Chapter 8 – Conclusion and Future Enhancements

This chapter provides the research summary, its contributions and future enhancements. The research summary is discussed in Section 8.1 and the research contributions are discussed in section 8.2. The suggestions and recommendations obtained from the evaluations carried out are discussed in Section 8.3.

8.1 Research Summary

This thesis presents the efforts made to develop a web-based tool that utilizes the web agents in supporting primary schools jigsaw collaborative learning. The theoretical aspects of collaborative learning, especially the Jigsaw technique created by Aronson have been reviewed. The jigsaw collaborative learning activity proposed by a group of teachers in a workshop which serves as the core foundations for the construction of the G-Jigsaw process model are presented. A G-Jigsaw prototype is developed to incorporate the G-Jigsaw process model into a web-based environment. Reviews on the software agent literature specializing in the web agent are carried out. How a multi-agent architecture is formulated to enable the web agents to communicate with each other in simplifying and automating the jigsaw activities is described. The development and implementation of G-Jigsaw that incorporates both the process model and the multi-agent architecture in supporting the jigsaw collaborative learning with the deployment of web agents is presented. The teachers (pilot testing) and students (hands-on testing) evaluations are carried out and the results that indicate that web agents greatly simplifying the complex jigsaw processes are highlighted.

8.2 Research Contributions

The research contributions are as follows:

1. It introduces a G-Jigsaw process model to support the primary schools jigsaw collaborative learning. The proposed G-Jigsaw process model introduces three levels of students' collaboration (i.e. Initial Level, Expert Level and Jigsaw Level) to support the students' collaborative learning activities. This process model is then incorporated into a web-based tool called G-Jigsaw. From the evaluation carried out on the G-Jigsaw, it indicates that students find the G-Jigsaw very interesting and challenging.

2. It discovers the potential of agent technology in supporting collaborative learning and proves its usefulness through the development of G-Jigsaw that implements the web agents. From the thorough review carried out on the software agents, it is discovered that the agent technology has great potential in supporting collaborative learning application. However, not many current collaborative learning applications are implementing agent technology in their applications. During G-Jigsaw development, web agents are implemented in the following ways:
   i. To automate the complex jigsaw flows so that the jigsaw activity can be simplified.
   ii. To provide retrieving and integrating facilities in order to speed and smoothen the collaboration process.
   iii. To create a profile for each user to assist the jigsaw navigation.
   iv. To administer the database back-end processing such as filtering and categorizing.

3. It formulates a multi-agent architecture in supporting the collaborative learning which can be applied to other collaborative learning applications. The multi-agent architecture supports the deployment of web agents. The implementation of web-agents in G-Jigsaw has made an impact on the jigsaw activity process. Based on the evaluation carried out, G-Jigsaw with web-agents performed more effectively and this shows that web-agents can be used successfully in supporting collaborative learning activities.

4. It simplifies the complex jigsaw process and brings the jigsaw technique into a web-based computer supported collaborative learning environment. Although the Jigsaw technique has achieved great success for the past few decades, however, its complicated structure and flows makes it difficult to be incorporated in a computer supported collaborative learning environment. Many of the primary and secondary school teachers carry out their Jigsaw lesson manually. The development of G-Jigsaw has successfully simplified the Jigsaw activities through its computer supported collaborative environment. G-Jigsaw even enables students to participate in Jigsaw activities at a distance. This greatly enhanced the levels of collaboration.

5. It serves as one of the WebCL module, which supports the Jigsaw-type collaborative learning activity in schools. WebCL is a collaborative learning system that supports various types of collaborative learning activities. G-Jigsaw serves as a module that highly demonstrates the concepts of collaborative learning. Students who participate in this module can easily understand the concepts of collaborative learning and will be able to experience its benefits. Hence, this is G-Jigsaw vast contribution to the WebCL system.

8.3 Future Enhancements

Although this research has achieved most of its objectives and provides contributions particularly in supporting jigsaw collaborative learning technique, however it still has several aspects that can be improved.

G-Jigsaw current version restrictions are:

1. The G-Jigsaw only supports a maximum of 25 students in 5 different groups per jigsaw session. In a standard classroom, the number of students is normally more than 25 people. Therefore, for the remaining students to participate in a jigsaw session, they have to share with other students. For this reason, G-Jigsaw should be improved so that it can dynamically support any number of students and groups.
2. The automation process of G-Jigsaw is not robust enough. The numbers of questions that can be set are based on the number of students. The numbers of students that can participate for each jigsaw session are 4, 9, 16 or 25 only. Therefore, this restriction should be modified in order for it to supports any number of students per session. In order to overcome this problem, web agents can be used as students' dummies. The role of these dummies is to stimulate students' participation. For instance, if a class has only 23 students, therefore the new version of G-Jigsaw will still be able to support 5 groups by using 2 dummies for the last 2 groups.
3. The G-Jigsaw navigation can also be enhanced by implementing exceptions handling functions to make it more robust and reliable. To achieve these objectives, more longer period testing and evaluation session should be carried out. This is to ensure that all the errors are detected and enhancement possibilities are identified.

4. Although G-Jigsaw interfaces are quite well established, however many students who have used G-Jigsaw suggested that there should be more multimedia elements embedded into G-Jigsaw. The students say that by incorporating these multimedia elements in G-Jigsaw, the learning process will be more interesting. This enhancement requires further research efforts to ensure that it will not violate with the students' learning.
5. G-Jigsaw is currently designed for primary school students to carry out their jigsaw collaborative learning. Further studies and evaluations should be carried out to expand its scope so that it can be used to support secondary schools, colleges and universities as well.
6. The evaluations of this research are mainly focus on how potential web agents can be used to support the jigsaw collaborative learning successfully. However, it is very important to carry out further testing on how well the advantages of Aronson's Jigsaw Classroom are supported in G-Jigsaw.

Besides all the recommendations suggested, there is another further investigation that could be carried out. The investigation is to compare the augmented G-Jigsaw process with other types of collaborative learning such as Circle of Learning, Student Teams-Achievement Division (STAD) and Teams-Games-Tournament (TGT). This research will provide great contributions towards the determination of the best approach to support students' collaborative learning activities effectively.