A Web-based Peer Assessment System for Assigning Student Scores in Cooperative Learning

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Abstract **– Working in groups has become increasingly important in order to develop students' skills. However, it can be more successful when peers cooperate and are involved in the assigned tasks. However, several educators firmly show disadvantages when all peers received the same reward, regardless of individual contribution. Some teachers also considering peer assessment to be time and effort consuming because preparation and monitoring are needed. In order to overcome these problems, we have developed a web-based peer assessment referred to as the 'Scoring by Peer Assessment System' (SPAS) that allows teachers to set up the process of peer assessment, in order to assign scores that reflect the contribution of each student. Moreover, a web-based application allows students to evaluate their peers regarding their individual contribution where cooperative learning and peer assessment are used. The paper describes the system design and the implementation of our peer assessment application.**

Keywords **– Cooperative learning, Peer-assessment, Student Contribution, Web-based application.**

1. Introduction

In recent years, a growing challenge for teachers using group work in a class is to ensure that it will be a great benefit for students. Several universities worldwide intend to develop students' abilities and socialization among students in order to encourage teamwork as a crucial skill. Therefore, cooperative learning becomes an important teaching approach, as it can facilitate both knowledge acquisition and the development of teamwork skills [1]. Teachers often assign various tasks, relevant to both group and individual work. Mostly, they also use group work to ensure that students will gain a positive learning experience. Powell and Wimmer examined the group work for mobile application development within a programming course in an attempt to improve learning experience [2]. The result indicated that most students in the case study have positive perceptions regarding group work. These literatures help us to understand why working in groups for undergraduate students has grown increasingly important. Murray and Boyd have claimed that having students work in collaboration with each other brings a distinguished benefit to individual learning [3]. However, teachers often face difficulties in marking the group work assignments produced by each group. Several papers, such as Cheng and Warren [4] and Gibbs et al. [5], indicate that group work may cause unfair situations for those who contribute more within the assigned tasks. Nevertheless, all members in the group received the same score regardless of their individual contribution. Some students in the class were unhappy and unwilling to accept this unfairness. This drawback also causes teachers to have problems in asking their students to work collaboratively. Moreover, teachers cannot determine the real contribution of each member because the outcome produced by the groups cannot reflect the real effort of each student. When a group of students have been assigned to do a complex task, all members of the group will have a brief discussion. They will separate the assigned task into smaller tasks and then distribute these to each member. In many cases, some students may ignore their assigned task. In order to complete the whole task on time, some other members may have to help in finishing it. In some other cases, some peers hand in bad quality work, which may lead to a bad outcome overall. This task will be fixed by the other members. In other words, someone may benefit from the work of other hard-working students. As a result, it may not be

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beneficial in terms of individual learning, because not all members of the group participate in the group work. The members who put more effort to complete these tasks work efficiently and help finishing the group work [6]. However, all members in the groups receive the same mark. Thus, working in groups is often criticized as inequitable, which is especially true for students who work harder than others. In addition, Cheng and Warren [4] argue that the peer assessment of group members' contributions proved to be a realistic and realizable objective, able to enhance the student skills needed for future careers. Lin and his fellows [7] cited that web-based peer assessment had some advantages over ordinary peer assessment. Therefore, it motivates us to develop a web-based tool that helps to support the teacher to create peer assessments in order to assign scores that reflect the role and the contribution of each student.

The paper is divided into six parts, including this introductory section. Section 2 describes the works involved in group work and peer assessment. The rest is structured as follows. Section 3 demonstrates the process of SPAS including a use case diagram and user interfaces. Section 4 gives an example, and shows how to calculate the final individual student marks. Section 5 illustrates the empirical case study in order to see how efficient is SPAS. The last section includes conclusions and potential future works.

2. Peer Assessment and Cooperative Learning

Presently, cooperative learning has grown more important for many universities. Typically, it is defined as an essential tool for developing participants' abilities and education, notably by Peng [8], Falchikov [9], and Kulkarni et al. [10]. Peng cites that peer learning and assessment of students are helpful for developing students' thinking, lifelong learning and collaborative skills. Falchikov states that the assessment of students is an alternative activity for any professional in higher education, and quite effective in terms of developing students' skill. Kulkarni et al. describes an online assessment approach in Massive Online Classes. Liu et al. used a system named NetPeas at a university, in order to explore student's feedback for the assessor used for the instructor evaluation, which aims to encourage students to improve their assessment skills [11].

Elliott and Higgins cited that it is a challenging topic for teachers to consider ways of assessing both the process and the outcome, and to ensure equality in grading group work [1]. They reported that the majority of students in their case study considered the self and peer assessment as a fair method of evaluating the individual's contribution to group work. Accordingly, interesting studies have been conducted on marking student grades or scoring regarding student contributions.

Freeman and McKenzie reported that both self and peer assessment for students in the study was a good approach, assuring equity and fairness in marking their group work [6]. They also cited that students in their case study knew the criteria for group work that influenced their grade. However, the students would not have taken these factors seriously.

It has been argued by Strong and Anderson [12] that students should have an opportunity to secretly evaluate their group members' contributions. Strong and Anderson firmly stated that it is hard for a teacher to evaluate each member's contribution and responsibility.

In order to assess the contribution and responsibility of each member, Earl [13] presented a measuring method for finding an individual's contribution to group performance. In this work, teachers will use an interview to evaluate each member's contribution. Then, teachers can convert the effort of each student to the real score. However, in some cases, many students cannot explain in detail what they have done in the group work even though their task is important. Teachers sometimes require a longer time to find this out. Using this process becomes time consuming. For this reason, Cheng and Warren proposed a method that allows teachers to mark the individual score more accurately [4]. They explain how this method helps in eliminating the unfairness that might have occurred in the group work. It is a great way to help students learn more effectively. Thus, teachers will be more satisfied with the performance of students. The method involves evaluation of the other members during the work. Most important is that all group members must be aware of, and involved in, helping the group to complete the assignment task. Cheng and Warren have developed the method based on the concept of Conway et al. [14], where self-assessment is not included in the process. The individual participant is used in the method in order to calculate a score as shown in the equation as follows:

$$Final\ individual\ student\ mark = IWF * Final\ group\ project\ mark \quad (1)$$

And,

$$IWF = Individual\ effort\ rating / Average\ effort\ rating\ for\ group \quad (2)$$

, where IWF stands for individual weighting factor.

The individual effort rating derives from the real contribution of each member in completing the assignment, such as group meetings, presentations, and oral examinations. The average effort rating for

the group is the total score from all members divided by the number of the group. From this approach, we can see that each student's score is related to the group's success and the cooperation of the students in the group. The derived score will be higher or lower depending on the Individual Effort Rating. Then, Chang and Chen [15] proposed a diagram of group E-learning in evaluating the performance of the group as presented in Figure 1. In the Conway et al. study [14], students were involved in the assessment and determined the group mark using a five-point scale for three criteria. Therefore, for each question we use a typical five-level Likert scale [16] in the peer assessment of students from 1 (strong disagree) to 5 (strongly agree).

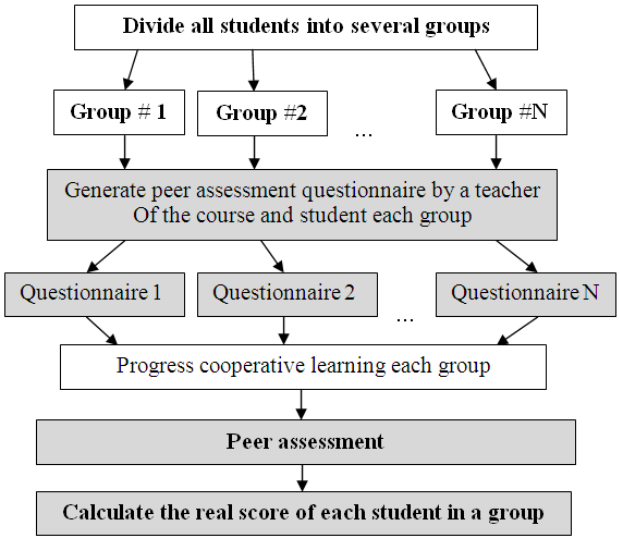


Figure 1. A diagram of group E-learning for evaluating the performance of the group proposed by Chan and Chen [15].

In this paper, we use the diagram illustrated above and the questionnaire made by Chang and Chen [15] for calculating the score of each student in a group. The questionnaire is revised and contains ten questions, which are displayed as follows.

1. He/ She demonstrates responsibility in the group.
2. Participant in the group.
3. Contribution to the completion of tasks in the group.
4. Expressing options in every discussion.
5. Participating in discussions punctually.
6. Punctually accomplishing the tasks assigned.
7. Maintaining focus on the task during every discussion.
8. Enthusiastic about helping other members.
9. He/ She has team spirit.
10. He/ She can lead others.

3. The System Design of SPAS

This part describes the design and application of a web-based peer assessment system referred to as the 'Scoring by Peer Assessment System' (SPAS). We aim to develop it as a tool for teachers in the classes where cooperative learning is used. We have developed the application using following software:

- Microsoft visual studio 2010.
- MySQL database.
- AppServ 8.4.0 which contains Apache 2.4.20 for Windows 7.

3.1 The SPAS Processes

In order to understand the use of the system for assigning student scores, the steps of the SPAS are illustrated in Figure 2.

Step 1: Teachers initiate the classes and peer assessment questionnaires. Student lists can be entered into the system in this step as well. Students can be divided into smaller groups in order to work for the assigned task related closely to the course objectives and class content. The group size varies depending on the objective of the activities or teacher decision.

Step 2: Students select the classes to do the peer assessment. When the peer assessment questionnaire of the current assignment has been set, each student can do the assessment. If the evaluation process has been finished, the students can see their final score. This step can be taken over many days until it meets the assignment deadlines.

Step 3: Students do the final submission for their peers. Any modification can be made before the final submission. The peer assessment scores will be automatically sent to be stored in the database. However, if the students miss this step, the evaluation will be automatically sent to the database within the specific deadline.

Step 4: The teachers will do this step to complete the SPAS process. However, they can do this step whenever they want before the deadline. Once the teachers mark the score for each group, the final individual student mark can be completely calculated. The results will be sent to the students as well as the teachers.

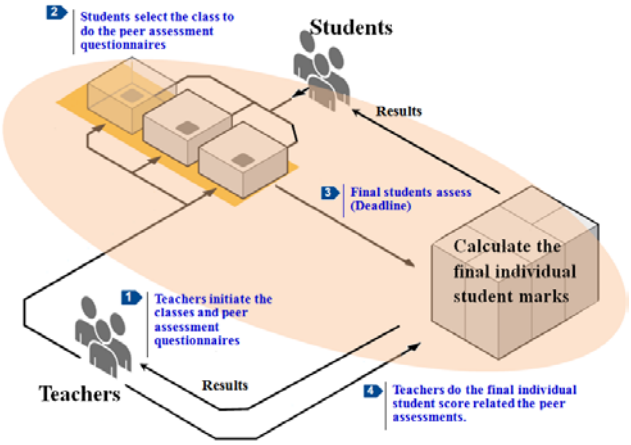


Figure 2. The SPAS processes.

3.2 Use Case Diagram

A use case diagram of the SPAS is demonstrated in Figure 3. The three types of users are administrator (Admin), teacher, and student.

3.2.1 Admin: All users were created by the admin. Only registered users can enter the SPAS by logging on to the system. A screenshot of the program is shown in Figure 4. The admin can specify a new user and password. Administrators can create more Administrators.

3.2.2 Teacher: Teachers can set up classes and management online as follows:

- Manage student lists and help to separate students into several groups. After registering the course, the teacher clearly sets the educational goals of peer assessment, and the whole procedures associated with the group project. A screenshot example for registering the course is presented in Figure 5. The assigned projects must be divisible into multiple tasks of the same complexity, which can be assigned easily to each member. The teacher also details the assignments and discusses these with the students. In addition, some guidelines and materials may be prepared for students in order to complete the group assignment.
- Initiate peer assessment questionnaires associated to the course for all students. Teacher sets a questionnaire online, which is adapted from Chang and Chen [15] as presented above. Alternatively, the teachers can select or deselect questions from the list as they prefer. An example of this is illustrated in Figure 6. Then, students work on each assigned task within a limited period of time according to the teacher's instruction.
- Mark the final individual student score accurately based on peer evaluation using (1) and (2). The final score of the project is derived by the teacher who is responsible for the course.

3.2.3 Students: The screenshot examples for the student interface in selecting peers and assessing individual contribution are presented in Figure 7. and Figure 8. respectively. As presented in both figures, there is no self-assessment in our system. Once assessors evaluate the peer associated with the work, the system automatically returns the scores to the teachers to mark the final individual student score. Then, the system returns the final score to each student.

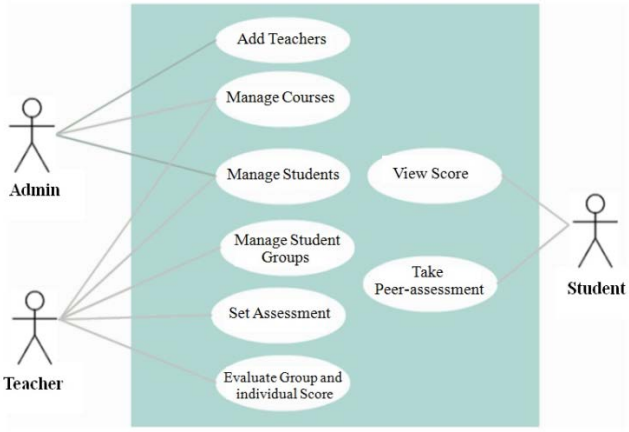


Figure 3. A use case diagram for SPAS.

Figure 4. Log on to the SPAS.

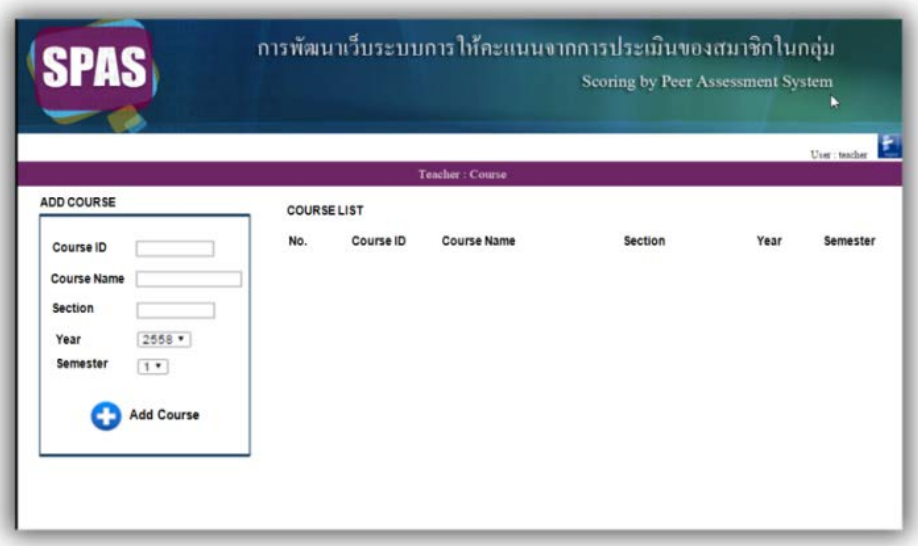


Figure 5. A screenshot example for registering new courses.

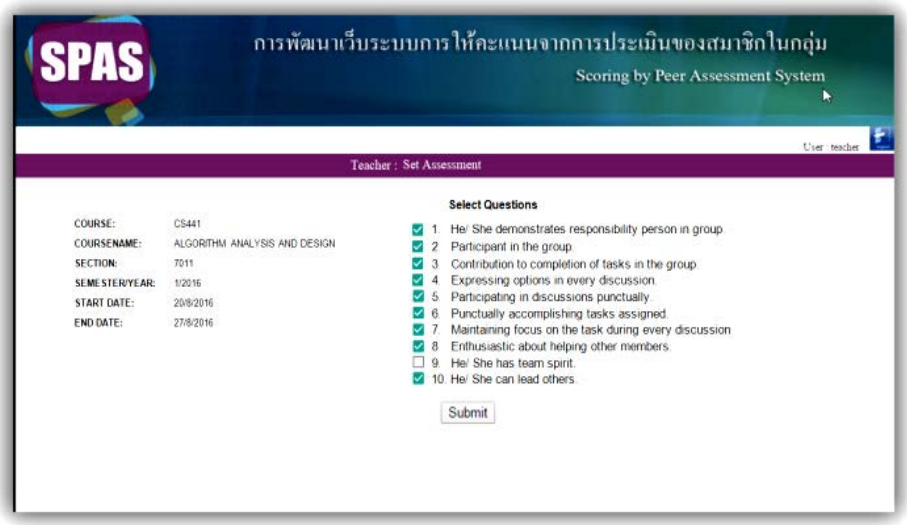


Figure 6. A screenshot example for a teacher to set a questionnaire for a course.

Figure 7. A screenshot example for students to choose peers.

Figure 8. A screenshot example for students to assess peers.

4. Example Calculation of the Final Individual Student Mark

The important task that the teacher needs to do before using SPAS is to provide students with objective criteria by which individual contributions may be judged. All students should be aware of how important peer cooperation and peer assessment are before starting the assigned project. Once they understand clearly, peer assessment may motivate students to contribute more to the group. In our paper, the final individual student mark is calculated by two factors: a group mark given by a teacher, and the individual score derived by peers. For example, a group of students contains four members: Ann, Ben, Candy, Dan. They have been assigned to cooperatively work to complete the project. In the final assessment, the teacher awards 70 out of 100 to the group. Suppose the average individual score derived by the peers is presented in Table 1.

Table 1: Example of average individual score derived by peers.

Questions	Ann	Ben	Candy	Dan
He/ She demonstrates responsibility person in the group.	1.5	3.67	3.33	1.66
Participant in the group.	1.5	3	1.67	1.5
Contribution to completion of tasks in the group.	2	2.33	1.67	2.33
Expressing options in every discussion.	2	3.33	2.33	1.33
Participating in discussions punctually.	2.5	2.67	1.67	1.66
Punctually accomplishing tasks assigned.	2.00	2.67	1.67	2.67
Maintaining focus on the task during every discussion	2.3	2.33	2.3	2.3
Enthusiastic about helping other members.	1.0	3.33	2.33	1.3
He/ She has team spirit.	1.33	3.0	1.3	1.5
He/ She can lead others.	1.00	3.33	2.0	2.0
Sum	**17.13**	**29.66**	**20.27**	**18.25**

Note: There is no self-assessment. And, the average evaluation of each student is derived from the other peers. For example, Ann is assessed by Ben, Candy, and Dan.

The average effort rating for the group is calculated as below:

$$\frac{17.13+29.66+20.27+18.25}{4} = 21.33.$$

Based on (2), the individual weighting factor (IWF) for each member can be calculated as below:

IWF for Ann is $\frac{17.13}{21.33} = 0.80$,

IWF for Ben is $\frac{29.66}{21.33} = 1.39$,

IWF for Candy is $\frac{20.27}{21.33} = 0.95$, and

IWF for Dan is $\frac{18.25}{21.33} = 0.86$.

Since the teacher awards 70 out of 100 to the group, the final individual student mark of each student can be demonstrated as follows:

Final individual student mark for Ann $= 0.80 * 70$
$= 40.16$
Final individual student mark for Ben $= 1.39 * 70$
$= 69.53$
Final individual student mark for Candy $= 0.95 * 70$
$= 47.52$
Final individual student mark for Dan $= 0.86 * 70$
$= 42.78.$

Furthermore, the teacher can modify the way of calculating the final individual student mark to the 50/50 split mark process in providing the safe margin which was first introduced by Gatfield [17]. For the group receiving 70 out of 100 for their group mark, each member receives 35 for the fixed portion. The rest, which is 35 points, will be multiplied by the IWF. Based on the fixed portion of 35, the individual marks for each group member is presented as follows:

Final individual student mark for Ann $= 35 + .80 * 35 = 63$

Final individual student mark for Ben$=35 + 1.39 * 35 = 83.65$

Final individual student mark for Candy$=35 + .95 * 35 = 68.25$

Final Individual Student Mark for Dan$=35 + .86 * 35 = 65.1$.

The comparison of teacher marks without the IWF, teacher marks with the IWF, and teacher marks with the IWF and 50/50 safe margin portion is presented in Figure 9. It indicates that calculating the individual marks for each group member based on the fixed portion results in individual student marks higher than the other processes.

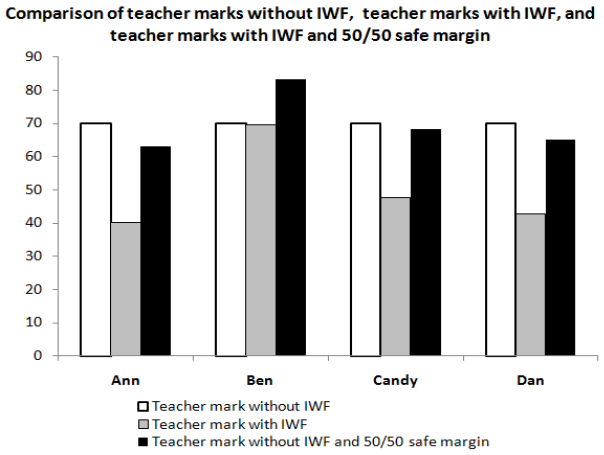
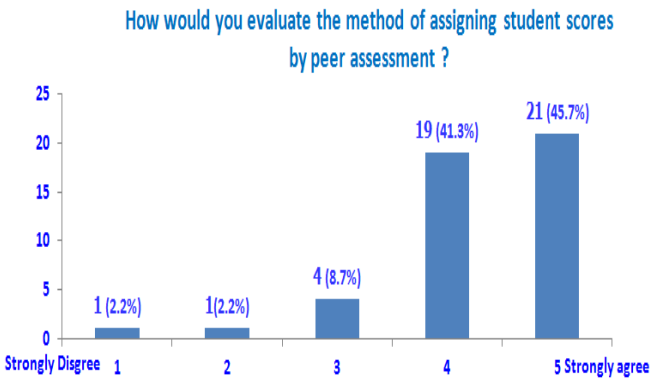


Figure 9. Comparison of teacher mark only, teacher mark with IWF, and teacher mark with IWF including the 50/50 margin portion.

5. Empirical Case Study

In this empirical case study, the "traditional methods" are defined as the learning group methods in which the group members have no opportunities to evaluate peer's contribution during the assessment. Many teachers fully ignore the situations in which some members of a group are freeloading. Working in the tradition methods fail mostly because of a lack of clarity about what the objective of group assignment really is. Additionally, it may cause problems when the assignment topic cannot be separated into smaller piece of tasks for each member. In addition, the group members have a lack of experience in order to separate projects and tasks so they can not start getting things done in terms of cooperation. In these situations, some members are given no identical assignments leading student's refusal to work.

In order to capture the students' reaction and feedback related to the developed application, two satisfaction questionnaires were used in an empirical class where a team work and a scoring peer assessment approach are employed. In this paper, the first questionnaire is to ascertain the students' satisfaction after using the SPAS. The second is to find the attitudes and preferences about participation. The survey was completed by the undergraduate students majoring Information Technology and Innovation, Bangkok University, Thailand, who registered the course CS440: Design and Analysis of Algorithms in the second semester 2016. There were 46 participants that filled in the questionnaire. Students were separated into 8 groups. Each group was assigned to do the assignment associated with the aim of the course. Since a few students misunderstand the purpose of scoring by peer assessment, it is helpful to introduce students to the concepts and the benefit of scoring by peer assessment. At the end of the process, each student was required to fill in an online questionnaire. The results are presented as follows.



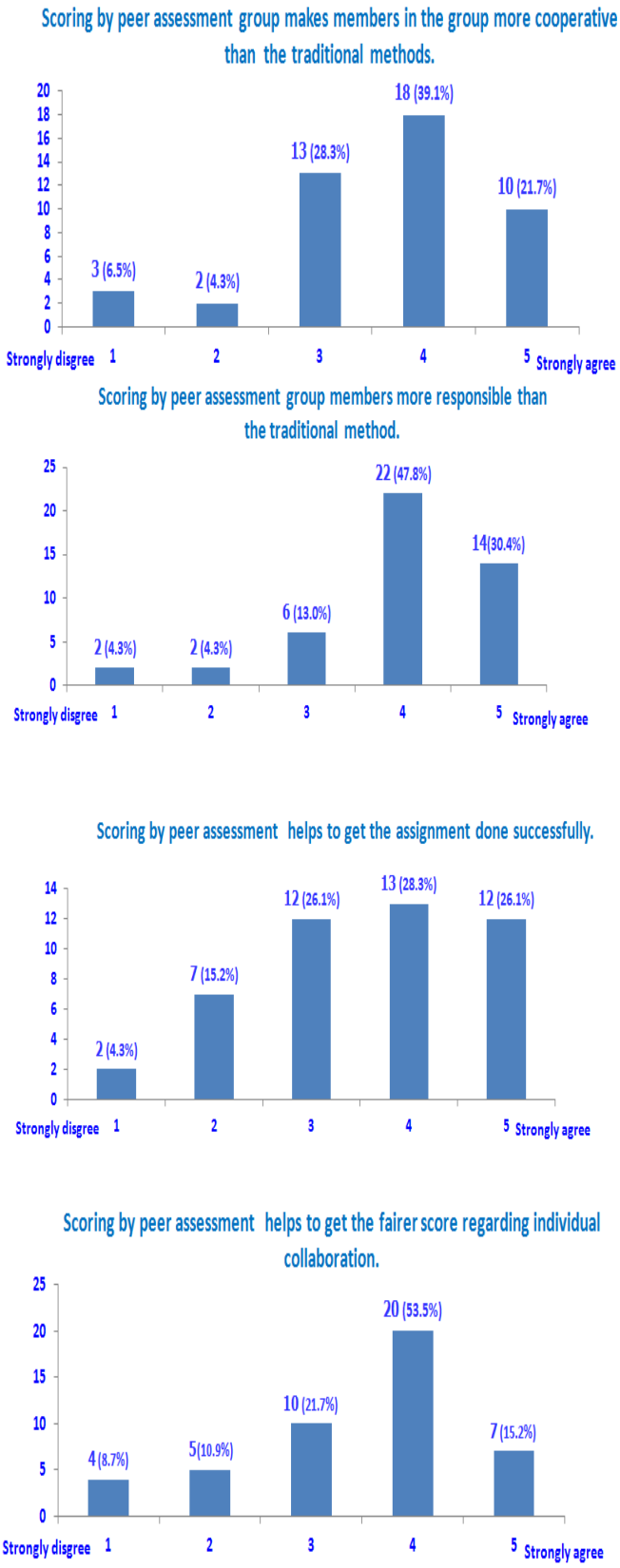


Figure 10. The results derived from assessing the approach undertaken (46 responses).

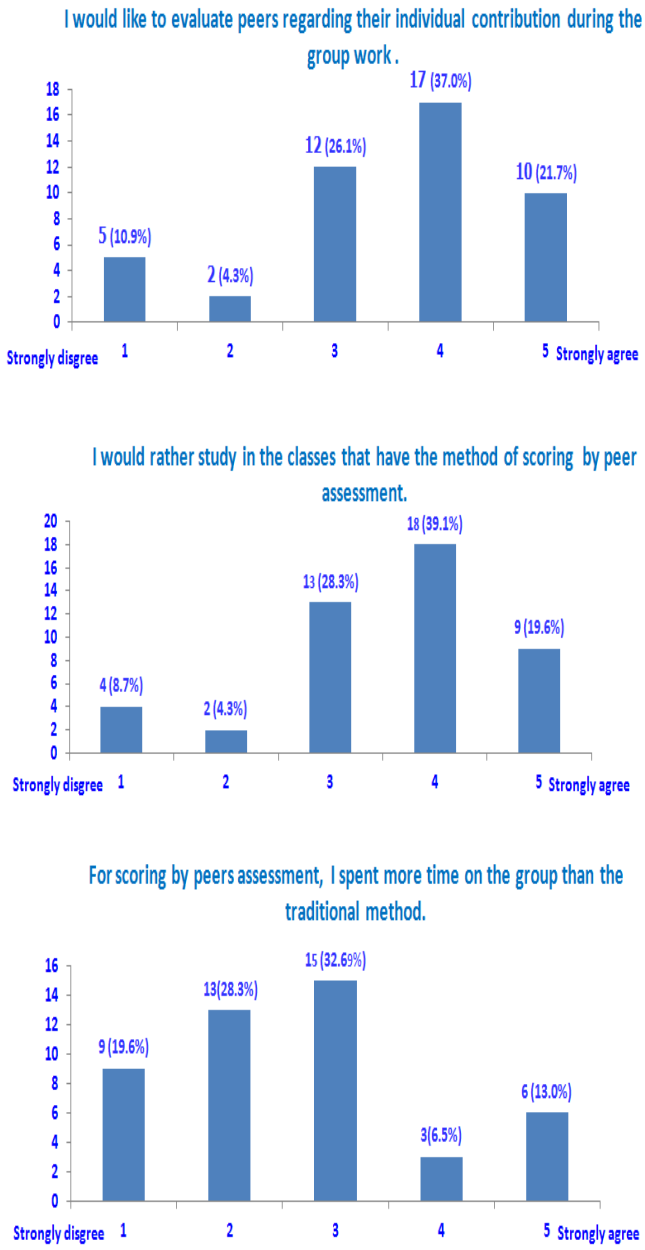


Figure 11. The results on attitudes and preferences about participation (46 responses).

6. Conclusion and future work

In this paper, the web-based application named SPAS is presented in order to assign scores that reflect the real contribution of each student. We hope that it helps in creating fairness in cooperative learning and reducing the preparation time needed for peer assessment. Students will have the opportunity to assess each other's contribution and see how other members view themselves in the team. Additionally, we present the design and user interfaces of our web-based application. Regarding the survey results, they illustrated that the use of the peer assessment system for assigning scores in which students make formal assessments of others within a group work can inhibit more cooperation. Moreover,

most students preferred to use the peer assessment to get the score regarding individual contribution.

For future works, we will apply the SPAS as a tool to improve the students' performance. Several classroom case studies to determine the effectiveness of the SPAS are needed. A student satisfaction questionnaire must be designed for students where a team work and a peer assessment approach are used. The main objective of the questionnaire is to find how well the SPAS helps in marking scores more accurately, and in its ability to reflect the contribution of each student. Additionally, we will see the perception and satisfaction of both teachers and students related to the peer assessment system in different subject areas. In the meantime, the assessment criteria affecting the overall learning outcomes will be concerned. The balance between student assessment and teacher score in any given cooperative assignments is also taken into consideration.

References

[1] Elliott, N., & Higgins, A. (2005). Self and peer assessment–does it make a difference to student group work?. *Nurse Education in Practice*, *5*(1), 40-48.

[2] Powell, L. M., & Wimmer, H. (2015). Evaluating the Effectiveness of Student Group Work for Mobile Application Development Learning, Productivity, Enjoyment and Confidence in Quality. In *Proceedings of the EDSIG Conference* (p. n3456).

[3] Murray, J. A., & Boyd, S. (2015). A Preliminary Evaluation of Using WebPA for Online Peer assessment of Collaborative Performance by Groups of Online Distance Learners. *International Journal of E-Learning & Distance Education*,*30*(2).

[4] Cheng, W., & Warren, M. (2000). Making a difference: Using peers to assess individual students' contributions to a group project. *Teaching in Higher Education*, *5*(2), 243-255.

[5] Gibbs, G., Habeshaw, S., & HABESHAW, T. (1986). Interesting Ways to Assess Your Students (Bristol, Technical and Educational Services).

[6] Freeman, M., & McKenzie, J. (2002). SPARK, aconfidential web–based template for self and peer assessment of student teamwork: benefits of evaluating across different subjects. *British Journal of Educational Technology*, *33*(5), 551-569.

[7] Lin, S. S., Liu, E. Z. F., & Yuan, S. M. (2001). Web-based peer assessment: feedback for students with various thinking-styles. *Journal of Computer Assisted Learning*, *17*(4), 420-432.

[8] Peng, J. C. (2010). Peer assessment in an EFL context: Attitudes and Correlations. In *Selected Proceedings of the 2008 Second Language Research Forum, ed. Matthew T. Prior et al* (pp. 89-107).

[9] Falchikov, N. (2013). *Improving assessment through student involvement: Practical solutions for aiding learning in higher and further education*. Routledge.

[10] Kulkarni, C., Wei, K. P., Le, H., Chia, D., Papadopoulos, K., Cheng, J., ... & Klemmer, S. R. (2015). Peer and self assessment in massive online classes. In *Design thinking research* (pp. 131-168). Springer International Publishing.

[11] Liu, E. Z., Lin, S. S., & Yuan, S. M. (2002). Alternatives to instructor assessment: A case study of comparing self and peer assessment with instructor assessment under a networked innovative assessment procedures. *International Journal of Instructional Media*, *29*(4), 395.

[12] Strong, J. T., & Anderson, R. E. (1990). Free-riding in group projects: Control mechanisms and preliminary data. *Journal of Marketing Education*,*12*(2), 61-67.

[13] Earl, S. E. (1986). Staff and peer assessment-measuring an individual's contribution to group performance. *Assessment and Evaluation in Higher Education*, *11*(1), 60-69.

[14] Conway, R., Kember, D., Sivan, A., & Wu, M. (1993). Peer assessment of an individual's contribution to a group project. *Assessment & Evaluation in Higher Education*, *18*(1), 45-56.

[15] Chang, T. Y., & Chen, Y. T. (2009). Cooperative learning in E-learning: A peer assessment of student-centered using consistent fuzzy preference.*Expert Systems with Applications*, *36*(4), 8342-8349.

[16] Bertram, D. (2007). Likert Scales… are the meaning of life: CPSC 681–Topic Report.

[17] Gatfield, T. (1999). Examining student satisfaction with group projects and peer assessment. *Assessment & Evaluation in Higher Education*, *24*(4), 365-377.