the central heating timer is a different kind of device from the digital watch. Unlike the users of the digital watch, in order to complete realistic tasks on the central heating timer, the user needs to know not just what each of the buttons does (device-oriented knowledge) but also how to use the device to perform tasks (task-oriented knowledge). The second reason put forward to explain these results was that participants in this study had prior knowledge of how this class of devices works, so once they had learnt what each of the buttons does they thought there was nothing else to learn. This over confidence resulted in them not setting themselves realistic tasks from which to learn how to use the device.

A simple initial model of exploratory learning of a pared down version of the device was built in ACT-R (Anderson & Lebiere, 1999). The model added support to the argument that in order to use the central heating timer successfully, participants need to acquire knowledge about the relationship between scenario situations and the actions on the device and that this can only be done by completing realistic tasks during training.

A more detailed account of this work can be found in (Cox & Young, 2000).

A Closer Look at Exploration. Concurrent verbal protocols were taken from participants while they carried out unstructured exploration of the central heating timer. These protocols provided evidence for a number of classes of different exploratory acts for example, pressing a button to see what effect it has, generalizing knowledge about the effect of one button to another, conducting an experiment to confirm a currently held belief, etc. Analysis of one of these protocols in particular resulted in predictions being made regarding the beliefs a participant held about how the central heating timer worked. These predictions were confirmed after inviting the participant back to answer a series of further questions.

A New Rational Framework and a Model in COGENT. The different exploratory acts that were identified as a result of the protocol analyses were used as the basis for a rational framework for modelling exploratory learning. Due to problems fitting this framework on to ACT-R's machinery that are outlined by Young & Cox, (2000), it was decided to try to implement the model in COGENT (Cooper & Fox, 1998). A more detailed account of the framework, protocols and model can be found in Cox & Young, (2001).

Although this model of exploratory learning is not expected to provide data that exactly matches any particular participant's record of interactions, it is predicted that it will provide keystroke records similar in nature to those of the human participants.

Furthermore, analysis of the knowledge acquired by the model is expected to show that device-oriented knowledge is easily acquired but that an accurate understanding of domain-oriented knowledge is less common.

In addition, the framework predicts that there will be a difference in the knowledge acquired by those conducting free exploration against those conducting focused exploration and this is expected to be shown by the implemented model. This prediction is supported by evidence found by Trudel and Payne (1995) when they compared the performance of people who explored a digital watch under those 2 conditions.

Study 2. A further study was conducted in order to test the prediction that realistic domain tasks must be completed during training for people to successfully use a device. This compared the post-exploration performance of those completing a period of free exploration against those completing two different kinds of focused exploration. Half of those completing focused exploration were given a list of device-oriented goals to try to achieve, which directed them to focus on identifying what each button did. The other half was given a list that directed them to try to use the device to complete real tasks.

The results showed that there was no difference between the groups regarding their performance on the questionnaire or online test. However, a significant difference was found in the performance of those with prior experience of other central heating timers, against those without. Although both groups performed at similar levels on the questionnaire, the group without prior experience outperformed those with prior experience on the online test. This suggests that the mental model of how this class of devices works that was gained from interactions with other central heating timers only served to confuse participants when they interacted with this particular device.

Study 3. As one of the explanations for not replicating Trudel and Payne's findings with the CH timer was that it was a different class of device than the digital watch they had used, a study was conducted to investigate whether a replication of their result could be found using a more devicey-device. A simulated medical laser was identified as being an example of this class of device and two groups were tested following a period of free exploration with either a mouseclick limit or not.

It is expected that the results will confirm the hypothesis that improved levels of post-exploration performance will be found in the group who conduct their exploration with a limited amount of mouseclicks. This data will support the argument that increasing the cost of the interaction encourages reflection on the part of the user and discourages mindless clicking only when it is sufficient simply to learn what the function of each button on the device is.

Further Modeling. The empirical work above will be used to inform further developments of the model.

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