

Available from: http://www.editlib.org/p/40891

Copyright © 2012 Association for the Advancement of Computing in Education.
This is the author’s version of the work, posted here with the permission of the publisher for your personal use. No further distribution is permitted. You may also be able to access the published version from your library. The definitive version is available at http://www.editlib.org/p/EDMEDIA.
Engaging students in cognitive and metacognitive processes using screencasts

Catherine McLoughlin
Australian Catholic University
Canberra

Birgit Loch
Swinburne University of Technology
Victoria

Abstract
Interest has grown in recent years in what is sometimes referred to as the learner experience, because it situates learners at the centre of the experience, empowers and motivates them to assume responsibility for their own learning, and adopts teaching and learning strategies designed to encourage students to see themselves as active thinkers and problem-solvers. Learner-centred education may be facilitated by technology, for example through the provision of online learning material. Flexible, self-paced delivery of learning resources has the capacity to engage students in both cognitive and metacognitive processing of abstract concepts. Examples will be drawn from a project that uses mathematical screencasts to assist students to learn abstract concepts independently.

Introduction
A screen cast is a video recording of movement on a computer screen, together with audio narration. In mathematics learning, screencasts have been used to capture the handwritten step-by-step solution of a mathematical problem. With such recordings, students are guided by an expert as they would in face to face explanation, but there is an added benefit of flexibility of access and use of these explanations. Students can watch a screencast, just in time, from anywhere where they have access to the Internet, pause it to make an attempt at a solution themselves and replay as often as required. Screencasts may be designed to allow students to personalise their learning, highlight important information, and listen at their own pace (Sutton-Brady, Scott, Taylor, Carabetta and Clark, 2009). Sutton-Brady et al. emphasise the need to focus on pedagogical design when producing short screencasts targeting individual topics to distinguish them from a repeat of lecture content. Heilesen (2010) recognises the opportunities available through this technology, as screencasting “has opened up for new ways of integrating classroom teaching and net-based learning on the basis of pedagogical concerns rather than mere administrative convenience”. In evaluating the merit of screencasts to support learning, the literature on metacognition was investigated.

The project: Mathematics screencasts
Most Australian universities offer mathematics support to their students online or in face-to-face support sessions. To provide explanations to students outside opening hours and without the need to physically attend, tutors at the Mathematics and Statistics Help Centre (MASH) at Swinburne University of Technology produce screencasts for students to access through the MASH website and the learning management system. These recordings are part of MathsCasts, a collaboration between three universities, and can be downloaded via iTunes U and http://www.mathscasts.org. The decision about which topics to record and how to design the screencasts is made from experiences in face-to-face support of students. Students tend to struggle with similar concepts in each semester and tutors are used to repeat explanations several times per semester. The screencasts are meant to capture the tutor’s explanation for more students to see and to be made accessible at any time. The aim of this paper is to explore whether and how students applied cognitive and metacognitive skills when learning through maths screencasts.

The MASH Centre produces screencasts for students to access in flexible mode, both on and off campus. The students typically download screencasts to their mobile phones or other mobile devices and use them to study
complex mathematical concepts. To date, a large number of screencasts has been made available to students. By accessing video based instruction that combines multiple media formats, it is expected that positive learning outcomes will be achieved. Currently, we are attempting to redesign the instructional format of the screencasts, and to avoid reliance upon a didactic model of pedagogy (Loch & McLoughlin, 2011). As instructional designers, we include scaffolds to ensure the active engagement and participation of the learner.

Theoretical background to metacognitive knowledge

Metacognition has received considerable attention in the educational psychology literature (Murphy, 2008). Nelson (1992) cited a 1990 survey in the American Psychologist listing metacognition among the top 100 topics in cognitive and developmental psychology. The attention is not surprising given that the development of metacognitive expertise has been described as crucial for fostering and improving individual as well as group and team learning (White & Frederiksen, 2005) and that the use of metacognitive strategies distinguishes competent from less competent students (Pellegrino, Chudowsky & Glaser, 2001).

Azevedo (2005) argued that the effectiveness of computer-based learning environments, in relation to online learning, actually depends on learners’ regulation of their learning and on the deployment of metacognitive and self-regulatory processes. In the online classroom, self-regulation and metacognitive processes take on a particular importance because learners are physically separated from each other and from their teacher. As Straw (2008) commented, student learning and engagement requires participation and deeper levels of thought and, metacognitive strategies that regulate self-awareness, self-control, and self-monitoring.

Flavell (1987) divided metacognitive knowledge into the three variables of Person, Task and Strategy as follows:

1. **Person**: All that is known or believed about the characteristics of humans as cognitive beings. Subdivided into three types: *Intra-individual*, which refers to “knowledge or belief about one’s interests, propensities, aptitudes; Inter-individual, which involves comparing between persons; and Universal which involves ‘acquired ideas about universal aspects of human cognition or psychology’” (p. 22).
2. **Task**: All information acquired by a person in terms of the task or different types of tasks. Appreciation of the quality of available information. “How the nature of the information encountered affects and constrains how one should deal with it” (p. 22)
3. **Strategy**: Means chosen to succeed in various cognitive tasks.

Jacobs and Paris (1987) refer to the knowledge component of metacognition as *Self-appraisal of cognition*, and explained that it relates to “the static assessment of what an individual knows about a given domain or task” (p. 258). The *Self-appraisal* may be of “one’s abilities or knowledge, or it might involve an evaluation of the task or consideration of strategies to be used” (pp. 258-259). The category of *Self-appraisal of cognition* includes three subcategories of knowledge as follows:

1. **Declarative knowledge** refers to what is known in a propositional manner ie “know-how” (ie self and strategies);
2. **Procedural knowledge** refers to an awareness of processes of thinking (how to use strategies);
3. **Conditional knowledge** refers to an awareness of the conditions that influence learning (why strategies are effective, when they should be applied and when they are appropriate).

Supporting cognitive and metacognitive processing with screencasts

There are five assumptions shared by all pedagogic models that aim to foster metacognition and metacognitive strategies: Through appropriate task design, learners

- are supported in being active in all aspects of the learning process, ie in creating goals, inferring meaning and applying strategies
- are given opportunities to monitor, control and regulate aspects of their own cognition
- set goals for learning and self-monitor their own progress
- are active in problem solving and in applying concepts learnt to novel situations
To support effective learning with the screencasts, the instructional design approach was to prompt reflection, encourage goal setting, and set tasks for students to review their own learning following the screencasts (Table 1).

<table>
<thead>
<tr>
<th>Rationale</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are students able to manage their own learning?</td>
<td>Is there evidence of student self-reflection?</td>
</tr>
<tr>
<td>Do podcasts support learning and metacognition?</td>
<td>Do students demonstrate self-knowledge, strategic knowledge, task knowledge and knowledge of plans and goals?</td>
</tr>
</tbody>
</table>

**Table 1: Rationale, research questions, data collected and methods used**

<table>
<thead>
<tr>
<th>Context</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student responses to questionnaires</td>
<td>Responses to questionnaires</td>
</tr>
<tr>
<td>Interviews</td>
<td>Student feedback</td>
</tr>
<tr>
<td>Responses</td>
<td>Focus groups</td>
</tr>
<tr>
<td>Focus groups</td>
<td>Coding of data to determine categories of metacognitive skills</td>
</tr>
</tbody>
</table>

**Context of the study**

The screencasts were designed as independent, short, focussed explanations of core mathematical concepts for first year students studying towards an undergraduate degree in engineering (Civil Engineering and Mechanical Engineering). Selected topics covered pre-requisites at high school level, but also examples from the current curriculum with which previous cohorts had struggled.

Following the initial development students were interviewed with regard to their metacognitive skills before and after viewing the screencasts. Their responses were coded according to the categories of declarative, procedure and conditional knowledge. Table 2 shows examples of questions asked by the researchers of students who watched the screencasts.

**Analysis of data**

Measuring metacognitive processes is difficult. Many of the instruments developed to measure it suffer from criticisms about their validity. The vast majority of current metacognitive measures are self-reports. These include:

- retrospective verbal reports, in which individuals recall what they were thinking while they were doing a task;
- concurrent verbal reports, in which they record their thinking while it is occurring;
- written reports, in which individuals record their thinking in response to standardised questions following a task;
- self-estimates, in which individuals estimate their performance on a task prior to, or after completing it.

The approach adopted in this study was to analyse transcripts of the focus group discussions (retrospective verbal reports) for metacognitive processes and indicators (see Table 2).

**Table 2: Preliminary data analysis sowing metacognitive skills**

<table>
<thead>
<tr>
<th>Declarative</th>
<th>Procedural</th>
<th>Conditional</th>
</tr>
</thead>
<tbody>
<tr>
<td>I know that</td>
<td>I know how to perform tasks or procedures</td>
<td>I know the conditions under which certain strategies might be most effective</td>
</tr>
<tr>
<td>I can watch the screencasts and understand them</td>
<td>I can solve problems when I am really focussed</td>
<td>The screencasts are most useful after the lecture</td>
</tr>
</tbody>
</table>
I am able to take notes while watching  
I can focus on the explanations in screencasts in order to improve my understanding  
I benefit most when I have studied the problem in context

I am able to apply the concepts to other maths problems  
To really benefit from screencasts, I need to grasp the underlying concepts  
If I listen with friends, it makes the concepts easier as we can discuss

I feel frustrated when I cannot understand formulae  
I learn best when I view the screencasts several times  
I feel more confident after I have views the screencasts several times

I am about average in terms on my understanding of maths  
I can usually explain the maths problems after I have seen the screencasts  
I learn best from screencasts if I view them several times

Conclusions and further research
The framework of declarative, procedural and conditional metacognitive strategies might be used by designers of screencasts and podcasts of key concepts for evidence of engagement in metacognition, by instructors assessing learners’ capacity to reflect on their learning or by designers setting up metacognitive experiences for learners. Our research is in its initial phase and examples provided in this paper are meant as a general guide or as a starting point for identifying and promoting metacognition among students while viewing screencasts. For students who are asked to reflect on their own learning while viewing screencasts, there is evidence of engagement in the three aspects of metacognition depicted in Table 2 above. The analysis provides insights into the depth and level of metacognitive skills displayed by students.

References