Simulating Advanced Project Management Decision Making Processes with PMZONE Board Game

Vered Holzmann[1], Hamutal Weisz[2], Daniel Zitter[2]
[1]Tel Aviv Yaffo Academic College, Tel Aviv, Israel
[2]PMZone Ltd., Tel Aviv, Israel
veredhz@mta.ac.il
hamutal@pmzone.co.il
daniel@pmzone.co.il

Abstract: Project management is applied by diverse professionals in a variety of industries including construction and engineering, information systems, biotechnology, marketing, and more. There are established methodologies for project management, which are taught in universities and trained in organizations. However, the actual complexities involved in managing initiatives in an uncertain environment and making decisions on an array of interrelated issues, call for a simulation tool that will enable prospective – and present project managers, to experience the practice of managing projects while sitting around a table.

The PMZONE smart educational board game offers participants with an elementary level of knowledge in project management an opportunity to face common dilemmas from a project manager's world - through which they will develop new perspectives that will help them improve the way they deal with the same dilemmas in reality. Throughout the game, participants must plan their way forward, deal with planned and unplanned tasks, constraints and risks, play within budget and resources, understand the big picture, control the details, think creatively, compete with other players and cooperate with them.

At the end of the game, we conduct a mentored discussion on the key points that emerged during the game and their relation to challenges in reality, the impact of the project goals on the decisions made by each player, the need to plan in advance while considering the uncertainty involved in a project, the role of the project manager as a leader in the success of the project, and the value of gamification in project management.

The paper aims to analyze the learning process and the improvements in specific learning outcomes through game playing. It starts with a discussion on the rationale behind the design of the game, including the format, rules and materials. Then, we report on self-assessment survey results, which were collected from five different groups of players – three groups of MBA classes, one group of BA class and one group of project management workshop attendees. In addition, we summarize the lessons learned based on qualitative analysis derived from in-class open discussions.

The findings provide insights on the impact of simulating advanced decision making in a project environment and the contribution of games in project management education.

Keywords: Project Management; Board Game; Educational Game; Decision Making; Team Work.

1. Theoretical Framework: Developing Project Management Skills with Games

First, we present a brief review of the place of games in education and training. Then, we explain the complexities involved in project management field of knowledge, and the difficulties to teach and train students and practitioners to develop their skills for management of initiatives in an uncertain environment with multiple interrelated factors. We summarize the background section with an explanation of the rationale behind the design of the PMZone game that integrates the contents of the educational processes and the pedagogical approaches used for delivery of PM knowledge, skills and attitudes.

1.1 Games in education and training

The idea of games in the service of education was introduced by Clark C. Abt (1975) in the book Serious Games as follows: "Reduced to its formal essence, a game is an activity among two or more independent decision-makers seeking to achieve their objectives in some limiting context. A more conventional definition would say that a game is a context with rules among adversaries trying to reach objectives." In recent years, the utilization of serious games for educational purposes, mainly computer and digital games, has been significantly increased (Jackson, 2004; Connolly et al., 2012; Calderón & Ruiz, 2015) with the aim to promote students' motivation for learning (Glynn, Aultman, & Owens, 2005). Connolly et al. (2012) conducted a systematic literature review of 129 papers on computer games and serious games and report on the major role of simulations with 43 papers. Simulations are usually based on computer games, though several classroom-based simulation games are also used in some cases. A few examples of educational board games include the following: Halpern and Wai (2007) used Scrabble to test development of cognitive skills, Vahed (2008) applied a board game to improve performance in learning about tooth morphology, Mayer et al., (2004) utilized game-scenario techniques to demonstrate real world decision-making situations in an urban network, Bohn and Lynch-Caris (2011) used Lego boards and pieces to simulate stakeholders' management in a construction project, Azizan et al., (2018) instructed chemical

engineering students to develop a board game and embed technical based questions to enhance creativity and improve teamwork skills. Simulation games are a form of an effective training technique that enables the learners to take the role of active players in scenarios similar to those in the real world and motivates them to proactively learn by experience.

1.2 Teaching and training PM

In the last few decades there is a growing trend in business and social organizations to manage by projects (Davies et al., 2011), and as a result there is a growing interest in PM education (Egginton, 2012). The traditional education of PM was based on understanding "the iron (or golden) triangle" of cost, schedule, and quality that was used to measure performance and success (Atkinson, 1999; Ogunlana, 2010; Padalkar & Gopinath, 2016). This approach mainly involved the topics of scope, schedule, resources, budget, risk, and integration planning and management. It reflected the content in two leading international project management guides: A Guide to the Project Management Body of Knowledge and Managing Successful Project with Prince2, which were both used widely to teach PM although included only very limited regard to soft skills (Ewina et al., 2017). Throughout the years, PM educators realized that not only projects are heterogeneous by nature and require an understanding of a wide range of topics, but also the modern PM organizations deal with very high level of uncertainty and complexity, to which the acquired technical skills cannot provide sufficient solutions and call for proficiency of interpersonal and soft skills.

Thus, advanced PM education approaches emphasized additional aspects. For example, Pant and Baroudi (2008) and Turner (2016) focused on the importance of human skills in PM success and the apparent lack of emphasis placed on this within the context of university education. Córdoba and Piki (2012) presented a group-based approach to teach PM students in order to respond to the "real" complexed situations in projects. Shelley (2015) reports on an action research approach that was taken to embed the language of PM practice into an experiential learning environment with reflection about impact and concludes it increases the relevancy of the learning and retention of the knowledge. Thomas and Mengel (2008) referred to the complexity and uncertainty that is involved in real project management practices and argue that education programs do not prepare project managers for their mission. More recent study, by Ramazani and Jergeas (2015), analyzed the gap between education and practical needs in today's complex environment. They found that current studies of PM should consider developing skills for dealing with complexity, technical skills, and interpersonal skills.

1.3 Design of the PMZONE board game

Taking into account the review on the important role simulation games have in enhancing students proactive learning on one hand, and the review on the recent developments of PM education to include soft and interpersonal skills in addition to the basic technical skills, in order to successfully manage a project in a complex environment, we designed a board game to simulate advanced PM decision making processes. An elementary knowledge on project management concepts and practical techniques is needed before playing the game. The PMZONE smart educational board game is played in teams, where each one of the players is a project manager. The game is designed to simulate a multi-project environment, where each project has specific goals and objectives. At the beginning of the project each player gets a specific amount of money and quantity of resources. In addition, each one of the participants receives a list of tasks – specifically related to his/her project - to be completed, including details on the budget and resources required to accomplish each task. The project manager players should plan their way to complete the project and achieve its goals and objectives. During the game they have to deal with planned and unplanned tasks, face planned and unplanned constraints and risks, and wisely utilize their budget and resources to move forward with the project.

The following figure shows PMZONE board game. The board is divided into stages. In each stage there are tasks (planned and unplanned), milestones, constraints, risks and gates. Each gate shows what is required to be able to pass through it and advance in the game. Each milestone and gate that a player passes awards additional budget/resources to continue the project. On the board there are separate spaces for resource reserves, shared capital, and each type of playing card.

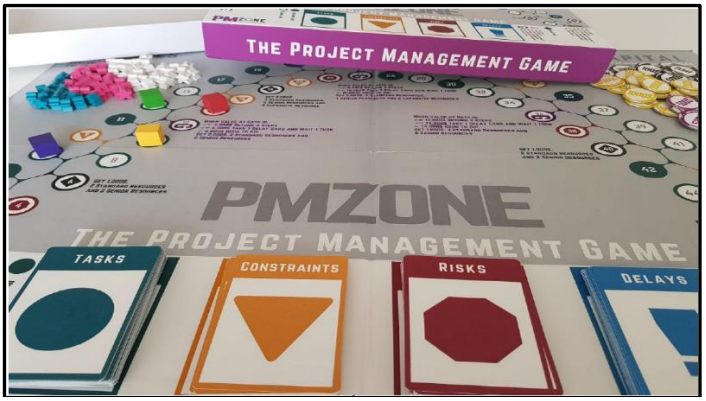

Figure 1: PMZONE board game

The game was briefly introduced to participants. Each team of three or four players received a game kit and a single sheet rule book. Each player received a project description sheet and a playing piece, initial resources (6 regular resources, 4 senior resources, 2 expensive resources) and an initial budget of $ 2,000. The rest of the resources were placed in the resource pool space on the board, the balance of money in the common capital space, and each packs of cards was placed in its appropriate space on the board. Players decided on the order of turns, who was responsible for the shared capital and who was in charge of the shared resources. The time allocated for the simulation game was 1.5 hours.

2. Methodological evaluation: assessment by participants in 5 different educational groups

The study aims to investigate project management teaching and learning process based on a simulation game. The research questions are: (1) Does learning through a simulation game provide additional value to learners, comparing to traditional learning methods? (2) To what extent learning through a simulation game can improve learners understanding of project management concepts? (3) To what extent learning through a simulation game can improve learners understanding of project management techniques? and (4) To what extent learning through a simulation game can improve learners understanding of teamwork and collaboration in projects?

In order to examine those questions, we used a self-assessment survey that the participants were requested to submit upon completion of the game session. This part describes the developed questionnaire used to assess the implementation and impact of the game and the participants in 5 different educational groups who played the PMZONE Board Game. The rational to examine the impact of the learning through a simulation game in varied groups is based on the assumption that it will be exploited differently by participants with different level of knowledge in project management.

2.1 Development of questionnaire

We developed a post-game questionnaire survey to assess participants' perceived effectiveness of the PMZONE board game as an educational device in teaching and training PM. The questionnaire includes 4 parts: (a) evaluation of the experience; (b) professional background; (c) personal data; and (d) open text comments. Part A was based on 22 statements for which the participants were requested to indicate their extent of agreement on a 5-point Likert scale. The statements represent the following topics: general concepts in PM, risk management, teamwork, objectives and control, in addition to evaluation of: the level of competitiveness, educational contribution, and the clarity of rules and goals.

2.2 Participants in educational groups

2.2.1 Descriptive analysis of the survey participants

The study was conducted in Israel on 2017-2018 and involved 105 participants.

It included 54 men (53.5%) and 47 women (44.8%) (4 participants did not specify their gender). The average age of the participants was 29.35 years (SD = 8.86).

The participants were asked about previous experience in project management and simulation games. Most of the participants reported that they had previous experience in project work (about 80%). About half of the students reported that they had previous experience in simulation games (47.5%) and about 40% of the students reported that they had previous experience in project management. The following table shows the frequency distribution of the responses.

Table 1: Sample information on PM previous experience and simulation games (N=105)

Previous experience		Percent %	N
In project management	Yes	40.6%	41
	No	59.4%	60
In project team work	Yes	80.2%	81
	No	19.8%	20
In simulation games	Yes	47.5%	48
	No	525.5%	53

The participants came from 5 different educational groups and the structure of delivering the game was a little bit different for each group, as described below. All the participants in the 5 educational groups completed the survey.

2.2.2 University MBA(1) students group

Group UniM1 represents 28 MBA University students (26.7%) who participated in a "technological project management" mandatory course. The session allocated for the game was 4 academic hours and it was delivered after the students have completed 12 academic hours of studies on the basic topics of PM in class. The method of delivery included 30 minutes of comprehensive introduction to the game and the rules of the game, a session of 2 hours for actual playing (and completion of the survey right after that), and additional 30 minutes of a mentored discussion on the key points that emerged during the game.

2.2.3 University MBA(2) students group

Group UniM2 represents 27 MBA University students (25.7%) who participated in another mandatory "technological project management" course, with the same instructor, during the following semester. This time, we allocated two separate, shorter, sessions of 2 academic hours each that were delivered after the students have completed 21 academic hours on basic and Agile PM topics in class. The students participated in a very short introduction session of 15 minutes and played for additional 60 minutes. One week later, we started the session with a short review of the first experience, and asked the students to play again for 60 minutes. Then, they were asked to complete the survey and we concluded the overall experience with a discussion that last 20 minutes.

2.2.4 Practitioners training group

Group PM1 represents 10 professional project managers (9.5%) from various project-oriented organizations, who participated in a training workshop on PM. Following the workshop, we explained the game's rules in 20 minutes and allocated 2 hours for the project managers to play the game. The session was summarized with additional 20 minutes in which we discussed the pros and cons of playing PM board game and the added value the participants gained through this experience.

2.2.5 University BA students group

Group UniB1 represents 27 international BA in management students (25.7%) who participated in an elective "project team management" course, delivered in English. This was the last lesson of the course, after we covered, in class, all the various theoretical aspects of PM. The time allocated for the overall experience was 4 academic hours, in one session. We started with a brief introduction, followed by 15 minutes for reading the full instructions guide by all the participants. Then, the students have played for 120 minutes and asked to complete the survey individually. The session was concluded with 30 minutes mentored discussion to elaborate on unresolved issues and suggestions on how to modify the game to be more relevant for unexperienced project managers.

2.2.6 College MBA students group

Group ColM1 represents 13 MBA College students (12.4%) who participated in a "project management" elective course. Here again, we allocated two separate sessions of 2 academic hours each that were delivered after the students have completed 21 academic hours on basic PM topics in class. The students participated in a very short introduction session of 15 minutes and played for additional 60 minutes. One week later, we started the session with a short review of the first experience, and asked the students to play again for 60 minutes. Then, they were asked to complete the survey and we concluded the overall experience with a discussion that last 20 minutes.

3. Findings & Analysis

Table 2 below summarizes the main research findings - averages and standard deviations of the questionnaire's responses to the entire sample, as well as the educational groups. It should be noted that one-way analysis of the differences between the educational groups was performed.

Table 2: Avg. and SD of the questionnaire's responses to the entire sample and according to the research groups

		Total sample N=105 M (SD)	UniM1 N=28 M (SD)	UniM2 N=27 M (SD)	PM1 N = 10 M (SD)	UniB1 N=27 M (SD)	ColM1 N=13 M (SD)	F (4,104)
1	The game helped me understand concepts in project management	3.86 (06.4)	3.57 (0.57)	3.63 (0.68)	3.90 (0.73)	4.11 (0.42)	4.38 (0.50)	6.70**
2	The game has improved my ability to implement project management techniques	3.70 (0.73)	3.54 (0.57)	3.41 (0.69)	3.70 (0.82)	3.89 (0.75)	4.31 (0.63)	4.69**
3	The game helped me understand the relevance of the theoretical material learned in the classroom	3.89 (0.71)	3.61 (0.62)	3.67 (0.78)	3.90 (0.87)	4.11 (0.42)	4.46 (0.66)	5.26**
4	The game helped me understand the importance of project planning	4.22 (0.80)	4.39 (0.56)	3.96 (0.89)	4.20 (0.91)	4.11 (0.84)	4.62 (0.76)	1.97
5	The game helped me to understand the uncertainty environment in which projects are performed	4.24 (0.87)	4.18 (0.77)	4.37 (0.74)	3.40 (1.57)	4.19 (0.68)	4.85 (0.37)	4.68**
6	The game helped me understand the importance of collaboration in project management	3.16 (1.08)	2.89 (0.89)	3.07 (1.07)	3.60 (1.50)	3.07 (1.03)	3.77 (1.01)	2.03
7	The game helped me understand the importance of teamwork in a project	3.17 (0.99)	2.82 (0.94)	3.04 (1.05)	3.80 (0.63)	3.15 (0.94)	3.77 (0.92)	3.46*
8	The game helped me understand how to plan risks	3.89 (0.82)	3.79 (0.78)	3.48 (1.01)	4.30 (0.48)	3.96 (0.64)	4.46 (0.51)	4.55**
9	The game helped me understand the meaning of project risk management	3.88 (0.81)	3.96 (0.63)	3.44 (0.93)	3.90 (0.87)	3.96 (0.75)	4.38 (0.65)	3.64**
10	The game helped me understand the importance of focusing on the goal that was defined for me	3.98 (0.89)	3.86 (0.89)	3.48 (0.84)	4.20 (0.78)	4.19 (0.87)	4.69 (0.48)	5.59**
11	The game helped me understand the importance of control points in the project (gates)	4.01 (0.82)	4.14 (0.70)	3.96 (0.80)	3.60 (1.26)	3.93 (0.78)	4.31 (0.75)	1.32
12	The game helped me understand that sometimes it is better to give up performing a task that does not advance me towards achieving the goals that have been defined	4.00 (0.95)	4.07 (0.81)	3.56 (1.18)	3.90 (1.10)	4.00 (0.62)	4.85 (0.55)	4.70**
13	The game helped me understand the meaning of project management under resource and budget constraints	4.28 (0.70)	4.63 (0.62)	4.44 (0.69)	3.56 (0.88)	4.19 (0.55)	4.46 (0.77)	3.48*
14	All of my team members worked to achieve the goals	3.85 (1.03)	3.61 (0.99)	3.78 (1.15)	3.33 (1.11)	4.15 (0.81)	4.23 (1.01)	2.07

		Total sample N=105 M (SD)	UniM1 N=28 M (SD)	UniM2 N=27 M (SD)	PM1 N = 10 M (SD)	UniB1 N=27 M (SD)	ColM1 N=13 M (SD)	F (4,104)
15	The level of competitiveness among my team members was high	3.50 (1.20)	3.79 (1.10)	3.89 (1.08)	3.00 (0.92)	3.11 (1.36)	3.23 (1.16)	2.44*
16	The level of competition between my team and the other teams in the class was high	2.87 (1.17)	2.71 (1.08)	2.59 (1.30)	3.40 (1.07)	2.96 (1.16)	3.15 (1.06)	1.24
17	The rules of the game were clear	3.21 (1.02)	3.29 (0.97)	2.59 (0.88)	4.20 (0.42)	3.07 (1.03)	3.85 (0.80)	7.80**
18	The goals of the game were clear	3.55 (1.08)	4.04 (0.83)	3.04 (0.89)	2.90 (0.87)	3.37 (1.07)	4.46 (1.12)	8.01**
19	The time allocated for the game was enough	2.62 (1.36)	2.14 (1.00)	1.70 (0.95)	4.30 (0.67)	3.37 (1.24)	2.69 (1.49)	14.83**
20	I enjoyed the game	4.46 (0.63)	4.57 (0.50)	4.52 (0.58)	4.50 (0.97)	4.04 (0.59)	4.92 (0.27)	5.72**
21	Learning through a simulation game is better than a lecture	4.14 (0.82)	4.00 (0.77)	3.89 (1.01)	4.50 (0.52)	4.30 (0.66)	4.38 (0.87)	1.89
22	Learning through simulation game is better than exercises	4.24 (0.76)	4.00 (0.77)	4.26 (0.85)	-	4.22 (0.64)	4.77 (0.59)	3.18*
	** *P*<.01, * *P*<.05							

It can be seen that relative to the entire sample there is a *relatively high consensus* that the game was enjoyable, that learning through a simulation game is better than exercises and also over a lecture, that the game helped to understand the meaning of project management under resource constraints and budget, to understand that sometimes it is better to give up performing a task that does not advance towards achieving the goals that have been defined, to understand the importance of control points (gates), the uncertain environment in which projects exist, the importance of project planning, general project management concepts, the importance of focusing on the project's goals, the meaning of risk management, and the relevance of the theoretical material learned in the classroom.

There is also a *medium-high agreement* that the game improved the ability to implement project management techniques, that the level of competition among team members was high and that the goals of the game were clear. There was a *moderate agreement* that the game helped to understand the importance of collaboration in projects, the importance of teamwork, and that the rules were clear and there was enough time allocated for playing.

By comparing the different educational groups, significant differences were found between the groups in most statements (16 statements out of 22). In general, the findings of Scheffe's post-hoc test for analysis of the variance showed that international undergraduate students and MBA college students demonstrated more positive attitudes than did students MBA university students (statements 1-3, 8, 10, 17, 18, 22).

In addition, MBA college students demonstrated more positive attitudes than professional project managers in relation to the fact that the game helped them understand the uncertain environment in which projects are taking place and they were also more positive comparing to group UniM2 with regard to the clarity of the game rules. However, the students in group UniM2 demonstrated a more positive attitude compared to professional project managers in relation to the fact that the game helped them to understand the meaning of project management under resource and budget constraints.

An interesting result is demonstrated by professional project managers who expressed more negative attitudes than the other groups in relation to the high level of competition among their team members, but on the other hand, they showed more positive attitudes compared to groups UniM2 and UniB1 regarding the clarity of the game rules, and more positive attitudes than the other groups (except for UniB1) in relation to the fact that the time allotted for the game was sufficient.

For the next level of analysis, the questionnaire's statements were grouped into four content-related categories as follows: general concepts in PM (Statements 1-4, 13 α = 0.63); risk management (statements 8-9 α = 0.76), teamwork (statements 6-7 α = 0.84); project objectives and control (statements 10-12 α = 0.53). In order to examine the differences between the research groups in these indices, a one-way analysis was conducted. The findings are presented in the table below.

Table 3: Avg. and SD of the categories of the questionnaire according to the research groups

	UniM1 N=28 M (SD)	UniM2 N=27 M (SD)	PM1 N = 10 M (SD)	UniB1 N=27 M (SD)	ColM1 N=13 M (SD)	F (4,104)
General concepts in PM	3.89 (0.35)	3.82 (0.48)	3.85 (0.43)	4.08 (0.39)	4.44 (0.44)	5.89**
Risk management	3.87 (0.61)	3.46 (0.90)	4.10 (0.45)	3.96 (0.63)	4.42 (0.53)	4.83**
Teamwork	2.85 (0.85)	3.05 (1.02)	3.70 (0.82)	3.11 (0.91)	3.76 (0.94)	3.11**
Project objectives and control	4.02 (0.60)	3.66 (0.64)	3.90 (0.84)	4.03 (0.43)	4.61 (0.46)	5.81**
** *P*<.01						

The following chart presents the average contribution of the game for each category.

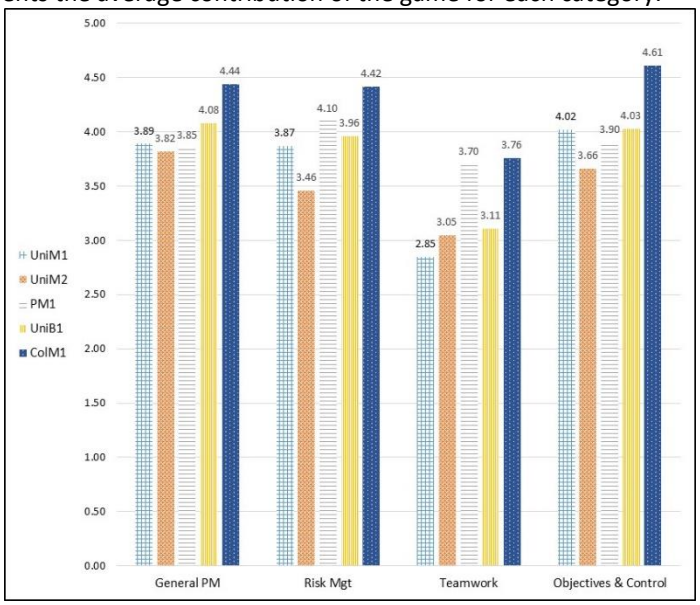

Figure 2: Avg. contribution of the game to 4 main categories, by research groups

It can be seen that there were significant differences between the groups in all the indices. The findings of the Scheffe post-hoc test for analysis of the variance showed that MBA college students demonstrated more positive attitudes towards the game contribution to a better understanding of project management in general compared with all other groups, except for the international BA students. MBA college students even expressed a more positive attitude towards the game contribution to a better understanding of risk management, and project's objectives and control compared with UniM2 group, and expressed a more positive attitude towards the contribution of the game to a better understanding of the importance of teamwork compared to MBA university students.

The following table presents the relationships between the questionnaire indices using the Pearson test.

Table 4: Correlations between the questionnaire indices

	General concepts in PM	Risk management	Teamwork	Project objectives and control
General concepts in PM	---			
Risk management	.42**	---		
Teamwork	.34**	.12	---	
Project objectives and control	.36**	.35**	.21*	---
** *P*<.01, * *P*<.05				

The figures above indicate that there are significant positive correlations between most of the questionnaire indices. The more positive the attitudes were towards the contribution of the game to a better understanding of project management in general, the more positive attitudes were with regard to a better understanding of risk management, the importance of teamwork and objectives and control. Also, the more positive the attitudes towards a better understanding of risk management, the more positive attitudes were with regard to a better understanding of goals and control. Finally, the more positive the attitudes were about the importance of teamwork, the more positive the attitudes were regarding a better understanding of goals and control.

4. Discussion & Conclusions

The current paper presents a study on the perceived effectiveness of a board game for PM educational purposes. This game simulates the environment in which project managers act and the decision they have to make. However, it is important to differentiate between the well-known project based learning (PBL) method that organizes learning around projects and involves the use of authentic questions, a community of inquiry, and the use of cognitive tools (Thomas, 2000) and the simulation game presented here, although it is aimed for learning project management methodologies and techniques. In the PBL case, projects are the method of learning while in our case, management of projects is the content to be learned. The PMZONE game was developed in order to support training and teaching of PM concepts and techniques of implementation. Although several serious games in PM are available (Bayart et al., 2014; Calderón & Ruiz, 2015) it is a relatively a unique game in this field of study, which calls for a high level of complexity that is involved in a wide range of heterogeneous expertise, including scope, schedule, resources, budget, risk, control, communication and teamwork. Today, we see more and more digital educational games, and still the PMZONE game was designed as a board game where participants are playing in an unmediated environment for a defined timeframe. The results of the quantitative survey, and the additional open discussions we conducted with each group at the end of the games, clearly indicate that the game is enjoyable and helped in understanding both theoretical and practical aspects of PM. Even though it was indicated by some of the players that the rules were not clear enough, almost all of them agreed that they did not have enough time to play, and actually preferred more time for experiencing the simulation rather than getting more detailed instructions. It can be inferred that participants prefer to learn by playing (or doing) rather than by learning theoretical topics and speculating how they will bring those concepts into realization in the future. However, interesting finding is related to the appropriate stage in training to play the game. Advanced management students are the best beneficiaries, probably because they have solid knowledge on PM and a little bit of experience in practical PM. Thus, comparing to less PM educated students, they have an adequate understanding and knowledge to rely on, and comparing to professional PM they feel there is still a gap between the theoretical understandings and the actual implementation which can be partially closed through the simulation.

Based on the encouraging findings presented in this paper, but taking into consideration the differences between the different groups that were examined, we aim to further develop the PMZONE board game in order to respond to different levels of PM professionalism. An additional interesting direction for future research will be to compare the performance results of those who experienced learning PM through serious games to those who learned it in the traditional methods in class.

References

Abt, C. (1970), *Serious Games*, The Viking Press, New York, NY.

Atkinson, R. (1999). Project management: cost, time and quality, two best guesses and a phenomenon, its time to accept other success criteria. *International Journal of Project Management*, 17(6), 337-342.

Azizan, M. T., Mellon, N., Ramli, R. M., & Yusup, S. (2018). Improving teamwork skills and enhancing deep learning via development of board game using cooperative learning method in Reaction Engineering course. *Education for Chemical Engineers*, 22, 1-13.

Bayart, C., Bertezene, S., Vallat, D., & Martin, J. (2014). Serious games: leverage for knowledge management. *The TQM Journal*, 26(3), 235-252.

Bohn, A., & Terri Lynch-Caris PhD, P. E. (2011, January). Increasing project management skills using role-playing simulations. In *IIE Annual Conference. Proceedings* (p. 1). Institute of Industrial and Systems Engineers (IISE).

Calderón, A., & Ruiz, M. (2015). A systematic literature review on serious games evaluation: An application to software project management. *Computers & Education*, 87, 396-422.

Connolly, T. M., Boyle, E. A., MacArthur, E., Hainey, T., & Boyle, J. M. (2012). A systematic literature review of empirical evidence on computer games and serious games. *Computers & Education*, 59(2), 661-686.

Córdoba, J. R., & Piki, A. (2012). Facilitating project management education through groups as systems. *International Journal of Project Management*, 30(1), 83-93.

Davies, A., Brady, T., Prencipe, A., & Hobday, M. (2011). Innovation in complex products and systems: implications for project-based organizing. In *Project-Based Organizing and Strategic Management* (pp. 3-26). Emerald Group Publishing Limited.
Egginton, B. (2012). Realising the benefits of investment in project management training: Evidence supporting the need for a more strategic approach. *International Journal of Managing Projects in Business*, 5(3), 508-527.
Ewina, N., Luckb, J., Chughc, R., & Jarvisa, J. (2017). Rethinking Project Management Education: A Humanistic Approach based on Design Thinking. *Procedia Computer Science*, 121, 503-510.
Glynn, S. M., Aultman, L. P., & Owens, A. M. (2005). Motivation to learn in general education programs. *The Journal of General Education*, 54(2), 150-170.
Halpern, D. F., & Wai, J. (2007). The world of competitive Scrabble: Novice and expert differences in visuopatial and verbal abilities. *Journal of Experimental Psychology: Applied*, 13(2), 79.
Jackson, M. (2004). Making visible: using simulation and game environments across disciplines. *On the Horizon*, 12(1), 22-25.
Mayer, I. S., Carton, L., de Jong, M., Leijten, M., & Dammers, E. (2004). Gaming the future of an urban network. *Futures*, 36(3), 311-333.
Ogunlana, S. O. (2010). Beyond the 'iron triangle': Stakeholder perception of key performance indicators (KPIs) for large-scale public sector development projects. *International journal of project management*, 28(3), 228-236.
Padalkar, M., & Gopinath, S. (2016). Six decades of project management research: Thematic trends and future opportunities. *International Journal of Project Management*, 34(7), 1305-1321.
Pant, I., & Baroudi, B. (2008). Project management education: The human skills imperative. *International Journal of Project Management*, 26(2), 124-128.
Ramazani, J., & Jergeas, G. (2015). Project managers and the journey from good to great: The benefits of investment in project management training and education. *International Journal of Project Management*, 33(1), 41-52.
Shelley, A. W. (2015). Project management and leadership education facilitated as projects. *International Journal of Managing Projects in Business*, 8(3), 478-490.
Thomas, J. W. (2000). A *Review of Research on Project-Based Learning*. Autodesk Foundation, San Rafael, CA.
Thomas, J., & Mengel, T. (2008). Preparing project managers to deal with complexity–Advanced project management education. *International Journal of Project Management*, 26(3), 304-315.
Turner, M. (2016). Beyond the iron triangle: reflections of an early career academic. *International Journal of Managing Projects in Business*, 9(4), 892-902.
Vahed, A. (2008, October). The tooth morphology board game: an innovative strategy in tutoring dental technology learners in combating rote learning. In *2nd European Conference on Games Based Learning* (pp. 467-480).