Chapter 3 – G-Jigsaw (Group Jigsaw) Process Model

This chapter studies the Aronson's Jigsaw Classroom technique in depth. It also exemplifies an example of Jigsaw Classroom activities and describes the benefits and limitation of this technique. Next, it discusses the similarities and differences between the Jigsaw Classroom and the proposed G-Jigsaw by the teacher discussed in chapter 2. This chapter further formulates a G-Jigsaw process model with three levels of collaborations to support the proposed G-Jigsaw. It summarizes the steps to be performed in both the Aronson's Jigsaw Classroom as well as the G-Jigsaw Process Model. This chapter also investigates tools to support the jigsaw technique. Lastly, it discusses G-Jigsaw prototype that incorporates the G-Jigsaw process model.

3.1 Jigsaw Classroom

The Jigsaw Classroom (Aronson et. al., 1978) was first introduced by Elliot Aronson to cope with cultural diversity in classrooms. In Jigsaw Classroom (also referred as Cooperative Classroom), the students achieved success through paying attentions to their peers, asking good questions as well as helping, teaching and assisting each other rather than outshining their competitors as in present traditional classroom. Aronson and his colleagues shifted the role of teachers to become the major resources to each of the learning groups and the students treat each other as resources (Aronson, 2000a). This surroundings is accomplished in three ways:

1. The learning process was structured so that individual competitiveness was incompatible with success.

2. It is convinced that success occurs only after cooperative behavior among the students in a group.

3. Each student is in a position to contribute a unique gift of knowledge (i.e. a piece of vital knowledge that is only available by a particular student) to his/her group-mates.

According to the jigsaw technique, students are first divided into small groups (e.g. 5 students in a group) and these groups are called "jigsaw groups". The learning materials (e.g. exercises, tutorial questions, group project etc.) are also divided into five sections accordingly. Every student of each group is assigned to one section of the learning materials and can only access to their own section. Each student read and learns his own section and then joined his counterparts from other groups. These temporary groupings are called "expert groups".

"Expert groups" are where students who are assigned the same section of the learning materials discuss about their section in more detail. This process is important because it provide the opportunity, space and practice for less articulate and skilled students to learn their materials and see how smarter students organize and present their answers. The "expert groups" provide all students with the possibility to gain a clearer picture on how to present their answers – regardless their inequities skills knowledge.

After spending some amount of time in their "expert groups", the students returned back to their original "jigsaw groups". Then, each student in the "jigsaw group" take turns to teach or present his section answers and the knowledge and experience gained from his "expert group". Therefore, the students are able to produce a final outcome covering the entire sections of the learning material. Based on these activities, the author draws a diagram to illustrate the jigsaw classroom processes in a diagrammatic way as shown in figure 3-1.
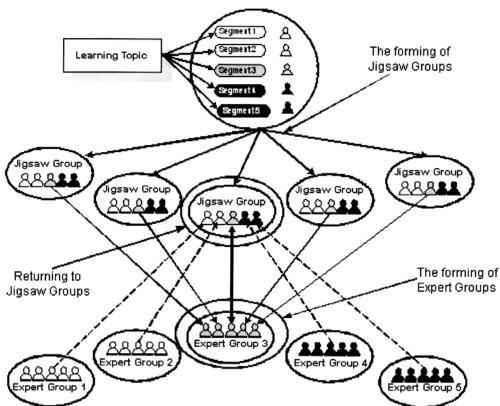
Figure 3-1 Aronson's Jigsaw Classroom Process Model

The Jigsaw Classroom is a highly structured technique. Interdependence among the students is required. Students learn from each other and try not to out perform each other because one student's learning will enhance the performance of the other students. This interdependence makes the Jigsaw Classroom a unique learning method and encourages the students to actively take part in their learning activity.

Clearly, students in a jigsaw classroom have to depend on each other to learn all their learning materials. This situation initiates students to be responsible for his/her own learning and to help the entire group understand the entire scope of the learning materials. The jigsaw process is highly reminiscent of a jigsaw puzzle, where each student possesses a single vital piece of the big picture. Because of this resemblance, Aronson and his colleagues refer this process as the "jigsaw" model.

3.2 An Example of Jigsaw Classroom Activities

This section illustrates how the jigsaw classroom technique can be carried out by year 5 students focusing on Science subject. The example below presents the steps for both teacher and students in a jigsaw classroom.

Step 1: Forming jigsaw groups

The teacher should divide the students into several jigsaw groups. Ideally, each group should consist of five or six students.

Step 2: Appointing group leaders

Each jigsaw group should have one group leader.

Step 3: Preparing the jigsaw materials

The teacher should prepare learning materials that could be divided into several smaller related segments. Let's say the jigsaw activity is about "Mammals", the following are a few possible questions that can be used.

1. What is the largest mammal in the world?

2. What are the characteristics of mammals?

3. How do mammals take care of their children?

4. Why are some mammals dangerous to people?

5. Why are some mammals useful to people?

Step 4: Assigning topic segments to each student

The teacher should assign each student with one segment and ensure that he/she can only access his/hers segment. For example, Rahman, Adip, Fahmi, Husna and Sarah are in the same jigsaw group. Rahman is assigned to question 1, Adib is assigned to

question 2, question 3 is assigned to Fahmi, question 4 is assigned to Husna and question 5 is given to Sarah.

Step 5: Reading the segments

Then, the students are required to read their segment for at least twice to familiarize with it and this will prepare them for the expert group discussion.

Step 6: Forming the expert groups

Next, the students are required to form temporary groups called expert groups. Each student in a jigsaw group will joint other students whom are assigned to the same segment. For example, Rahman will joint students from other jigsaw groups who are also responsible for question 1.

In the expert group, the students will discuss the main points of their segment as well as rehearse their presentation, which they will present when they return back to their jigsaw group.

Step 7: Return to jigsaw groups

After the students are ready with their segment, they return back to their original jigsaw group.

Step 8: Presenting the segments to the jigsaw groups

Every student is required to present their segment to their group. Other students should listen and learn from each other presentation. At the same time, students are also encouraged to ask questions to clarify the information presented.

Step 9: Monitoring the jigsaw group.

During the student's presentation, the teacher should move from group to group to observe the process. The teacher will intervene if there are any groups that encounter problems. The group leader should be trained gradually to take over this role.

Step 10: Evaluating the students' achievement

At the end of each jigsaw classroom session, the teacher should give a quiz on the topic that the students have learned.

3.3 The advantages and limitation of Jigsaw Classroom

Aronson's jigsaw classroom is a technique with a three-decade track record of success (Aronson, 2000b). The research findings (Aronson, 2000a) have consistently showed the following desirable results:

1. Students in the jigsaw classrooms tend to establish a strong relationship within their group-mates compare to others in their classroom.

2. The students in the jigsaw classrooms enjoy school better than the students in traditional classroom thus reduced the absenteeism among the jigsaw students dramatically.

3. The self-esteem of the students in the jigsaw classrooms increased to a greater extent compare to students in competitive classrooms due to the opportunity on hand for the students to teach and learn from their group-mates.

4. In terms of mastering classroom learning materials, students in the jigsaw classrooms tend to out-performed students in competitive classrooms especially for the underprivileged minority students.

5. As the result of their experience in jigsaw groups, students learned to understand

and respect one another.

Besides, individual students in jigsaw classroom develop and share expertise in different aspects. This highly structured technique facilitates interaction among all students in the class lead them to value each other as contributors towards their common task. It is especially useful in modeling technical assignments or projects. These activities normally require the expertise of a variety of individuals in order to complete them. Under such circumstances, students developed an expertise in one specific aspect, teach the knowledge and skills to their group or to the class and at the same time learn different points of views from other students with different expertise.

The Jigsaw approach is certainly not limited to technical areas solely. In fact, it may be applied to any subject where pieces of information need to be gathered to produce a group work. According to Clarke, "The use of the reconstituted work groups in classrooms, such as in the Jigsaw approach, is based on the same principles of interdependence that operate in the cross-team roles in the workplace. Class members bring their personal abilities and ways of thinking and working, as well as specialized knowledge, to analogous cross-role groups. The Jigsaw approach was developed as one way to help build a classroom as a community of learners whereas students are valued" (Clarke, 1994, cited from Panitz, 1997a).

Despite of the advantages discussed previously, the jigsaw approach also has its challenges. For instance, students who are first time exposed to the jigsaw technique may have some difficulty to understand the complex jigsaw approach (e.g. the forming of jigsaw and expert groups, the teaching and learning activities such as material preparation, segment discussion and rehearsal of presentation involved at different

levels). This is remarkably true especially for students who are not familiar to this technique. Table 3-1 summarizes the benefits and limitations of Aronson's jigsaw classroom.

Table 3-1 The advantages and limitation of Jigsaw Classroom

The Advantages of Jigsaw Classroom	
1	Encourages strong friendship among group-mates.
2	Decreases the student's absenteeism dramatically.
3	Increases the student's self-esteem.
4	Increases underprivileged minority student's performance.
5	Promotes listening, engagement and empathy among students.
6	Facilitates interaction among all students in the class.
The Limitation of Jigsaw Classroom	
1	Students who are first time exposed to the complex jigsaw technique may encounter difficulty to understand the technique.

3.4 The proposed G-Jigsaw versus Jigsaw Classroom

Table 3-2 compares the requirements of the Jigsaw Classroom with the proposed G-Jigsaw from the workshop (discussed in chapter 2). By observing the comparison as depicted in table 3-2, it is found that the Aronson's Jigsaw Classroom (refer section 3.1) have much similarities with the requirements proposed by the group of teachers. Differences between the requirements are marked in bold.

Table 3-2 Jigsaw Classroom and G-Jigsaw Requirements Comparison

Requirements for the Jigsaw Classroom	Requirements for the proposed G-Jigsaw
Students are first divided into jigsaw groups.	Students form their own groups consist of 5-6 members.
One student from each group is appointed as the leader.	Each group is assigned with a group leader.
The lesson is divided into 5-6 segments.	The problem is broken into smaller segments.
Each student is assigned to learn one segment. **Students have direct access only to their own segment.**	Each student is responsible for one segment. **Students must respond to all other segments first before they have access to their own responsible segment.**

Students are given time to read over their segment at least twice and become familiar with it.	Students in the same group first contribute their ideas and opinions to their group members and receive comments from their members at the same time
Temporary "expert groups" are formed by having one student from each jigsaw group join other students assigned to the same segment. Students in these expert groups are given time **to discuss the main points of their segment and to rehearse the presentations** they will make to their jigsaw group.	Expert groups are formed by having students with the same segment from each group. Students in these expert groups **present the main point of their segment, comment on the main point presented and recompose a report to improve their previous answer** they will present when they return to their original group.
Students are brought back into their jigsaw groups.	Students return to their original group.
Each student is required to present his/her segment to the group. **Others in the group are encouraged to ask questions for clarification.**	Students present his/her segment report to the group. **The group leader will combine each segment report into a complete piece of group work.**
The teacher floats from group to group, observing the process. If any group is having trouble, the teacher can make an appropriate intervention.	The teacher wanders from group to group, monitoring the activity session and intervening when necessary.
At the end of the session, the teacher will give a quiz on the discussed material.	**The quiz assessment is not supported in this module.**

The major difference from this comparison occurs in the first stage of the activity. In Aronson's Jigsaw Classroom, no collaboration is allowed among the students at the first stage. Students obtained their segment and they are given time to read the segment at least twice to become familiar with it. The students' collaboration only begins at the expert group level. Conversely, in the proposed G-Jigsaw, the student collaboration exists at the first stage. Students are required to give comments to other members in their group during the first stage.

According to Aronson's jigsaw classroom, students are only allowed to collaborate during the discussion in "expert" groups. The students will only gain full understanding of their learning topic after the completion of the final stage at "jigsaw" groups. Even though this technique enables the students to share their ideas and solve conflicts during

expert and jigsaw group, however it prevents them from gaining an overall picture of the task beforehand. In other words, student who is responsible for one section of learning materials may not be aware of other sections until at the final stage of the jigsaw group. Therefore, this method leaves the space for further enhancement.

On the other hand, based on the G-Jigsaw proposal, during the initial level students must respond to all other members' segments first before they have access to their own responsible segment. This allows students to gain an overview picture about the learning topic before they start to prepare their segment answer. In this way, students will have a brief understanding about the entire learning topic beforehand and get the complete understanding during the jigsaw group.

As a result, the author makes use of Aronson's jigsaw classroom technique with some modification to fulfill the proposed requirements. In order to achieve the desired results, the activities at the first level are restructured. Rather than forming the jigsaw group for students to obtain their question segments as what Aronson did, students in G-Jigsaw are required to respond to other members in the same group. The member-to-member collaboration is fostered during this early level of collaboration. Groups that are formed during the initial level of collaboration are named "Initial Group". Student's activities in "Expert Group" and "Jigsaw Group" are very much similar to Aronson's Jigsaw Classroom. During the expert level, the group-to-group collaboration is emphasized. As such with G-Jigsaw, the students' collaborations occur at every stage. The details of group jigsaw process model are explained in section 3.5.

Another difference is that in Jigsaw Classroom, the students are required to rehearse their presentation during the expert group whereas this feature is not proposed in the G-

Jigsaw. The presentation rehearsal is replaced during the expert group where students are able to give comments and learn from each other. Therefore, students can improve their previous answer and compose a report for their segment and present it during the jigsaw group.

Besides, the proposed G-Jigsaw module does not support the last step of Aronson's jigsaw technique, which is having a quiz on the material learned. This is due to the reason that G-Jigsaw is designed as one of the WebCL module, since the WebCL has a module called Group Quiz, thus G-Jigsaw does not support this feature. However, students accessing WebCL can make use of Group Quiz to carry out the evaluation after the jigsaw session in G-Jigsaw.

3.5 The G-Jigsaw Process Model

The G-Jigsaw process model is formulated based on the teachers' proposal and Aronson's Jigsaw Classroom to support the proposed G-Jigsaw requirements. The process model restructures the first level of jigsaw activities to enable student collaborations at every level throughout the jigsaw collaborative learning session.

In this process model, students collaborate by responding to each member's different segment, received feedback for their own segment, prepare their segment's draft, read and comment on other members same segment drafts, improve their draft and compose a report, review group members report and finally integrate the reports into a complete integrated report.

To accomplish these goals, students are required to engage actively in three levels of

group collaborations namely initial level, expert level and jigsaw level throughout the process model. The following sections describe each level of collaboration in more detail.
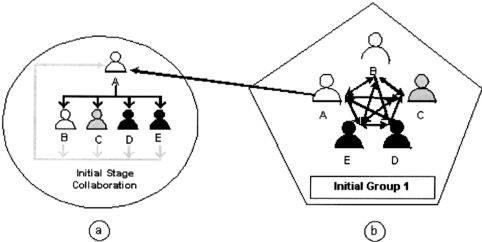
3.5.1 Initial Level of Collaboration

In the initial level of collaboration, the teacher must divide the learning topic (jigsaw task) into three or more smaller segments. The students are then divided into three or more groups according to the number of segments. Each group should consist of three or more members according to the number of segments. These groups are called "Initial Group" rather than "Jigsaw Group" because unlike the original jigsaw technique, students in the Initial Group are also required to engage in the member-to-member collaboration. Another reason for renaming the group as "Initial Group" is because it is the first collaboration level in the process model. Figure 3-2 shows the formation of Initial Group. As shown in figure 3-2, each student in the "Initial Group" is responsible to a different segment of the learning topic. The learning topic can be a case study or a group project.
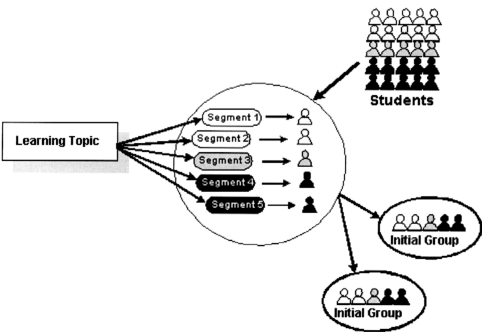
Figure 3-2 The Forming of Initial Groups

As stated earlier, students are required to collaborate among their group members in the Initial Group before they are allowed to enter the expert stage. During this inter-member collaboration, rather than just working on their own segment, each student is required to respond to other his/her group members' segments. Therefore, each student will receive feedback from each group members.

Figure 3-3 Initial Level of Collaboration

For instance, let's take a scenario where the learning topic consists of five smaller segments. Under such circumstances, five Initial Groups must be formed with five students in each group. Figure 3-3 illustrates the initial level of collaboration in Initial Group 1. Assume that student A in Initial Group 1 is responsible for segment 1, hence he/she need to propose his/her ideas and opinions for the other four segments (i.e. segment 2, 3, 4 and 5) which are responsible by students B, C, D and E respectively.

Similarly, other students (B, C, D and E) in Initial Group 1 are also required to respond to four other segments as described for student A. As a result, every student in Initial Group 1 will receive responses from his/her group members. This process is presented in figure 3-3 (a). Subsequently, student A will receive four responses from his/her group

members. He/She will be able to use these responses as guidance and references in preparing his/her segment 1 draft.

Through this initial collaboration process, students become more prepared before they start discussing their own segment in more detail in the Expert Group during the expert stage. The entire student collaboration process of Initial Group 1 promotes multiple perspectives and is depicted in figure 3-3 (b).
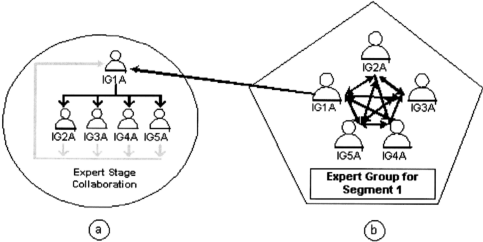
3.5.2 Expert Level of Collaboration

After the first level of collaboration in the Initial Groups, students engage with another level of collaboration, which is the expert level. Every student with the same segment from each Initial Group will split into five newly formed groups called the "Expert Group" as shown in figure 3-4.
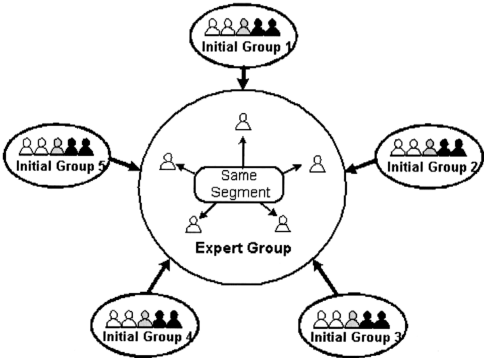
Figure 3-4 The Forming of Expert Groups

Figure 3-4 shows the student collaboration in the expert level. During the inter-group collaboration process, each "expert" member will present their draft to his/her expert group members. Every draft from each group member is studied in depth. Students in Expert Group collaborate through giving comments, discussions, arguing and defending their point of views. At the same time, they also receive feedback from their expert group members. Students will take note on they members' strong points and improve their segment draft own weaknesses or incompleteness. At the end of this collaboration, each student should become an "expert" in their responsible segment. Therefore, they should be able to bring the knowledge gained via the collaborative process in Expert Group to the "Jigsaw Group".

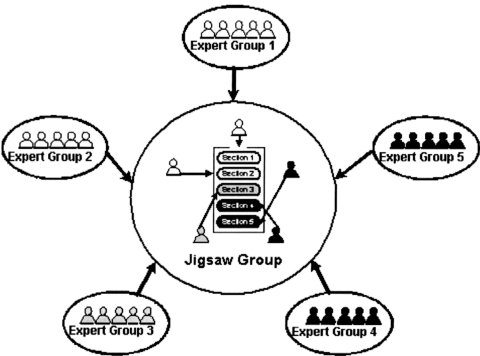**Figure 3-5 Expert Level of Collaboration**

Take a look at Expert Group for segment 1 for instance. This Expert Group consists of students from each Initial Groups (i.e. IG1, IG2, IG3, IG4 and IG5). Suppose every student A in the Initial Groups is responsible for segment 1, thus Expert Group for segment 1 will have 5 students (i.e. IG1A, IG2A, IG3A, IG4A and IG5A).

Student IGA1 will present his/her draft to the group and are discussed further among

other expert group members. If there are any unclear points presented in the draft, students, other members will be able to raise the issue through a discussion. The author of the draft must try to clarify or defenses their points. At the end of this session, the students are able to improve their segment draft and produce a segment report.

3.5.3 Jigsaw Level of Collaboration

The last level of collaboration is named the jigsaw level. In this level, every student from the Expert Groups will return back to their original groups. Since the activities involved at this level are different from what they have carried out during their initial level, thus these groups are now called "Jigsaw Group". The forming of Jigsaw Group is presented in figure 3-6.

Figure 3-6 The Forming of Jigsaw Group

During the jigsaw level of collaboration, students teach and learn from each other. Each "expert" of a particular segment takes turn to present his/her segment report. After each

presentation, questions are raised and answers are provided until every student in the Jigsaw Group obtains a full understanding about the segment presented. Therefore, the student now has the knowledge for the entire learning topic.

Then, they are required to produce a full report of the learning topic discussed. During the integration process, students in Jigsaw Group once again collaborate in order to produce the best outcomes for their group. The outcomes should then be presented to the whole class group by group so that the whole class would achieve maximized collaboration and cover as much as they can on the learning topic.

3.6 Summary of Aronson's Jigsaw Classroom and G-Jigsaw Process Model

Table 3-3 summarizes the steps for both Jigsaw Classroom and G-Jigsaw process model.

Table 3-3 Steps for Aronson's Jigsaw Classroom and G-Jigsaw Process Model.

Steps in Jigsaw Classroom	Steps in G-Jigsaw
1. Teacher forms the jigsaw groups.	1. Teacher prepares learning materials that can be divided into three or more smaller segments.
2. Teacher assigns group leader for each jigsaw group.	2. Teacher forms initial groups for the students. The number of segments, number of initial groups and number of student in each initial group should be the same.

3. Teacher prepares learning materials that can be divided into five or six smaller segments.	3. Teacher assigns each student with one segment. Students must respond to other segments in their group before they can start answering their own segment.
4. Teacher assigns each student with a segment. Make sure the students have direct access to their responsible segment only.	4. Students read the responses posted by their group members toward their segment.
5. Students read their segment at least twice to make them familiar with their segment.	5. Students create a summary for their own segment after considering each group members responses.
6 Students form expert groups. Students assigned with the same segment will meet together in the expert group. Students discuss the segment's main points and rehearse their presentation.	6 Students form expert groups. Students assigned with the same segment will meet together in the expert group. Students read other expert group members' summaries and give comments.
7. Students return to their original jigsaw group.	7. Students read comments provided from other expert group members toward their own summary.
8. Students present their presentation for each segment in turns. Students ask questions for clarification during the presentations.	8. Students improve their previous summary based on the feedback from expert group members and create a report for the segment.
9. Teacher and group leaders monitor the jigsaw process and intervene when necessary	9. Students form jigsaw groups. Students present their report and presentation for every segment in turn. Students also ask questions and give suggestion on each report presented.
10. Teacher conducts quiz on the topic learn during the jigsaw session.	10. Teacher assigned group leaders for each jigsaw group. The group leader is responsible to integrate the entire collaborative group outcomes into a complete piece of work.

3.7 Tools to support jigsaw technique

To date, there are hardly any thriving computer-based efforts to support the jigsaw technique. Although this technique has been introduced for more than 30 years ago, its application in classroom is mostly unsupported with any computer applications. Countless hours of searching the journals, conference papers and Internet revealed that no tools for supporting jigsaw technique are being developed. Only until recently in the year 2003, Gallardo and his colleagues attempt to support the jigsaw technique through a web-based tool for both the preparation of the collaborative learning activities and the execution of the activities.

The approach of this research is different from the Gallardo and his colleagues' works. Firstly, Gallardo's system supports the jigsaw session via the pairs and groups interaction in face-to-face setting whereas the G-Jigsaw process model enables all the students communicate with each other in a group basis. Secondly, in Gallardo's pair interaction, the students only change partner once. As a result, each student only communicates with the two out of three other students with same segment. Contrary, the group collaborations in G-Jigsaw process model involve the mutual engagement of students in a coordinated effort to solve the problem together. Hence, every student in the group will communicate to each group member.

Gallardo's system intends to support Aronson's jigsaw technique by providing tools for teachers and students in participating the collaborative learning session. It has a collaborative editor, a chat tool allowing teachers and students to communicate through various channels, a wizard for supporting the interventions while monitoring the activities controlled by teacher and two viewers (group and pair) for the teacher to

monitor the students' work at any phases. The students have access to three user interfaces, according to the phase in which they are working.

The collaborative learning session has six phases. In phase 1 (Group Creation), students log in to identify their group members and group name, get the lesson, objectives and topics to be studies. The material is assigned to each group members. Then the group splits to carry out their individual research. In phase 2 (Preparation Pairs), Students leave their groups and form pairs. Students in each pair are assigned with the same material piece. The pair of students use collaborative editor to access the material and produce a joint document at the end of this phase. In phase 3 (Practice Pairs), Two of the previous pairs that studying the same subject exchange partner to form a new pair. Students make contributions to the shared document prepared in previous phase using the collaborative editor. Students practice their presentation in turns, where one student presents his document while the other criticizes on it. When this is done, students return to their original group and present their work in turns to the group. During each presentation, discussions, questions and new concepts can be annotated with the presentation tool. When the presentations are over, teacher closes the session and evaluates each student in an on-line test (Phase 6: Evaluation). Throughout the entire session, teacher monitors and makes interventions if necessary (Phase 5: Monitoring).

3.8 G-Jigsaw Prototype

A prototype was developed using a fast prototyping method to incorporate the G-Jigsaw process model into a computer supported web-based environment. The purpose of developing this prototype is to determine how well the process model in supporting the jigsaw collaborative learning technique. It provides a good understanding in tracing the

drawbacks that occurs in the prototype. Thus it serves as a blueprint on how the prototype can be further enhanced.

An informal testing on the prototype was carried out by a group of primary school teachers. This group of teachers had participated in the WebCL workshop as described in section 2.7. The teachers were asked to create G-Jigsaw learning materials, highlight the difficulties and problems for preparing the learning materials. Besides, the teachers were also asked to participate in the jigsaw activity as students. By doing so, the teachers could predict the problems faced by the students.

Feedback from the teachers indicated the following drawbacks:

1. The prototype was not easy to use due to the complex level of collaboration.

2. For the first time users, it is difficult to understand the concept of Jigsaw.

3. The prototype should enable the teachers to share and reuse the learning materials.

4. Students had to remember the levels of collaboration starting from their Initial Group until Jigsaw Group.

Web agents have many potential roles in assisting both teachers and students in carrying out their collaborative learning activities (Lang, 1995; Lashkari, 1995; Pazzani el. at., 1996; Starr et. al., 1996; Joachims et. al., 1997; Luke and Hendler, 1997). The author attempts to utilize web agents to automate and simplify the G-Jigsaw activities. Chapter 4 explores the field of web agents and attempts to utilized these agents to support the collaborative learning activities.

3.9 Chapter Summary

The Aronson's Jigsaw Classroom technique is studied in depth and its pros and cons are discussed. An example of how to participate in Aronson's jigsaw session is also described. A comparison on the requirements between the Jigsaw Classroom and the proposed G-Jigsaw has been made and the similarities and differences between the Jigsaw Classroom and the proposed G-Jigsaw are pointed out. The formulation of a process model with three levels of collaborations to support the proposed G-Jigsaw is discussed. The steps for both the Aronson's Jigsaw Classroom technique and Group Jigsaw process model are summarized. Tools to support the jigsaw technique are investigated. A prototype that incorporates the G-Jigsaw process model is discussed at the end of the chapter.