What are worked examples?

One definition for worked examples is “a step-by-step demonstration of how to perform a task or how to solve a problem"

According to another definition, these are “instructional devices that provide an expert's problem solution for a learner to study.”

In other words, a worked example is an example that is broken into different pieces. These pieces are gradually revealed to the reader as a step-by-step process. Each step has explanation of the logic involved it the particular step.

Why worked examples for learning computing science?

The common assumption that the best learning is by practicing solving problems is not necessarily true for learning Computing Science. Renkl(2005) argues that without being exposed to worked examples first, novices have a very restricted knowledge on the domain to be able to effectively reach a solution. Solving problems involves a lot of working memory resources. However, the memory capacity of beginners should be used for building new knowledge instead.

Studying worked examples “is one of the earliest and probably the best known cognitive load reducing techniques”. While worked examples reduce the cognitive load, they also provide a better understanding of the concepts under consideration. This builds up the necessary expertise required to solve a particular type of problem effectively.

Problems of the existing forms of worked examples

* The worked examples in books or lectures are not interactive enough. The readers of books or the attendees of a lecture are presented with some examples, but often the process of thinking why a particular action is undertaken or is a better option for reaching a solution remains unexplained. One can argue that the university context has some grounds for interactivity or discussions. Yet many students may not exploit this due to shyness or simply because they might not know what questions to ask. Even if some interaction happens, this is not recorded or captured as part of the teaching process so the students cannot go back and review it.
* The worked examples present may not fit well enough to the teaching needs. Books aim to target a large portion of potential readers so they need to be general enough to fit every reader’s needs. However, this means that one particular reader may need to adjust their studying or teaching around this general example. What would be more beneficial is to adjust the worked examples depending on the teaching or learning needed.
* Worked examples in books provide little or no feedback on how they were used to the author or to teachers who benefit from using such examples in their teaching. For example, the only available information for a book would be the number of copies sold. This would not provide any insight on the value the examples brought to the reader. What is desired is information about how a particular worked example was used, were there any problematic areas and how the readers benefited from it. Such information would allow the authors to improve their future work at constructing worked examples. In addition, this information could be beneficial to teachers or lecturers who could use them for assessing what parts of the example were problematic and adapting their teaching accordingly.

The solution to these problems

As part of his research project, the former Glasgow University PhD student Dr. Yulun Song developed a Java standalone application to facilitate the creation and viewing of worked examples. The thesis statement for the research outlines the basic aims for the project. The system developed is such that it:

* “delivers usable, best practice interactive worked examples to students in a computing science context;”
* “enables teachers to create such interactive worked examples without bespoke programming, and to evolve them on the basis of feedback from the students.”

The context of worked examples in this project

The outcome of this Level 4 project is intended to be a tool for worked examples to be used in schools across the UK. This would be an attempt to improve the techniques used to teach Computing Science in the classroom.

How well does IWE fit the context of this project?

Dr. Song’s prototype aims to prove that worked examples are beneficial as a technique for learning Computing Science. This prototype, however, was not aiming any but was rather an experimental tool. The fact that the prototype is a Java application brings in some complications for deploying it in schools. The reason for these complications comes from the fact that in schools across the UK there tends to be a blanket policy about the provision of software for any subject. . In order to install a program on a school machine, a request to the service provider responsible for the particular school needs to be made. The service provider will then need to analyse the risk that installing a new program will pose to the whole system and submit a further request to a local authority responsible for the particular school. This overhead would be enough to prevent most teachers from considering adoption, both from a time and cost standpoint.

The alternative

The issue of software provisioning in schools gives the major motivation for this project to recreate IWE as a web-based application in order to start effectively presenting worked examples in a larger context. This will avoid the complicated and time-consuming process of installing IWE in schools. The web-based version of IWE is called *Worked Examples Viewer*

Other benefits

* Schools will be able to receive the latest updates of the application and its worked examples with no effort.
* A web-based system could share worked examples developed nationally and even internationally, not only the examples created by one teacher.

Taking a step further…

In addition to being a more easily deployable version of IWE, WEAVE takes a step further to move from author-student to author-student-teacher target user groups. This brings in interesting new aspects. Teachers will be able to see personalised information about how their pupils interact with the examples. Authors, on the other hand, will receive information about the general usage of these examples, rather than personalised one.

A necessary condition

It has been decided that the main purpose of this project is the provision of a student interface and a teacher interface. This essentially means that the system will need to use the worked examples created using the author interface of the old system. It is essential for the new system to be able to upload examples created by the IWE tool.

This project aims to achieve four goals:

**G1**- build a web-based viewing system that is interoperable with the author interface of IWE, i.e. ensure that worked examples created using the old system can be viewed in the new system.

**G2**- provide an interface for teachers that will help them gain more information on how the worked examples are used by their own pupils.

**G3**- replicate as closely as possible the student interface of IWE.

**G4**- ensure that worked example authors can view usage data in an anonymous manner, such that individual pupils, classes or schools are not identifiable.

Deliverables

* an interface to be used by pupils to view worked examples student interface referred to in this presentation as the student interface. The functionality and the looks of this interface are based on the Java application developed by Dr. Song
* an interface for teachers enabling them to view how their students worked with the examples which is a completely new aspect of the system

Teacher Interface

The purpose of the teacher interface is to enable teachers to see usage data for their classes as well as individuals in these classes. I will show you how this is achieved using a screenshot of the main page. Teachers will register each of their classes as a group. They will then specify the number of students in the class they are creating it. They can add more students to this group using the update option, or delete a group. Once the group is registered, the teacher can view the student ids which were automatically generated by WEAVE. Such automatic random generation of student ids is to ensure that the id does not reveal the student identity to avoid privacy issues. They are advised to print the list write down the names of the student for each id. Then they can cut one of the columns for the pupil id and give it to the pupil.

View Data

In order to view data for their classes, the teacher needs to click on the view statistics option. Then they need to enter the details of the group they want to view data for, as well as the type of data they are interested in. The type of data usually is represented in the form of graphs and includes the average time spent by all students at different steps of an example, time spent by an individual student at different steps of an example, as well as any answers to questions in the example.

Student Interface

One of the goals of this project is to translate the student interface of IWE into an online version. The research of Dr. Song clearly indicates that the user interface he uses for his system is effective at communicating the worked examples. I will illustrate how WEAVE’s interface incorporates the main features of the interface of IWE.

1. An area for showing the worked examples installed on the system and enabling the user to choose an example to work on.

2. Panels showing different documents for a particular worked example.

3. An area for controlling transitions between steps.

4. An explanation area where the expert’s process of thinking involved on the current step is shown.

5. Highlighting of the newly appeared text at a particular step for drawing the user’s attention to the new content relevant for the current step.

6. Highlighting of fragments of interest for a particular step.

As the student uses the controls in area (3) to move through the worked example, the contents of the documents panels and the explanation area change to reveal the developing solution and the thinking process behind it.

Other features of IWE’s student interface, which are not shown on the screenshot, are the ability of the tool to ask the user questions and to record data such as time spent at each step and answers to questions.

What was the most difficult task? –resizing

How did you resolve it- I realised I have to prioritise tasks. Since it was not preventing the correct functionality of the system but it was rather a cosmetic detail, I will address this in a later version of this application due to time constraints.