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Star Power for teaching professional skills to engineering students

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ABSTRACT

The objective of this study is to evaluate the potential of a game called *Star Power* to teach professional skills to mechanical engineering undergraduates. The game was conducted as an activity in a final year Professional Practice unit. A survey in the form of a questionnaire was administered to participating students in the following semester of studies after a summer break. The survey showed that the majority of the students believed they had improved their professional skills from playing *Star Power*. Although the game is typically used in the teaching of sociology, this study demonstrated that the game can provide a rich and versatile setting in which different elements of professional skills that are important to an engineer can be incorporated and developed.

Keywords: Game, simulation, engineering, professional skills

INTRODUCTION

An engineer today requires not just strong technical capabilities to succeed in his or her career, but also skills in communication and persuasion, the ability to lead and work effectively as a team member, and an understanding of the non-technical forces that affect engineering decisions [1]. As a result of these workplace demands, there has been an increase in emphasis on professional skills in higher engineering academic programs [2]. Initiatives to incorporate professional skills within formal engineering education have been pursued in many countries including Australia [3,4] and Malaysia [5].

The learning of professional skills may be implemented in various forms, ranging from team projects to individual units in the academic curriculum [1,2]. An extensive discussion of these activities has been presented by Shuman et al. [1]. However, each activity is not without challenges to

administer. For example, experiential activities that resemble 'real' workplace conditions are more difficult for the instructor to manage as well as being resource intensive and time consuming for the students [1]. On the other hand, if the activities do not accurately mimic the real-world situation then there is a danger that the learning outcomes may be misleading [6]. Students may also delineate between the academic context and the 'real' practice, thus behaving differently in class [7]. In addition, formal lessons that involve traditional lectures may not be appropriate in the teaching of professional skills, and are therefore not popular with students [2].

A particular challenge in teaching professional skills is that inherently, professional skills are difficult to define and measure [8]. For example, effective communication skills could be identified as fluency in a particular language or the ability to use technology during presentation [5]. However, effective communication skills at the workplace mean more than just being able to articulate well. They include being able to show empathy, negotiate, interact and influence to obtain the expected results. Shuman et al. [1] proposed that professional skills be divided into two groups. The first group comprises the 'process' skills where students learn a robust process to address each skill. The other group comprises the 'awareness' skills where students learn how to be aware of the importance of each one and to include them in their problem-solving activities.

The lack of contextual clarity in professional skills education calls for innovative but simple pedagogical strategies that allow for real student participation and learning. To this purpose, various methods have been proposed in the literature. For example, the usage of movies such as *12 Angry Men* has been proposed to expose students to various barriers to effective communication and decision making, and to help identify strategies to overcome those barriers [9]. Similarly, exposure to performance dramas has been proposed, since the unfolding of events brings to bear a wider range of human concerns which are liable to influence decision making [10]. Another method is that based on games which target learning of specific professional skills such as innovative problem solving [11] and ethics [12]. Games provide a way of getting students to use their practical knowledge in managing indeterminate, open-ended situations within a rule-bound, social and competitive environment [12]. In games, students actively participate in problems in a fun manner and this may result in a higher efficiency of learning [13].

The aim of this paper is to evaluate the potential of a game called *Star Power* [14] to teach professional skills to mechanical engineering undergraduates. The game was implemented as part of the curriculum of a final year Professional Practice unit. The main objective for conducting the game is to increase the awareness of students about how certain approaches of decision making can lead to demotivation or even resentment by other employees or team members.

STAR POWER

Star Power was originally developed to teach students about the creation of inequality through the use and abuse of power [15]. There are various modifications to the game, e.g. see [15] or [16] for a fuller exposition of the game.

To summarise, the goal of the game is for individuals to achieve the highest possible score by drawing and trading chips, each chip being assigned a different point score. During the game, the individuals are divided into three categories based on 'status', i.e. 'high' status, 'intermediate' status and 'low' status. Those with the highest number of points are rewarded with the highest status, while those with the lowest scores are given the lowest status.

The game begins with the individuals blindly drawing a fixed number of chips. They are then allowed time to trade their chips with other teams. Scoring is based on the value of the chips. Extra points are also given for certain combinations of the chips.

At the end of the trading session, the total score of each individual is calculated and their status determined to reflect the score. The manifestation of the status may be as simple as rearranging where the individual sits, e.g. those with the highest status may sit at the highest areas in the lecture room.

The trading round may then be followed by a bonus round, where the members of each status category must unanimously award three bonus chips to one or more members of that category. The bonus round thus allows for the promotion of some members from a category of lower status to another category with a higher status. At the same time, some members who previously had a higher status will be demoted, since they now have lower scores compared to those who are promoted.

The trading rounds may be repeated several times as the game proceeds. In this case, the game is similar to other games which emphasise communication or negotiation skills. However, in *Star Power*, most members of each category unknowingly receive different chips at the beginning of the game as well as in each subsequent trading round. Thus, most members will remain in the same category as they did after the first round [16]. Only a few would move from one category to another and this serves as a disguise to the skewed dynamics of the game.

After a few trading rounds, the individuals with the highest status 'earn' the right to determine a set of new rules for the game. The game then proceeds under the new rules [16]. From this point onwards, the game becomes more open-ended, although the results invariably demonstrate the notion that those who have power may maintain their positions of power by making rules and taking actions that work to their advantage, while impeding others from advancing [15–17].

While *Star Power* is typically used in the teaching of sociology (e.g. [18]), it adapts well to the teaching of professional skills in the engineering curriculum. Firstly, the game is cost-effective and

is not resource intensive. Secondly, the game contains elements of 'process' skills such as intra- and inter-teamworking for decision-making, negotiation and communication skills as well as creative thinking. Depending on how the rules of the game have been set up, the basic game play may be varied to emphasize these 'process' skills. Furthermore, the game play can also be varied to highlight different world settings and problems [19].

Thirdly, *Star Power* provides a platform to facilitate affective learning. One of the important abilities that an engineer should have in the present world is to function globally and effectively in teams that consist of members from different backgrounds [20]. Some graduates may also find themselves in positions of authority shortly after starting professional practice [21]. In order to 'work with anybody, anywhere' [20], the graduate engineers need to be able to show empathy, understand how their decision making may influence others, and recognize human and social dimensions that may affect their successes or failures in spite of their technical abilities. *Star Power* may be used to demonstrate a number of scenarios such as

- How a project leader, a manager or an administrator may motivate or alienate project members through the way decisions are made or through inequal distribution of resources and opportunities, or
- How the monopoly granted through intellectual property rights may impact on innovation and welfare of society, e.g. assessiblity to new technologies by poorer countries, or
- Why corruption [15] may occur in certain societies.

METHOD

The Professional Practice unit is a required fourth year mechanical engineering unit at Curtin University. The unit involves one hour weekly lecture which is supported by two hours of tutorials. The *Star Power* game was implemented at the Sarawak (Malaysia) campus in 2009 as part of the curriculum of the unit. Thirty year 4 students and twenty six year 3 students were enrolled in the unit for that year.

The game was played during a lecture, with details of the rules and game play posted on Moodle before the lecture commenced. A total of fifty students attended the class and they were divided into different teams of about six members each according to their previous tutorial activities. Although the game is typically played by individuals [e.g. 15, 16], in this case, the game was played in teams. This was done because of the large class size and also to introduce teamworking dynamics in the game. Each team had a set of chips which were traded against one another. Decisions and strategies were made on a team level but only one member of a team could leave the team at any one time to negotiate.

The students were told that the goal of the game was to achieve the highest score and that they would be required to reinforce their negotiation and teamworking skills to win the game. Coincidentally, the students had earlier experienced playing games as a team, and reference was made to an earlier game called *Tricky Tales* [22] where the objective was to practice negotiation and teamworking.

Pulko and Parikh [2] suggested that small 'prizes' can encourage participation from the students in games. This was implemented in earlier games where students were awarded 0.25 bonus marks to their final marks either for participating or for winning the games. For the *Star Power* game, the incentives of winning the game were not outlined before play began.

The game was ended after the free rule-making round had run once. A short debriefing exercise was conducted based on a few guiding questions including 'What is the point of the game?', 'Why would you like/not like to continue playing after you get promoted/demoted?' and 'What did you learn?'. The debriefing exercise was then followed by a lecture of ten minutes on how the way decisions made by leaders or managers may affect the motivation of others and the concept of empowerment.

Response to the game was obtained from a survey in the form of a questionnaire. The survey was conducted in the following semester of studies after a summer break. The lag time for obtaining the response was to allow the students to complete the unit and to reflect on what they have learnt, particularly as some of them had undertaken an internship during the summer break. It was stated in the questionaire that the purpose of the survey was to 'to know if the game was an effective tool for students' learning'.

Students who had already graduated were not included in the survey. The response options on the questionnaire ranged from strongly agree to neutral to strongly disagree. Open-ended comments were also solicited, and these were separated as positive or negative.

RESULTS

Table 1 shows the response in terms of percentages to the questionnaire. In total, 31 responses (22 students in their final year and 9 students in their third year of study) were collected from a total of 42 students who were still remaining in the university, giving a 74% response rate. One of the students who responded did not attend the lecture, and was not included in the final percentage calculations.

The majority of the students were able to recall the game (97%) and claimed that they actively participated in the game (90%). In addition, they agreed that the game was enjoyable (80%) and

		Agreement	Neutral	Disagreement
1	I remember participating in the game	97	3	0
2	I actively participated in the game	90	10	0
3	I found the game to be too complex	3	57	40
4	I enjoyed the game	80	17	0
5	I improved my communication skills from the game	63	27	10
6	I improved my negotiation skills from the game	50	40	10
7	I improved my teamworking skills from the game	73	23	3
8	I improved my leadership skills from the game	33	53	13
9	I improved my awareness of ethics from the game	50	37	13
10	I improved my critical thinking skills from the game	60	40	0
11	If we had not played the game, I would have achieved the same learnings from a powerpoint lecture	10	20	70
12	If we had been briefed about the objectives of the game at the start, I would still play the game in the same manner	37	33	30
13	I recommend that the game be included as an activity in the Professional Practice unit.	87	10	0

Table 1: Percentage scores from the questionnaire. The response options of 'Strongly Agree' and 'Agree' are pooled together under 'Agreement' while the options of 'Strongly Disagree' and 'Disagree' are pooled together under 'Disagreement'. The shaded boxes represent >=50% response.

that the game should be included as an activity in the unit (87%). Seventy percent of the students thought that they would not have achieved the same level of learning if the game was not played and only a lecture was delivered, while 10% of the students thought otherwise. The students were undecided whether they would have played the game in the same manner if the objectives of the game had been briefed to them at the beginning of the game. In terms of professional skills learnt, students found that they improved their teamworking (73%), communication (63%), critical thinking (60%), awareness of ethics (50%) and negotiations skills (50%). Most students did not 'agree' that their leadership skills had improved (33%).

DISCUSSION

The results of this study suggest that the *Star Power* game may be implemented as an activity to teach professional skills in an engineering program. The game incorporates a number of professional skill elements and its gameplay may also be readily modified to emphasise different elements of professional skills. For example, while the game is normally played with individuals as the participants, in this study, the game involved teams instead. Hence the survey scored highly on teamworking skills. Some students also commented about their negotiation experience as well as their strategies to develop 'win-win' plans. Some of their responses (as reproduced exactly without correction for grammar or spelling) include:

'The game provides a lot of negotiating skills and trust issues during trading.'
'The game was very helpful in terms of helping the team to think too critically and get organize. Planning what to do would be important strategy and must have certain goal to get the win-win situation.'

Similar comments on the trading nature of the game have also been reported in previous surveys [e.g. 23]. These comments accentuate the flexibility of the game to incorporate different elements of professional skills. Further comments such as:

'Fun. Understand more on what was to be learnt from the slides through the games.'
'Learn from games is a new way to achieve learning rather from slides. It will let the student remember more well.'
'It's more effective to learn from this kind of activity in addition to study from books and notes.'

also indicate that the game offered a different and possibly more enjoyable approach to practice professional skills compared to traditional lectures.

Some students disagreed that they have increased their awareness of ethics and this could be due to their feelings of injustice as a result of a lack of understanding of how the game was designed to work. For example, they commented that:

'The bad is when starter started with low marks, the chances of them getting from last place to the top rank is rare.'
'Once the group with higher marks set ridiculous rules, the fun just ended.'

These comments suggest that some students had not adequately understood how the chips were distributed or drawn during the game. Similar observations have also been made in previous studies [e.g. 24]. Although it would have been possible to provide prior explanation of the game, some students indicated that they might have behaved differently if they had known the real objective before the game started. Furthermore, it is likely that the gaming experience would be diminished if the students already knew what the results could be [19]. The survey thus suggests that it is necessary to provide an effective postgame discussion to obtain maximum or correct learning as recommended by Bredemeier & Greenblat [19]. However, for a relatively large class of 50 students, the one hour allocation was insufficient for detailed postgame discussion. This could be the reason why some students were not able to understand completely the mechanics of the game. Some students also commented that not all students played active roles during the game. This could be attributed to an unequal distribution of tasks within the teams or the inherent nature of the students.

Previous studies [e.g. 19,25] have reported that different students respond differently to learning through games, either due to the characteristics of the students or their attitudes towards games. This may lead to different degrees of participation in the game. For example, some comments referred to the participation of students:

'The game was rather disorganised as not all the students were playing their 'roles' well. It is obvious that some students stayed silent throughout the game. The choice of language in the team communication was not monitored.'
'Not all participated in the negotiation.'

Furthermore, if the percentage scores in Table 1 had been broken down into responses from students remaining in their third year and those in their final year of study, a large difference in their perceived learning of the professional skills could be found. For example, the percentage scores for 'agreement' for the final year students were communication (68%), negotiation (55%), teamworking (77%), leadership (41%), awareness of ethics (59%) and critical thinking (68%). On the other hand, the percentage scores for 'agreement' for the third year students were communication (50%), negotiation (38%), teamworking (63%), leadership (13%) awareness of ethics (25%) and critical thinking (38%). The differences are quite considerable and similar observation of differences in students in different years of study as well as different ages have also been reported in the literature [e.g. 25,26]. It did not appear that the third year students 'disagreed' that they had learned the professional skills, rather they were generally 'neutral' about whether they had learned the skills. The 'neutral' percentage scores ranged from 38% to 75% for the third year students compared to 18% to 45% for the final year students. Thus, the final year students were more convinced of their learnings from

the game, probably because they were closer to graduation and could relate better to what may happen in the workplace.

While it is possible to teach certain professional skills such as presentation skills, it is more difficult to use traditional teaching methods to increase empathy or change perspectives and attitudes [19]. Simulation games such as *Star Power* can help to improve affective learning [19] and does not require relatively much time and resources to organize. Other games that involve perspective taking have also been proposed such as ISLAND TELECOM [27] or the international trade simulation by Peterson & Wallace [28]. The latter is somewhat similar to *Star Power* as students are 'born' into countries with different level of resources and must produce and sell goods to survive. However, these games have a more sophisticated game play which may not be suited to engineering students. On the other hand, the trading of chips in *Star Power* is based on a simple and generic gameplay. There are also many games that can be used to develop teamworking, critical thinking or negotiation skills. These include the two games, *Tricky Tales* [22] and *Machines* [29], that were played by the current students prior to playing *Star Power*. However, compared to *Star Power*, these games lack the distinctive twist in the game play to demonstrate how their decision making and actions can affect others. In *Star Power*, students may also be encouraged to think about possible ways to motivate others to achieve win-win situations. The usefulness of Star Power to simulate these aspects may be shown by the following comments:

'The game gave a view on how people would respond when they are given authority and how the people below their position would respond to rules which they think are abused.'
'The game was meaningful and will encourage participants to think more about workplace ethics. Besides, communication skills can be improved throughout the game session.'
'We can aware of the workplace possible scenario where professional skills have played an important role'
'The game was fun, at least better than lecture since everyone participated. And since it was made a competition everyone put their efforts in trying to win although eventually the objective of the activity is to reflect on ethics.'
'It was fun and challenging. I learnt how to negotiate with the others to reach win-win situation. This skill might help me in the future where I aim to be a businessman.'
'Very interactive, improved awareness of ethics, negotiate in a proper way (professionally).'
'The game showed us how unfair some dominant players can be.'

The effectiveness of simulations to enhance learning has been reported to be inconsistent, for example, Jackson [30] suggested that 'participants simply like simulation exercises, and that this

liking has no detectable educational consequences'. For *Star Power*, some studies [e.g. 23] have indicated that some participants did not achieve any learning from the game. Nonetheless, it is accepted nowadays that the effectiveness of games is dependent on a number of factors [e.g. 19, 25 and 26]. For *Star Power*, a strategy to increase its effectiveness in learning may be to repeat the game so that the students are able to practice what they have learned through their previous experience in the game. A similar idea has also been thought of by Humphrey [23]. The first experience of the game would serve to increase the students' awareness of how their decision making may affect others. In the second attempt, the students may apply their learning and understanding to achieve a truly 'win-win' situation for all. In fact, from the results of this study, it may be proposed that the game be repeated three times, each time allowing for a new learning experience:

First time: Play the game with chips randomly distributed and without bonus rounds. No free rule-making round is played. The objective here is to increase awareness of negotiation, communication and teamworking skills.

Second time: Play the game with chips unevenly distributed and drawn, with free rule-making rounds. The objectives here are to practice negotiation, communication and teamworking skills, as well as to increase awareness of how decisions are made or how distribution of resources may affect other related parties.

Third time: Repeat the game as played during the second time. The objective here is to consolidate all previous learning to achieve a 'win-win' situation for all.

By playing the game three times, it may also be possible to incorporate different assessment methods to track and strengthen students' learning. The current study is dependent on self-reported scores, which have been reported to contain some shortcomings such as being prone to response bias [see 31]. By slowly building in new learning experience in the games, assessment methods such as behavioral observations [32], lifelong learning inventories [33], concept maps [34] and multisource feedback [35] may additionally be applied.

CONCLUSIONS

Although *Star Power* is normally played from a sociology context, the current survey suggests that the game can provide a simulation to practice professional skills that are relevant to an engineer.

The game is relatively easy to prepare and provides a versatile setting in which different professional skills can be incorporated. Furthermore, students found it to be an enjoyable experience to improve their professional skills and recommended that the game be included as part of their curriculum. In order to achieve maximum learning from the game, it is proposed here that the game be repeated three times with some variations in the gaming parameters.

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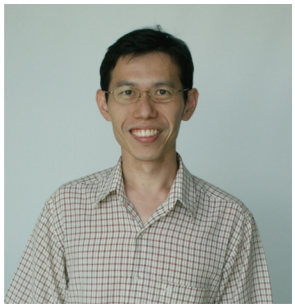

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