Application of the Jigsaw Method in a Learning Session for Analysis Class Diagrams

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Abstract

Cooperative or collaborative learning methods are based on student cooperation aimed at the achievement of a common goal. This kind of methods generates more significant and lasting knowledges. Additionally, the student has to face the challenge of not only learning individually, but also explaining their classmates the ideas that they do not quite grasp, which implies a practice of their communication, argumentation and discussion skills.

That is why at PUCP, since 2002, this kind of methods has been implemented in courses related to object-oriented software development, as reinforcement for the lectures previously given on each subject. Feedback from students that have taken part in cooperative sessions or classes has been very positive.

This document presents the design of a cooperative learning-based class using the jigsaw method. Also included are the results of tests about analysis class diagrams taken before and after class, as well as a detailed report of the students' perception about this method according to the answers from an anonymous questionnaire.

1. Introduction

One of the cooperative learning methods is the jigsaw method. Proposed by Aronson et al. [1] [5], it consists of splitting the material into various partial tasks or themes. Each student in a jigsaw team will have to perform one of these partial tasks, which eventually will end up integrated by all team members.

The growing complexity of software development, which provoked the so-called “software crisis”, has been approached through the posing of new methods, methodologies, techniques and paradigms aimed to diminish the aforesaid crisis’ impact. The object-oriented paradigm is one of the most recurrent nowadays. Although the aforementioned authors state that this is the easiest one to learn and use, it isn’t really so concerning uninitiated learners.

Keeping in mind this issue, the present article shows the results of the application of the jigsaw method on a class focused on learning one of the tasks of object-oriented software analysis.

This document is structured as it follows:

- section 2 shows a brief summary of the phases and products of the software development process;

- section 3 shows the design of the cooperative learning session;

- section 4 details the results obtained from the application of learning assessment tools;

- finally, there is a presentation of the conclusions and lessons learned from the application of the jigsaw method.

2. Phases and Products in the Software Development Process

Development good software is not only about programming. Good Software Engineering practices recommend following a process that comprises a set of defined activities and tasks, besides programming, which allow the creating of software systems easy to maintain and update. With that in mind, a set of models and diagrams must be created so the developer understands the magnitude and complexity of the software to develop.

Figure 1 shows a simplification of the phases to be followed in order to develop object-oriented software, as proposed by Ari Jaaksi [2], plus the products to be generated in each of them.

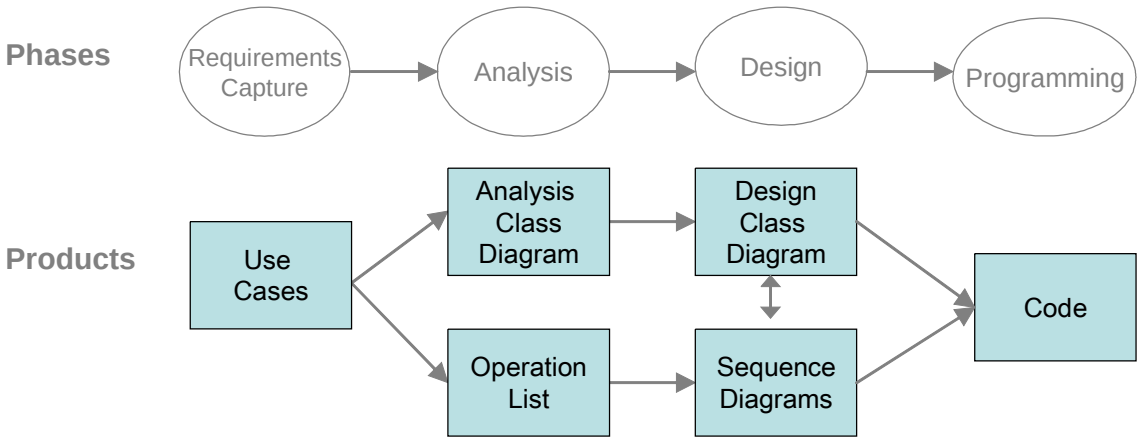


Figure 1. Phases and Products in an Object-Oriented Software Development Process

The session presented in this article addresses one of the products generated from the analysis phase: the analysis class diagram. This item must come up based on a previous product called “use case” [4] [6].

Leung and Bolloju analyzed a set of projects performed by undergraduate students [3] and were able to identify the mistakes that students made during the elaboration of this sort of diagrams. One of these mistakes – also very usual among PUCP students – is identifying relationships among analysis classes incorrectly. That’s why one of the session’s objectives was to have students learn how to perform this task properly.

3. Session Design

The session was designed for the students to draw diagrams of analysis classes for a case study. In this section we will present the case study, the instruments used to evaluate students learning and the tasks performed in class.

3.1. The case study

The full case study consisted of a musical CD playing/copying software, and it was divided in two parts: one of them was “copy CD to tape” and the other “play CD”.

The students were provided with only the use cases documentation corresponding to the diagram they had to draw.

3.2. Instruments used in the session

Following are the instruments used to gauge if the session influenced the students' learning positively:

- Two tests evaluating theoretical knowledge. One was taken at the beginning and the other at the end of the session.
- An anonymous questionnaire consulting the student's opinion about the session.

The tests consisted of multiple-choice questions and one question demanding the elaboration of a class diagram.

The purpose of multiple-choice questions was to determine if the students understood the differences between the types of relationships among classes. Regarding the class diagram question, the purpose was to determine if they could apply the analysis class concepts accurately in order to elaborate the diagram.

3.3 Tasks performed in the session

The following table shows the tasks carried out in the session, together with the approximate duration times

No.	Task	Duration
1	Initial test	10'
2	Delivery of material, explanation and formation of groups (2 people)	10'
3	Performance of an assigned task by the students	15'
4	Formation of experts' groups (maximum of 6 students) and performance of an activity	15'
5	Formation of groups of students who will integrate diagrams (maximum of 6 students)	15'
6	Closure of cooperative work	15'
7	Final test and questionnaire	10'
	Total	**90'**

After the initial test was taken, working groups were formed, materials were delivered and the session's dynamics was explained. Each group was to carry out only one of the two defined functionalities.

During task 3, the groups formed for the previous task elaborated a class diagram corresponding to the appointed functionality.

In task 4, groups of 6 maximum were formed; in which all members had elaborated the same diagram (these groups are called the "experts"). They had to compare their diagrams in order to refine them and elaborate only one definitive diagram per group. Besides, they had to answer the integral questions related to the subject.

Then, after task 5, "mixed" working groups were formed, so that each one contained students that had carried out diagrams of different functionalities. This task's goal was to combine both types of diagrams in a single one; plus, they had to answer the integral questions related to the subject.

Finally, there came the session's closure, after which the final test and the anonymous questionnaire were taken.

4. Obtained Results

This section presents the results obtained alter applying the jigsaw method in the session. First, we show the tests' results, and next, the questionnaire's results.

4.1. Test results

Regarding the results obtained from the first test, some students answered the questions about relations between classes, while others didn't. In the second test, the number of students who answered perfectly increased. Figure 2 shows these results.

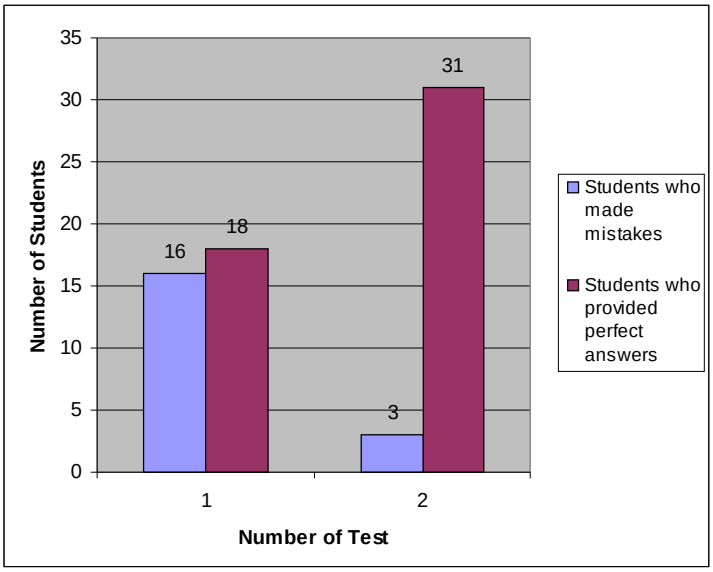


Figure 2. Results of the questions about identifying relationships among classes for each assessment

Regarding the question about the elaboration of a class diagram, there was an improvement in some of the students who elaborated an inaccurate diagram in the first test (see Figure 3)

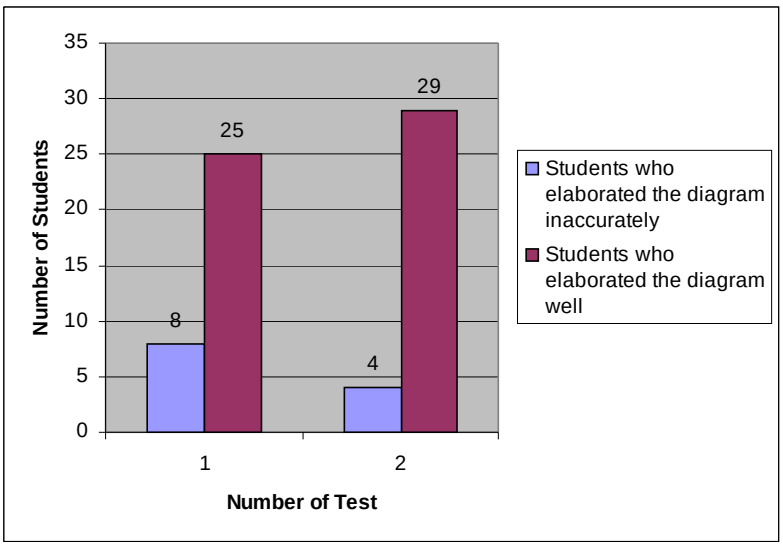


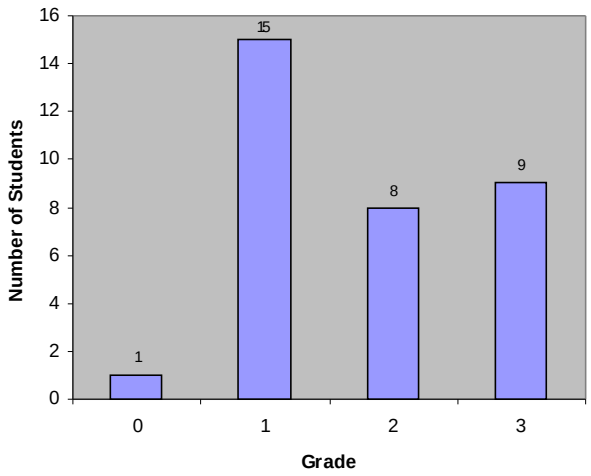
Figure 3. Results of the question corresponding to the elaboration of a class diagram

In Figures 2 and 3 you can see that, in general, there was an improvement in the students' learning.

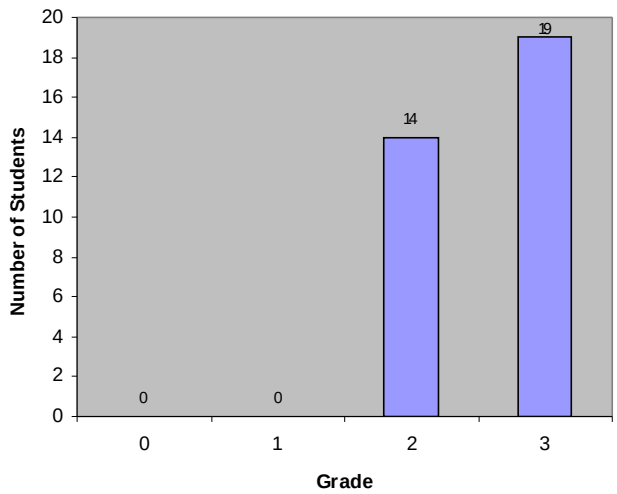
4.2. Questionnaire results

In the questionnaire, students had to grade, by a 0-3 scale, some statements concerning the following points: course organization, dictation of lectures and the cooperative session as it was carried out.

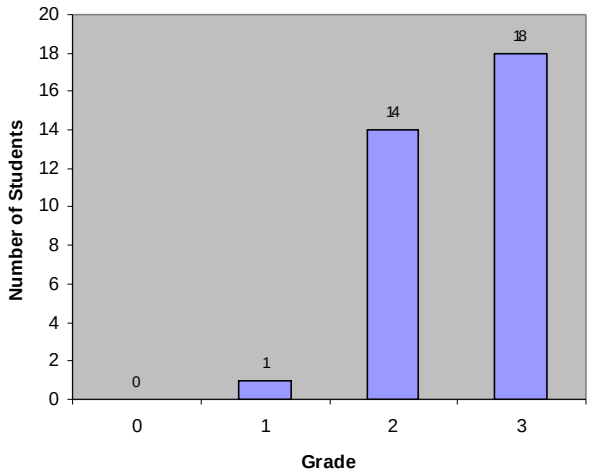
Next, the following figure presents the assertions referring to the cooperative work carried out and the students' answers.



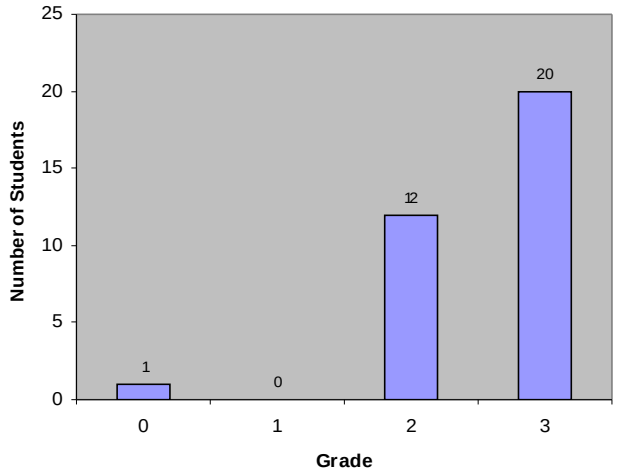
Statement 15: Before the group work kicked off, I felt I wasn't perfectly familiar with the subject



Statement 16: With my group work experience I have clarified some concepts taught in class, about which I had some doubts



Statement 17: I feel more confident at elaborating class diagrams correctly alter the group work was carried out



Statement 18: Our group activities provide us important learning opportunities, which wouldn't be the same in the context of individual work

Figure 4. Results of the questionnaire questions concerning cooperative work

In the previous figure, you can see the following aspects:

- According to answers to statement 15, at the beginning of the session there were many students who weren't perfectly acquainted with the subject of cooperative work, though an important number of them were indeed familiar with it.
- According to answers to statement 16, all students consider that, in some way, group work has helped them to clarify some concepts taught in previous classes.
- According to answers to statement 17, almost every student (except for one) considers that, in some way, group work has helped them to improve their knowledge in order to elaborate diagrams of analysis classes accurately.
- According to answers to statement 18, almost every student (except for one) considers that cooperative work helps them to create learning situations that they can't figure out in the context of traditional lectures.

Generally speaking, we can corroborate that the students who took part in the session show a very positive attitude toward the applied learning method. What's more, from the answers given, we can tell that the students feel that the session helped them to learn the subject.

5. Conclusions and Future Work

The employment of the jigsaw method in a class made students improve their knowledge about the correct elaboration of analysis class diagrams for object-oriented software.

The results of the tests taken at the beginning and the end of the session allowed us to corroborate that students who bore some misconceptions at first, eventually improved their performance after the cooperative work was finalized.

According to the answers provided in the anonymous questionnaire, we can tell that students consider that the work carried out improved their comprehension and learning of the subject.

True, this method was used to reinforce the theoretical concepts taught in class, but it remains as a future work to determine if sessions based on cooperative learning methods can replace lectures altogether.

6. Lessons Learned

The lessons learned from the application of this technique are:

- The number of students in a session shouldn't be larger than 30 per teacher. Although this work was performed with 36 students, it was a bit complicated at times to solve every group's inquiries.
- The closure of cooperative work is very important, since that's when the conclusions of the work done are presented, and the student becomes really aware of the achieved learning. This is why a proper time-controlling is necessary.
- It is advisable to have additional questions and tasks in store together with the already planned ones for the session, since there might be groups that perform their tasks more quickly than expected.

7. Appreciations

I'd like to thank Mónica Sánchez, at MAGIS-PUCP, and Luis Flores, teacher at the Dept. of Engineering, for their valuable suggestions, which made it possible for me to prepare this article.

8. References

[1] Aronson, E. et al, The Jigsaw classroom, Sage, Beverly Hills, 1978.

[2] Jaaksi, A., A Method for Your Object-Oriented Project, Journal of Object-Oriented Programming, Vol 10. No 9, 1998.

[3] Leung, F., Bolloju, N., Analyzing the Quality of Domain Models Developed by Novice Systems, Proceedings of the 38th Hawaii International Conference on System Sciences – 2005, IEEE Computer Society, 2005.

[4] Pow-Sang, J., La Especificación de Requisitos con Casos de Uso: Buenas y Malas Prácticas, II Simposio Internacional de Sistemas de Información e Ing. de Software en la Sociedad del Conocimiento-SISOFT 2003, Pontificia Universidad Católica del Perú, Lima-Perú, 2003.

[5] Roeders, P., Un Diseño del Aprendizaje Activo, Walkiria Ediciones con apoyo de la Cooperación Técnica Alemana, primera edición peruana, Lima, 1997.

[6] Schneider, G., Winters, J.P., Applying Use Cases, Second Edition, Addison-Wesley, Massachussets, USA, 2001.