**Chapter 7**

**Discussion and Conclusion**

This chapter summarises the work that has been undertaken as part of this project and describes ideas for future work for the developed prototype.

**7.1. Summary of the Project**

**7.1.1. Project Stages**

Below are the different stages for this Level 4 project.

* A potential problem with installing previously developed software that could improve the techniques for teaching Computing Science in the classroom has been identified and a solution to this problem has been proposed.
* Through discussion with school teachers ideas of how to make the proposed software valuable to them as well were developed.
* The design of the web-based application to be used in schools by both teachers and pupils was formulated in close cooperation with a secondary school teacher.
* The implementation of this web-based system was undertaken.
* The evaluation of this system clearly indicates that it will be valuable for use as a new teaching technique in schools and teachers are enthusiastic about the future development and integration of this system.

**4.1.2. Satisfaction of Requirements**

This section discusses the extent to which the requirements for WEAVE are satisfied.

**4.1.2.1. Functional Requirements**

The system satisfies all of its functional requirements.

Firstly, WEAVE is able to easily upload worked examples created with the author interface of IWE.

Secondly, the teacher interface provides an easy means for teachers to group their pupils, check the pupil ids in each class and see how the pupils in a class or an individual pupil interacted with the worked examples.

Thirdly, the student interface of WEAVE is a very close but slightly improved version of the student interface of IWE, and has proven to be able to communicate the worked examples effectively. Furthermore, it provides a means for identifying pupils in a way such that they are identifiable by their teacher but unidentifiable by authors of worked examples and researchers in Computing Science education.

**4.1.2.2. Non-Functional Requirements**

The majority of the non-functional requirements for the system have been satisfied. The results from the usability evaluation conducted for WEAVE clearly indicate that the prototype is easy to use, although it could benefit from some stylistic improvements. Tutorial and help guide the users of the system at the major parts of interaction. Shortcuts for transitions between steps are present in the system, although their presence might not be obvious to the users as shown through the evaluation. The panels and the explanation of worked examples are resizable for better control on the system.

Despite the satisfaction of the majority of the non-functional requirements, there is ground for improvement in this area as the results from the heuristics evaluation indicate. Most importantly, the cross-browser compatibility of the system needs to be improved before WEAVE is deployed in schools. Even though this is not crucial for the functionality of the system, it would improve the user experience.

**4.1.3. Current Status of the Project**

The prototype is fully functioning and it has been spread around schools so that teachers and pupils have the opportunity to familiarise themselves with the system. They are encouraged to express their opinions about it as well as any ideas for new features that could be beneficial to them.

The code for the system is left in a maintainable state. The methods have comments describing what they do. The separation of concerns imposed by the Model-Template-View design pattern used in Django has been followed. This means that any programmer that has some experience in Django will know where to add code to satisfy new requirements for the system. Further guidance is provided in readme.txt files in the code directories.

**4.2. Future Work**

This project is very ambitious. Due to the time constraints, many of the ideas for possible features have not been included to the requirements of this project. These ideas are briefly discussed in this section and will be shortly addressed.

**4.2.1. Improvements to the Current Interface**

Any issues found in the Usability Evaluation will be addressed in the next version of WEAVE. Most importantly, the problems with the cross-browser compatibility need to be resolved in this version.

**4.2.2. Web-Based Author Interface**

The next major step for this project is to provide a web-based interface for authors of worked examples. Anonymity of these authors is still under consideration. On one hand, the same privacy issues as with the other users of WEAVE are applicable for authors as well. On the other hand, it could be beneficial to be able to contact them. Another discussion point for this interface is the authentication of the content produced by authors due to the consideration that this content will be visible by pupils.

The author interface will have usage viewing mechanisms similar to the teacher’s interface, although more in line with the analysis mechanisms outlined in Song’s thesis.

**4.2.3. Worked Examples Tagging Mechanism**

If the system is widely used, the number of worked examples will quickly become unmanageable as a single list.  At this point, various additions will be required to manage the complexity:

* tagging of worked examples to enable effective searching by pupil or teacher
* allowing the teacher to attach particular worked examples to particular classes, so that pupils could be focussed onto just the worked examples for them - for example in a “My Class Worked Examples” section.
* where a teacher can see that a particular worked example is useful for a particular pupil, he/she could add that Worked Example to a “My Worked Examples” list for that pupil.
* although pupils might have teacher-specified worked examples at either class or individual levels, they could be permitted to search the whole database of worked examples and add any they want to study further to their “My Worked Examples” list.

**4.2.4. Comparison between Time Spent and Expected Time**

Song’s thesis demonstrated a way of viewing a student interaction with a particular worked example by comparing the times spent at each step with a sequence of times predicted by the worked example author.  These predictions were made on the basis of the author’s deep knowledge of their own worked example and on an estimation of the how challenging each step would be to a typical learner.  Additional interfaces could be added that would allow:

* the author to enter predicted times that a pupil would spend on each step if they were taking the worked example seriously and were at the right developmental stage for the example (i.e. not overly challenged, or way beyond this level already.)
* overlaying of the predicted times onto the average time / student time graphs.

This feature would allow a teacher to very quickly see whether the class as a whole, or individual pupils, were moving faster or slower than expected.  If the whole class is significantly slower on a particular step than expected, the teacher will be aware that there is some issue around that point in the worked example.  If particular pupils are slower, then some individual support is indicated.

**4.3. Personal Development and Reflection**

This Level 4 project has been a great opportunity for me. The topic of the project- improving the teaching techniques in Computing Science- has been of a particular interest to me for a long time. Coming to the University of Glasgow with absolutely no experience in Computing Science, I have encountered many difficulties typical for novices in Computing Science due to this lack of experience. To me, being part of developing a tool that could reduce the difficulties of other novices is an honour.

During the development of WEAVE, discussions with the project supervisor and, on some meetings, a secondary school teacher gradually built up the required features for the system. These meetings, however, rarely involved discussion on how to implement these features. One of the major personal achievements for me resulting from this project is the ability to analyse different possible solutions and to choose a good option.

Furthermore, despite having experience in Python and Django, I had never used them to build anything as large as this system before. I feel a lot more confident in the technologies used for this project. Building WEAVE helped me to reach a level of expertise satisfactory to become a tutor in the modules involving Django at the University- WAD2 and ITECH.

In addition to the technical skills gained during the last six months, I have hugely developed my communication skills. The most courses at the University develop mainly students’ technical skills. However, going in industry will most certainly involve giving talks and writing reports. At the beginning of the project, I was not feeling comfortable writing or giving presentations in front of professionals. Receiving constant feedback from the project supervisor helped me hugely improve myself in this area.

Last but not least, this project was a great opportunity for me to make a self-assessment of the knowledge and skills I have been building up during the four years of being a student at the University of Glasgow. I am happy to notice that I am capable of working on large projects myself and satisfying clients’ requirements. What is left for me to develop is to find a balance between being too self-critical and satisfying myself with an acceptable solution.

**4.4. Concluding remarks**

For the past six months most of my time and effort have been concentrated on this project. Looking at the outcome, I feel that they were well spent. The product is a well-accepted and easily deployable system for viewing worked examples in schools and for enabling teachers to better understand the difficulties of their students. Many good software engineering practices have been followed to make the system maintainable and to enhance its evolution.

Despite this advance, the system has a long way to go until it can become revolutionary in the techniques used for teaching Computing Science in the classroom. If this prototype is successful, WEAVE is just the beginning of a much larger system. I am looking forward to being part of the development of this system. For now, though, this is a project I am very satisfied with.