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Adapting robot soccer game in student self-centered learning

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Abstract

Robot soccer competition is a new learning method introduced in the Faculty of Information Science and Technology in the past two years. Previously, various friendly matches have been held between the National University of Malaysia team and Malaysian polytechnic students. However, not all of the students, especially the FTSM students felt the fun of the game. Therefore, the competition format is applied in two courses; TC2263 - Knowledge-based Systems and TR3343 – Real Time Systems. Parallel with the purpose of student self-centered learning method, assignments are given to the students to develop the best robot soccer game strategy. They only need to attend some lectures and laboratory sessions and they are given the opportunity to complete the remaining tasks individually until the day of the competition. There are three methodologies used in this research; the data taken during the in class competition where it is judged by external judges who are experts in robot soccer, the observation of the final grade, and finally the questionnaire through the Course Teaching Evaluation System provided by UKM. The application of robot soccer competition in this class has shown increased performance in analytical and critical thinking skills in problem solving, and programming skills and technical report writing. Besides that, the application of robot soccer competition can also realise self-centered learning among FTSM students.

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1. Introduction

Student’s understanding of the subject followed is an issue which is difficult to measure. Even though the students are used to answer final examination questions, it is not a perfect measure to ensure the students’ understanding of the subject. Lecturers or educators are often in this dilemma when they begin each lecture. One of the things in their mind is whether the students can really understand the lesson that will be presented later. Lecturers often feel discontentment with the students who sometimes display reactions like confused look, their eyes are not focused on the audio, video or lectures that are presented, often whispering to the friend beside them or often going out of the lecture rooms because they want to go to the toilet or any other reasons. Instead, lecturers will feel
happy if the students laugh, compete with each other to answer the questions given, ask if they are confused, or they can identify lecturer’s error when teaching. This shows that the students do not simply accept the knowledge, but they are trying to find rationality and their brains begin to think and simulate and match the practical knowledge of theories, formulas, or the principles introduced.

Therefore, a creative lecturer will constantly renew his teaching methods. Among the methods that have been done are pop quiz, practical in the laboratory, a visit to the real world, interview or invite outside speakers to learn in depth about the practical used. Are these classical methods sufficient?

Various teaching slogans are announced by academics around the world and UKM also responded to it. These slogans have only one goal that is to produce students who meet the market requirements, honorable, adaptable, and competent in specific field.

2. State of the Art

A variety of learning methods are introduced to all levels to meet the vision of Universiti Kebangsaan Malaysia, "UKM is committed to be ahead of society and time in leading the development of a learned, dynamic and moral society."

Among the methods that have been introduced are the objective based learning, problem-based learning (Drake and Long, 2009; Saemah Rahman, 2004), lifelong learning (Boyinbode and Bagula, 2011), adaptive learning (Wan Wan Hamidon Badaruzzaman, 2004), outcome based learning (Susan Pascoe, 2007), collaborative learning (Abdul Wahab Mohammad et al., 2010) and most recently is students self-centered learning.

In reality, students will strive to master and learn in depth about the topic introduced if they are interested in it. If a person is addicted to Android computer games such as "Angry Birds", he will put a lot of effort with full interest to find the best shooting strategy to save the birds that are tied or locked up. This game has few privileges where it adopts the spirit of helping one another, the more they release a trapped bird, the more rewards earned.

However, what is the relation of it with learning? Indirectly, we may relate the games with learning. Game learning methods have been actively applied in primary schools and secondary schools simultaneously with the creation of many compact disks and online games. Is the game learning method also rational at the university level? Although the game in primary or secondary schools needs to be regulated by the game structuring, how is it adjusted to the student self-centered learning activity?

From the lecturers’ aspect, they will feel embarrassed or excited when students know the subject better than them. However, for the concept of student self-centered learning, lecturers need to look at the positive aspect because it can produce students who are critical, creative, and innovative in a field. With the objective to eliminate boredom in the traditional teaching, the game method such as robot soccer game deserves to be applied in the course. In fact, it has been proven to be successfully applied in the undergraduate and postgraduate courses around the world such as Korea, Germany, Japan, the UK and U.S. Therefore, the international robot soccer competition is held every year to encourage the evolution and application of artificial intelligence algorithms in the application system. The idea of robot soccer was originated in 1995. In September 1995, Professor Jong-Hwan Kim from KAIST in Korea officially established the "International Organising Committee" (IOC) for the Micro-Robot World Cup Soccer Game (MiroSot) which had initially joined by 23 groups which consist of 10 states (www.fira.net).

Besides that, a study by Coradeschi and Malec (1999) had used the competition in the artificial intelligence subject. The challenge has been given to the students so that they are focused on the subject taught. The method used was Robocup simulator. At the end of the semester, a simulator Robocup competition has been held to give opportunities to the students to present strategies and give confidence to them.

Programming competition allows students to improve and evaluate their programming skills compared to their friends (Lawrence, 2004). The significant contribution in the study by Lawrence (2004) was an interactive competition during assignments that has improved student’s effort and satisfaction compared to the project when the competition was held after the assignment is completed. This competition increased motivation and efficiency. Learning motivation in general has great success (Fallows and Ahmet, 1999). Competition aspect also increases the students’ interaction involvement in different students learning styles (Felder and Silverman, 1998). In a study by
Lawrence (2004) the percentage of students who agreed on the fact that the project competition makes the course more interesting is 88%.

At St. Lawrence University, a study by Ladd and Harcourt (2005) found that the engagement and competition motivates students. They used a robot simulation software and found the excitement of students and their involvement during the competition are hard to observed with a traditional programming tasks. Students also often discuss the strategies and problems encountered to win the games. Besides that, Pratomo et. al (2010, 2011) also presented the some control and obstacle avoidance strategy which has been tested on a group of students to evaluate their analytical thinking in Robot Soccer programming. As conclusion, competition element has become an interesting integration attribute to world of learning and education.

3. Methodology

The Faculty of Information Science and Technology (FTSM) is also making the move to introduce a robot soccer game since two years ago. Various friendly matches were held between the National University of Malaysia and the polytechnics in Malaysia to improve students’ performance. The robot soccer is a new learning method for students who participate in it.

The study was conducted to see the students’ performance towards self-centered learning by applying a robot soccer match in two courses; TC2263 – Knowledge Based Systems and TR3343- Real Time Systems. These courses are taken by second year students in the Intelligent Systems program (TC) and third year students in the Industrial Computing program (TR) in the second semester, 2010-2011 session. Research hypothesis assumes that the students are less interested in the traditional course learning and the student’s lack of motivation in programming learning and teamwork. Besides that, does adding an element of competition and self-centered learning can transform a passive student to an active one?

Within the first seven weeks, the students are undertaken classical lectures, lab sessions and middle semester examination to grasp the theoretical and basic understanding of the intelligent system or real time system courses. Then, for the next seven weeks, the students will learn about Robot Soccer game by applying some fundamental concepts. Both courses allocate Robot Soccer element about 50% of their total course mark. The student must attend only two lectures and two lab programming sessions within two weeks time before participating in the Robot Soccer competition. The rest of the time, they are given their own free time to finish their full game strategy consisting of five different robot roles (Two attackers, two defenders and one goalkeeper). They should delegate those tasks within their group members. During the competition, each group should also present their strategy verbally and practically. Their proposed strategy will fight versus the Lingo strategy. Finally, the students are required to prepare and submit their strategy reports. As conclusion, instead of having final course examinations, these students are measured through Robot soccer game and their competency in interpersonal skills.

There are three evaluation methods used; data taken during the in class competition judged by external judges who are experts in robot soccer, the observation of the final grade, and finally the questionnaire on the evaluation of teaching courses provided by UKM. The judges awarded the marks by groups. Data was taken from TC2263 and TR3343 courses in the second semester, 2010/2011 session. A total of 50 students were evaluated from these two courses; 17 second year students in TC2263 from the Intelligent Systems program (TC) and 33 third year students in TR3343 course from the Industrial Computing program. Questionnaire provided by UKM to assess the course teaching is divided into three categories; general, faculty, and lecturer. Quantitative data obtained from the three methods are analysed using descriptive statistics and statistical relationships to achieve the objective of this study.

4. Results

The data obtained were analysed in two stages. The first stage uses descriptive statistics; students’ performance, the students’ interest in learning by applying a robot soccer competition in the TC2263 and TR3343 courses, to look at the student's ability in the existing strategies in a robot soccer game and to look at the satisfaction of learning from students in the course. Meanwhile, statistical relationship is used to look at the students’ performance in a robot soccer game.
4.1 Descriptive Analysis

From the analysis of results, it is found that the students’ performance and their interest in learning have increased. This can be seen in the students’ final achievement for the TC2263 and TR3343 courses where students have achieved excellent performance (A and A-) and good (B+, B, and B-) as shown in Table 1. A total of 47% of students in the TC2263 have obtained grades A and A-, while 53% obtained grades B+ and B. A total of 6.1% of TR3343 students achieved grade A, while almost 70% of the students get a grades of B+, B and B-. Figure 1 shows the graph for the final achievement for students in TC2263 and TR3343 courses.

Table 1. The students’ final achievement in TC2263 and TR3343 courses

| Grade | TC2263 | TR3343 |
|-------|--------|--------|
|       | N      | Percentage % | N      | Percentage % |
| A     | 4      | 23.5    | 0      | 0.0          |
| A-    | 4      | 23.5    | 2      | 6.1          |
| B+    | 4      | 23.5    | 9      | 27.3         |
| B     | 5      | 29.4    | 3      | 9.1          |
| B-    | 0      | 0.0     | 11     | 33.3         |
| C+    | 0      | 0.0     | 8      | 24.2         |
| C     | 0      | 0.0     | 0      | 0.0          |
| C-    | 0      | 0.0     | 0      | 0.0          |
| D     | 0      | 0.0     | 0      | 0.0          |
| E     | 0      | 0.0     | 0      | 0.0          |

Figure 1. The students' final achievement in TC2263 and TR3343 courses

Each group of students needs to develop robot soccer strategies and participate in the simulator competition, presenting, and writing the finding report. Each outcome is evaluated by at least three external and internal judges. Each judge needs to give scores on a scale of 1 to 5.

Table 2 and Table 3 show the mean of mastery for TC2263 and TR3343 students in problem solving, critical thinking, and programming strategies in a robot soccer game. From the analysis, it is found that most students are able to solve all the strategy problems except the defender and passing strategies. This means that the programming skills also increased when the strategy developed increased. In terms of personal skills, students could write a report
that is close to the satisfactory level but the worry is that the students still lack of confidence when presenting their work verbally (Figure 2).

Table 2. Mean of mastery of robot soccer game strategies for eight TC2263 groups after being judged by external judges

| Evaluation Item | TC1 | TC2 | TC3 | TC4 | TC5 | Mean |
|-----------------|-----|-----|-----|-----|-----|------|
| Analysis, Critical thinking, Problem solving, and Programming Strategies | Passing Strategy | 2.2 | 3.0 | 2.0 | 2.0 | 3.0 | 2.44 |
| | Shooting Strategy | 1.6 | 3.6 | 1.6 | 2.6 | 3.2 | 2.52 |
| | Ball Prediction Strategy | 2.0 | 3.2 | 1.8 | 2.6 | 3.6 | 2.64 |
| | Attacking Strategy | 1.8 | 3.6 | 2.2 | 2.6 | 3.6 | 2.76 |
| | Defense Strategy | 2.2 | 2.6 | 2.4 | 2.4 | 2.6 | 2.44 |
| | Goal Keeper Strategy | 3.0 | 2.6 | 2.6 | 2.2 | 2.6 | 2.60 |
| | Presentation | 3.0 | 3.0 | 3.0 | 2.6 | 2.6 | 2.84 |
| | Writing | 1.0 | 3.3 | 2.3 | 2.3 | 2.7 | 2.33 |

Table 3: Average of mastery of robot soccer game strategies for eight TR3343 groups after being judged by external judges.

| Evaluation Item | TR1 | TR2 | TR3 | TR4 | TR5 | TR6 | TR7 | TR8 | Mean |
|-----------------|-----|-----|-----|-----|-----|-----|-----|-----|------|
| Analysis, Critical thinking, Problem solving, and Programming Strategies | Passing Strategy | 2.2 | 3.0 | 3.0 | 1.6 | 1.8 | 0.4 | 1.0 | 2.0 | 1.9 |
| | Shooting Strategy | 2.6 | 3.4 | 3.2 | 1.8 | 2.0 | 0.6 | 1.2 | 2.0 | 2.1 |
| | Ball Prediction Strategy | 1.8 | 3.4 | 3.6 | 1.8 | 1.8 | 0.2 | 1.8 | 1.4 | 2.0 |
| | Attacking Strategy | 2.0 | 3.4 | 3.6 | 1.8 | 2.8 | 0.4 | 1.6 | 1.8 | 2.2 |
| | Defense Strategy | 1.2 | 3.8 | 2.6 | 2.2 | 2.6 | 0.4 | 1.2 | 1.2 | 1.9 |
| | Goal Keeper Strategy | 1.2 | 4.0 | 2.6 | 2.4 | 3.0 | 0.4 | 2.6 | 0.8 | 2.1 |
| | Presentation | 2.4 | 3.4 | 2.6 | 2.8 | 3.4 | 2.0 | 2.4 | 2.0 | 2.6 |
| | Writing | 3.4 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 3.4 | 4.2 | 4.2 |

Figure 2. Graph of mean for TC2263 and TR3343 students in the mastery of robot soccer game strategies.
The final descriptive analysis looks at the course teaching evaluation questionnaire by the students towards lecturers before the final examination week. Three categories were asked; general, faculty, and lecturer. This assessment is taken into account to look at students’ satisfaction for courses taught and the application of robot soccer game in the course. Students should rate their satisfaction level in a scale between 1 and 5. In TC2263 and TR3343 courses, about 50% of the total course marks are taken from the involvement in the robot soccer game. Results have shown that the evaluation scores given by the students in the three categories are very satisfactory as shown in Table 4.

| Courses | Categories (Mean) |  |  |  |
|---------|------------------|--|---|---|
|         | General          | Faculty | Lecturer |
| TC2263  | 4.18             | 4.26    | 4.30    |
| TR3343  | 3.97             | 3.56    | 4.18    |

In the general assessment category of the questionnaire, seven questions were asked but there are only three questions which emphasized on:

Q1: Appropriateness of course content with course learning outcomes
Q3: Suitability of course content with current needs and development
Q6: Comprehensiveness and functionality of teaching aids

In the faculty assessment category of the questionnaire, five questions were asked but there are only three questions which emphasized on:

Q1: Course content enables student to adopt critical thinking
Q2: Course content becomes a resource to life long learning
Q5: Incorporation of multidisciplinary or integrated project

In the lecturer assessment category of the questionnaire five questions were asked, but there are only two questions which emphasized on:

Q1: Well-versed in subject and confident delivery
Q2: Delivery is clear and interesting

Table 5 below shows the mean evaluation scores for each question that are highlighted in this study for the TC2263 and TR3343 courses.

| Qs | GENERAL TC2263 | TR3343 |
|----|----------------|--------|
| Q1 | 4.13           | 3.88   |
| Q3 | 4.19           | 3.96   |
| Q6 | 4.31           | 4.00   |

| Qs | FACULTY TC2263 | TR3343 |
|----|----------------|--------|
| Q1 | 4.23           | 3.68   |
| Q2 | 4.23           | 3.26   |
| Q5 | 4.23           | 3.63   |

| Qs | LECTURER TC2263 | TR3343 |
|----|----------------|--------|
| Q1 | 4.31           | 3.84   |
| Q2 | 4.19           | 3.84   |

4.2 Relationship Analysis

Chi-Square Test was used to examine the relationship between the marks of the robot soccer final game competition with the students’ performance in TC2263 and TR3343 courses.

Analysis of results found that there is a significant relationship (, p <0.005) between the TC2263 students’ performance with the students' final grades for the course. While there is a relatively significant relationship (, p <0.05) between TR3343 students’ performance and the students' final grades for the course. Table 6 shows the Chi-
Square value for courses. Figure 3 shows the expressions of students at the end of the robot soccer competition and prizes awarded to the winners.

### Table 6. Chi-Square value for TC2263 and TR3343 courses

|               | Asymp. Sig. (2-sided) |
|---------------|-----------------------|
| **Pearson Chi-Square** |                        |
| TC2263        | .002                  |
| TR3343        | .025                  |

Figure 3. Images of students at the end of the robot soccer competition and prizes awarded to the winners

5. **Future Work and Discussion**

From the analysis of result, it is found that there is a relationship between the students’ performance and the scores in the robot soccer game competition, although it is only a competition between groups in the class. Students with high scores showed high interest and effort. Excellent and good students’ results in their final grades also showed that the robot soccer game has a positive impact on their learning. This is shown by the questionnaire results that were given by the students on the teaching methods, the appropriateness of teaching, and lecturer for each course. In the robot soccer competition, it is also found that the levels of students programming and logic are good.

Although there are students who do not present themselves before, with the robot soccer game, they can show their ability in learning and teamwork. There are several groups which performed near or even better compared to the game conducted by a team which represents the University in the robot soccer game. However, students are still unable to master some strategies in the robot soccer game. Therefore, in the future, all the strategies in the robot soccer game should be viewed overall in learning. Besides that, students’ performance showed the otherwise if compared between presentation skills and writing. Employability of the students will be more meaningful if the three principles of problem solving in programming, presentation, and writing increase in parallel.

6. **Conclusion**
The application of a robot soccer game in learning shows positive impact on the students. Robot soccer game is also an easy method to be used in teaching and students understand the lesson more easily. The students’ final results showed that they can understand the lesson very well and the questionnaire results also indicate that they are satisfied with the methods of teaching done.

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