Designing and Evaluating Simulation Games For Professional Project Management Education

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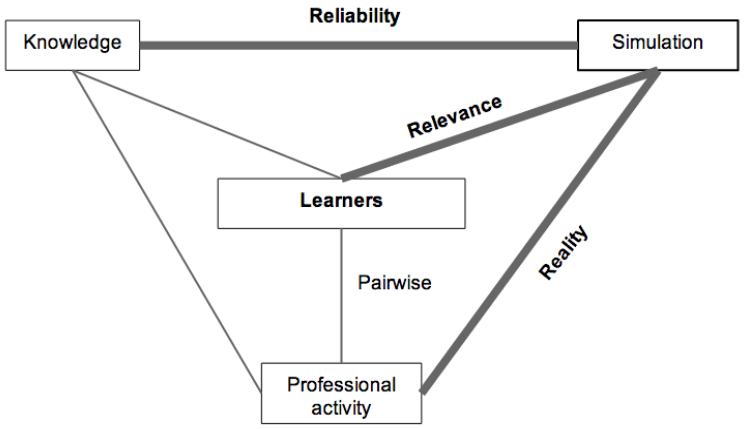
Abstract

Simulations and serious games are often considered to be efficient for professionals training. Experiential learning makes simulation a good pedagogical tool for educating working professionals. But the success of game based delivery depends on various factors such as the right blend of simulation and traditional theoretical lessons, concept and content of the simulation, link between the simulation and professional activities etc.

Paper proposes a simple model representing links of the simulation with other relevant elements of professional training. The model has been tested in the specific case of project management education where the authors offered training to professionals having experience of 5 to 25 years. The qualitative responses of participants were processed using Analytic Hierarchy Process (AHP) and the findings are presented in the paper. The study reveals that concept based learning need to be complemented with application based simulation software and identified three significant characteristics of simulation game, which are referred as 3R's (i.e. Reality, Relevance & Reliability) of simulation based pedagogical practice that trainers have to focus on while designing and delivering serious games.



Key words: Project management Body of Knowledge (PMBOK), professional training, experiential learning, Synthetic learning environment, Simulation, PM Game, 3R's, Analytic Hierarchy process (AHP).

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1. Introduction

Two factors that can significantly influence simulation based project management training are the design of the game & its effective administration. Experts in the industry across various businesses who were interviewed by the authors are of the opinion that an effective training can enhance project management capabilities of practicing professionals and such trainings need a good combination of class room delivery and activity based learning.

Early in the 20th century *Case studies* based approach was accepted as effective practice in project management pedagogy. Modern projects being complex require more robust techniques to meet the project challenges. This led to a wide range of project tools and techniques to plan control and schedule our projects. Bowers (2012) in their research observed that "Applied correctly, technology can be a great tool in improving education and training at all levels." A number of techniques such as case studies, serious games, role plays & simulation games are in practice to create a better learning environment for the learners.

Though the techniques have matured, the projects are not benefited fully and timely project delivery within the budgeted cost remains an area of concern. Present research attempts to identify the extent to which simulation based trainings can help in enhancing effectiveness of such trainings.

Organizations investing in large projects prefer to have project managers who have undergone a formal training in project management and are able to develop a holistic approach in managing projects. Training is generally challenging and more so in an environment where it has to match with the requirement and expectation of practicing professionals. Traditional teaching-and-learning environments are often too predictable and do not impress the participants as they fail to bring in "real-world" environments (Ruben B. D, 1999).

Authors of this paper being trainers themselves have tested simulation based software as a training tool for practicing project managers and realized that the observations are worth sharing with academic community.

The paper in the subsequent sections attempts to answer following questions.

- What could be the best project management pedagogy for practicing professionals?
- To what extent simulations are effective in training professionals?
- How to choose the right simulation?
- How to design the right simulation for professional project management training?
- Is there a simple framework that can link simulation with other elements of learning?

The paper addresses issues related to Project Management pedagogy and will be of interest to those professionals who design PM simulation games and those who teach Project management for practicing professionals.

2. Objective

The objective of present research is to evaluate the effectiveness of simulation-based training for practicing project professionals and to present findings. Paper also suggests a simple framework that can be of use to both designers & trainers of simulation games.

3. Literature Review

This section presents a detailed literature review highlighting various techniques adopted in in the past. Several key factors were recorded by researchers in the literature. Case study, role play, simulations are widely referred by various researchers as effective training techniques that create scenarios similar to real time projects. This motivates the learner to participate actively in the class room. Motivation, interest and role-play are found to enhance learning process and have been reported by many of the researchers in the past. One way to create better motivation is to provide scope for the learner a role playing opportunity in a real project environment (Drappa, A., Ludewig, 2000, Dantas, A.R., et al 2004). Problems can be structured with different alternatives and presented to the learner who will then be allowed to make decisions. Learner can evaluate the quality of decisions under a specific scenario and in the process will have a better learning experience. This is similar to case study approach introduced in 1950s. (Forrester J.W 2004, Dantas, A.R., et al 2004). Many researchers have attempted to identify unique characteristics of various experiential learning techniques. Henry Ellington recorded significant observations related to games, simulations, case studies and role-plays. "Learning is at its best when it is goal-oriented, contextual, interesting, challenging, and interactive" (Clark N.Q 2005).

Few definitions are available in the literature. Early use of Game as educational tool can be referred to "Serious Games", a book written by Clark Abt (1970). Abt explored methods to use games for training and education. Abt also gave a clear definition of "Serious Games". Serious games are those that have an explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement. However this should not be construed as serious games are not, or should not be, entertaining (Djaouti D. et.al 2011). Abt, (1968) also explained the need for two basic characteristics, namely overt competition and rules in an exercise for it to qualify the context of "Game". For the exercise to fit into the definition of simulation it also needs to have a real situation and it must be on-going (Henry Ellington). A detailed examination of real –life or simulated situation can be seen as a case study. (Percival and Ellington, 1980) A role-play requires a design that allows participants to act out the parts of other persons (Ellington, Addinall and Percival, 1982). Kolb (1984) stated that "Learning is a process whereby knowledge is created through the transformation of experience" (Collin, 2013). Experiential learning refers to the process of human cognition as stated by Fenwick (2000). Experiential education refers to learning activities that engage the learner directly in the phenomena being studied (Cantor, 1997). Adult experiential learning broadly speaking is a process of reconstruction performed by individual learner (Malinen, 2000).

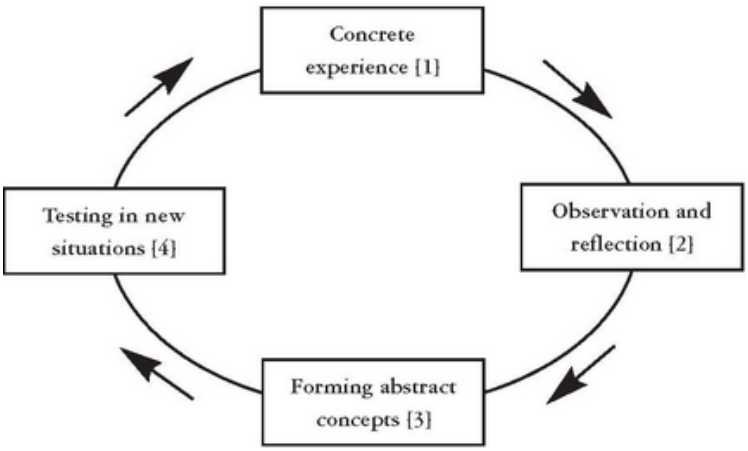

Fig.1 Kolb's learning cycle.

Experiential learning is the preferred design and it suits the adults learning as it is a learning process implying reflection on doing and thus "learning from experience". Experiential learning is the current way of learning for professional in their all day practice, following the Kolb's learning cycle model (Kolb 1984). ***Figure1*** shows Kolb's learning cycle. Six main perspectives on learning i.e. behaviorism, cognitivism, constructivism, social learning, humanism and cognitive neuroscience were identified by Wilson.

The first reported functional simulation game is the GREMEX game (Rowe, Gruendeman et al. 1968, Hussein B.A 2007) aimed to provide a synthetic experience illustrating the types of problems that can come up in an R&D project and possible control strategies. He classified the simulation games into two main categories namely functional & leadership Simulation. While functional simulation targets problems such as balancing cost, time and scope etc, leadership simulation deals with softer issues such as developing project strategy, negotiation and decision making in pursuit of several objectives. These findings also helped the authors in evaluating team performance.

Pioneers in Simulations & Games such as Bradford, Gibb, & Benne, 1964, Schein & Bennis, 1965; Rogers, 1967; Boocock & Schild, 1968; Gamson, 1969; Tansey & Unwin, 1969, Coleman, 1969; Abt, Egan,1970; Budd, 1972; Pfeiffer & Jones, 1969-1977; Greenblat & Duke, 1975; all recognized effectiveness of simulation tools (Ruben B. D, 1999).

Veshosky D and Johannes H. E (1991) used a simulation game to teach project management to civil engineering students at Lehigh University and found that the game was successful in teaching project management functions and the importance of a systems approach to project management. However they observed that simulations were less successful in teaching those concepts that are associated with financial and technology management. Authors of this paper also identified that areas such as financial and technology management, contract negotiations are still not explored fully. Only in very few cases we could see simulation games in contract related areas during our literature survey. In 1998, Dudziak. W and Chris H of Carnegie Mellon University applied simulation games based techniques as training tools for contract negotiations.

Adults develop resistance to pure theoretical concepts over a period of time and are not generally motivated to participate in a training that focuses only on concept without creating a connection with what they do in practice in real world or project scenario. Dantas A.R (2004) identified two vital attributes namely adult training and complexity as significant aspects that are to be covered by a simulation game based training for project professionals of software projects (Knowles M, 1984). Doyle identified two key challenges. i.e Replicating complexity of adequate nature & creating scope for the learner to connect the past experience to make future decisions are critical to the success of simulation based training. Conventional class room training is found not sufficient to meet such challenges (Dantas; Doyle, J.K et.al 2003).

Simulation-based games are well suited to be introduced for practicing professionals as these games enable the learner to experiment the consequences of executing or neglecting project management actions. These games also enable learners to adopt different approaches and experience the consequence (Dantas A.R 2004). Hence, professionals' trainings may require specific design. Hussein B.A (2007) presented the evolution of simulation games. Simulations are found to create a better learning environment (Boocock & Schild, 1968; Farran, 1968; Stembler, 1975) (Woodward J et.al.1988). Hemmasi, M and Lee A. G (1991) found simulation based training more effective for practicing professionals in enhancing specific skills such as teamwork, planning, and problem solving/decision making etc. Seidner (1978), Bredemeier & Greenblat (1981) and Dorn (1989) claim that there is a significant improvement in learner's interest level with the introduction of simulation based games. Use of games in education is recognized as a factor for increasing motivation (Dorn 1989), this may be right both for children, pre-graduate or postgraduate learners. Many other researchers like Boocock, & Schild (1968), Wentworth & Lewis (1973), Coleman (1973), Seidner (1978), and Bredemeier & Greenblat (1981). Dorn (1989), Clegg (1991) and Randel et al. (1992) agree that simulation games when presented correctly can increase the learner's motivation.

While some experts favour case study based training many others consider simulation as a better option. (Egenfeldt N S 2004). Some researchers also opine that the team size, group cohesion, game environment also can significantly influence the motivation of learning groups. (Clegg, 1991; Bredemeier & Greenblat, 1981; Wellington & Faria, 1996; Egenfeldt N S 2004).

4. Overview of the research problem

Training of practicing project engineers involves few challenges that differentiate it from pre-graduated education. Those characteristics include motivational aspects, strong link between training and prevailing professional problems. This leads to the requirement of specific design & delivery. Experiential learning is one kind of training design that is suitable for adult learning. It is a learning process implying reflection on doing and thus "learning from experience". Consequently, simulation games may be a good way of supporting experiential learning, as they provide an experience that is derived and analyzed during the training session.

4.1 Professional training- A combination of soft and hard skills.

Project management is a good example of adult training. Project management courses are mostly offered to post-graduate students or professional. These are sometimes included in bachelor or master programs, but nearly never to younger students. Project management in practice requires a combination of a multitude of different skills, which are generally divided between *soft skills* (leadership, negotiation, conflict management, stakeholder integration, communication, motivation, etc.) and *hard skills* (planning, risk management, financial analysis, control, etc). One of the difficulties with traditional education is that it mostly focuses on hard skills, as it is more difficult to teach soft skills. The other difficulty is about integration. Traditional education is mostly divided in chapters, and different aspects of project management are not integrated in a whole concept. Simulation-based training can be a way to include both soft and hard skills (for example by integrating role plays during the simulation) and be an effective tool to develop the systemic view needed for project management.

4.2 Challenges associated with simulation-Games design

Simulation-based training for professionals is often considered to be efficient. But efficiency may depend on various factors like the right blend of simulation and traditional theoretical lessons, concept and content of the simulation, link between the simulation and professional activities etc. There are a number of research papers about serious games and simulation games as tools for education, but only few about simulation design, and even less about simulation design for professional education. Designing the right simulation game requires a good analysis of learners' knowledge, environment and background. In order to continually improve simulation games design, it is mandatory to evaluate their effectiveness and rely on a standard assessment model.

Though it is widely agreed by researchers that concept based learning need to be supplemented with application based simulation software there is no precise information available in the literature describing the design requirements for a good simulation based learning that can serve as the right blend and a perfect fit for project management training. Earlier researchers like Egenfeldt have also cautioned that one may run a risk of not realizing the full potential of games if we try to put them into a procrustean bed. Teachers need to be specific about the learning outcome and find ways in which they can measure learning. This is very important failing which there is a risk of learning being repetitive, undocumented, confusing and pointing in different directions (Elder, 1973, Egenfeldt N S 2004).

Simulation games combine both theory and games aspects and provide the concrete experience to reflect on. Consequently, simulation games may be a good way of supporting experiential learning training sessions, as they provide an experience that may be derived and analyzed during the training session. Even if effectiveness of simulation games is still unclear, Chuda (1996) argue that well-conducted simulation games can provide excellent atmosphere for students. The above aspects of simulation game design is discussed by Cano and Sanez (2003) who argue that simulation games are widely used in project management education, but conditions needed to obtain optimal learning through simulation are still unclear. Hussein (2007) presented that simulation games are about solving well defined problems such as network calculation or cost estimation.

A closer look at the simulation games leads to a belief that these games shall be used for more than just solving well defined problems and the extent of application shall then depend on how the simulation is designed. The success of a training results in not imparting knowledge but to create scope for translating this knowledge into behavior (Ruben B. D, 1999). The pedagogical objectives have to be at the basics of the definition of the simulation with scope to include integration aspects where the focus is on solving global problems in a systemic perspective. All the above strategies were considered by the authors while carrying out the research and were built into the training sessions.

5. Project Management Pedagogical Practice-Present scenario

This section focuses on present practices adopted in training project managers. Authors of this paper are engaged in project management training to practicing managers and have tested effectiveness of simulation based games by including them as part of the training program. At present it is observed that most of the professional training programs are designed with lecture sessions and a case study approach. A number of concepts are introduced in the classroom and these are taught as standalone concepts while the trainee is expected to perform his role as project director/manager/team member in a holistic project environment. For example when a series of scheduling concepts such as Barchart, PERT, CPM etc are introduced on one day and a series of monitoring and control techniques such as progress charts, EMV are introduced on the other day, there are challenges to the trainee in integrating the concepts of project management.

Trainers also face a similar challenge when it comes to evaluation of performance of teams. Conventional evaluation methods reveal the understanding of the knowledge areas by the trainee but not the application capability. Project managers learn this concept of integration while they are actually executing projects with risk of time and cost over-run in projects. Project management training in a conventional classroom environment involves imparting knowledge on relevant tools and techniques of a specific knowledge area and has limited scope for integration of concepts within the training duration. Simulation based training focuses on specific scenarios. Activities are in the form of games played in a virtual environment and helps improving the overall learning experience to a reasonable extent.

Authors evaluated few games before finalizing the specific game. While some of the simulation tools are based on animation the others allow interactive environment. The game used for the purpose of this study (Name of the game not disclosed in this paper) is based on a pluri-annual experience in project management education in various environments (undergraduate and master levels, technical and managerial syllabus of academic and professional institutions). The specific game is chosen for this study as it allows much of user participation and reflects participant's performance on various scales. This is not scheduling software like MSP or Primavera but a simulation based game, which creates a virtual project environment and allows participants to evaluate their ability in converting their learning into actions in managing projects in a dynamic environment. The structure of the game helps participants to evaluate quality of their actions in meeting stakeholder's expectations and managing time, cost and quality of decisions during the course of project planning and execution.

The game displays various project phases and performance measurement scales and updates the same as participants play. Game consists of four phases (Initiation, planning, Execution and Closing) of project and five scales of evaluation (Management, User, Schedule, Cost and Quality of performance). The participant is expected to perform actions based on the project scenario with some constraint on efforts and resources. The paper restricts its scope only to evaluating effectiveness of the simulation game as a training tool and does not elaborate the various aspects or features of the game.

The game was introduced to participants as part of their formal training course in project management. The training was conducted for three different groups. Each group comprised of 18 participants who had experience in the range of 5 to 20 years. The game was introduced to the participants in a structured way and the participants were allowed to play in teams of two. Participants were reasonably familiar with the basics of project management as they were put through conventional classroom training before start of the game. At the end of the game participants were asked to fill a questionnaire and the responses were further analyzed for arriving at suitable simulation game design.

5.1 Test Measures

When it comes to evaluation of a simulation design it was observed that direct measures are not possible as it becomes difficult to directly measure link between knowledge and simulation, simulation and reality or simulation and participants. It was therefore decided to get the indirect measures. Indirect measures are those that derive conclusions based on the perception of participants. A questionnaire has been developed in order to have questions linked with the criteria that covers 3R's of simulation based training i.e relevancy, reality and reliability.

5.2 Development of questionnaire

In order to understand the requirement of good design of simulation based training it was decided to capture the participant's perception on effectiveness of training and other related features through a carefully structured questionnaire. Accordingly, a questionnaire was prepared and was circulated to the participants and the consolidated response is presented in ***Annexure B***. Out of 56 participants who were given the questionnaire 23 responded leading to a response rate of 41%. The present research involves a questionnaire survey, which covers most of these concerns presented by the previous researchers. The concepts presented by early researchers were further reduced to three critical criteria namely Reality (closeness to reality), Relevance (Educational relevance) and Reliability (reliability of the results) and presented in the following section.

5.3 The 3R's of Simulation Game

Based on the study of various elements in ***Annexure A,*** Authors derived three dimensions that can sufficiently reflect the success of the simulation-based training. This resulted in identification of three significant characteristics of simulation game, which shall be referred as 3Rs of Simulation based pedagogical practice. These three core features 3R's i.e. ***Annexure A*** shows core features of Simulation Game & their grouping under 3R Model.

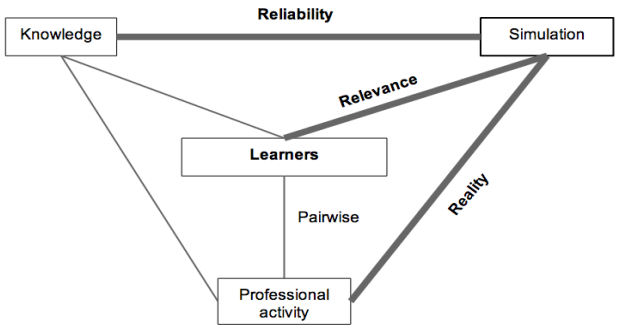

Figure 2: Link of the simulation with other components of the training session.

This specific model for simulation-based training session highlights the links of the Simulation with Learners, Knowledge and Professional activity. ***Figure 2*** presents the link of the simulation with other components of the training session.

This model referred as the "3Rs model", relates Reliability, Relevance and Reality.

Reliability is about the simulation behavior and its dependability in terms of changing variables and associated decisions in a dynamic environment.

Relevance is for "education relevance", how the simulation help the participant to better understand the subject and acquire the knowledge.

Reality is about the reflection of scenarios that can closely resemble challenges that the professionals face in their projects. As link between simulation and reality is difficult to measure in a multi-criteria scenario, we undertake a pair-wise analysis

The teacher is not included in the model. Of course, the teacher is present during the traditional acquisition of knowledge (training, teaching or supporting learning). For this part, the traditional pedagogical triangle may be used and very much has already been written about it. During the simulation part of the training session, the teacher acts more as a facilitator or an actor of the simulation than as a teacher. The 3R model focuses on the simulation part of the training session and on its articulation with the others parts of the course.

5.4 Simulation link with others training aspects

For choosing how to organize the acquisition of content centric knowledge, the traditional pedagogical triangle offers a good reference. This triangle focuses on the link between teacher, learners and knowledge. The pedagogical triangle does not include simulation. In other words, simulation-based activities are on the "learning" side, with learner acquiring knowledge through the simulation, in an experiential learning mode. But this triangle does not help to design simulation-based training session.

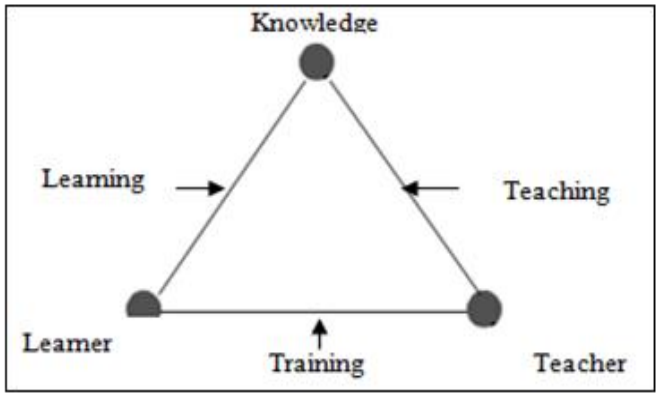

Figure 3 Pedagogical Triangle

For designing simulation-based training session one requires a specific model. This model should include simulation, its characteristics, the link between simulation and knowledge. As for adult training, link between knowledge and current professional activities is a main factor for learning motivation and knowledge integration and the model includes this aspect. ***Figure 3*** presents the link of pedagogical triangle. The research in the following section attempts to identify the extent to which this link is established in the present simulation game

6. AHP analysis of PM knowledge areas

Pair-wise comparison method was introduced by Fechner in 1860 and developed by Thurstone in 1927. Based on pair-wise comparison, Saaty proposed the Analytic Hierarchy Process (AHP) as a method for multi-criteria decision-making. Many researchers have later picked up the AHP method as a tool to solve multi criteria decision making problems as it provides a way of breaking down the general method into a hierarchy of sub problems, which are easier to evaluate. Hence authors adopted a similar strategy to evaluate participant's perception on various factors listed in PMBOK. Participant's qualitative responses were scaled and converted into quantitative values. (A.J. Antonio, and M. T.Lamata 2006). The evaluation process involves one to one comparison of each of the knowledge area under discussion. The factor weights were decided on a scale of 1 to 9. Knowledge areas that were more prominent as perceived by learners were given higher weights on a scale of 1 to 9 with 1 referring to low level of significance and 9 referring to very high level of significance.

All the knowledge areas of PMBOK were presented to the participants in the questionnaire. i.e. Scope, Time, Cost, Quality, HR, Communication, Risk, Procurement, Meeting stakeholder's expectation and Integration. Participant's responses to the questionnaire were analyzed. The questionnaire and consolidated response are shown in ***Annexure B***. Filled in responses were then consolidated before evaluation. The responses being qualitative it was found necessary to have an evaluation strategy that can be useful in managing a multi criteria assessment. Saaty's Analytic Hierarchy Process is found suitable in evaluating responses on PM knowledge areas and their reflection in the simulation games as perceived by the participants. Pair- wise comparison of these values resulted in the following PMBOK matrix. ***Figure 4*** shows the AHP Matrix for PMBOK with weights derived for various knowledge areas

	Scope	Time	Cost	Quality	HRM	Comm	Risk	Proc	Deliver	Stk Exp	Integ	G Mean	N Value
Scope	1	0.25	0.25	1	1	0.5	1	2	1	0.5	2	0.7579	0.053
Time	4	1	1	4	4	2	4	6	4	2	6	3.2875	0.229
Cost	4	1	1	4	4	2	4	6	4	2	6	3.2875	0.229
Quality	1	0.25	0.25	1	1	0.5	1	2	1	0.5	2	0.7579	0.053
HRM	1	0.25	0.25	1	1	0.5	1	2	1	0.5	2	0.7579	0.053
Comm	2	0.5	0.5	2	2	1	2	4	2	1	4	1.6245	0.113
Risk	1	0.25	0.25	1	1	0.5	1	2	1	0.5	2	0.7579	0.053
Procurement	0.50	0.17	0.17	0.50	0.50	0.25	0.50	1.00	0.50	0.25	1	0.3745	0.026
Deliverables	1.00	0.25	0.25	1.00	1.00	0.50	1.00	2.00	1.00	0.50	2	0.7579	0.053
Stake Exp	2.00	0.50	0.50	2.00	2.00	1.00	2.00	4.00	2.00	1.00	4	1.6245	0.113
Integration	0.50	0.17	0.17	0.50	0.50	0.25	0.50	1.00	0.50	0.25	1	0.3745	0.026

Figure 4: AHP Matrix with weight factors

6.1 Consistency check

The response matrix was also put to consistency check for evaluating reliability of the results while converting qualitative assessment into quantitative dimensions.

$RI_{(n=11)}$ is taken as 1.5 as $RI_{(n=10)}$ is 1.49 and the earlier research has shown that RI is an increasing and convergent function with increasing values of n. (A.J. Antonio, and M. T.Lamata 2006).

λ_{max} = 11.066; CI= (λ_{max} -n)/(n-1) Where n=11 & RI= 1.5

CR= CI/RI = 0.004 < 0.1 Hence, accepted

	Scope	Time	Cost	Quality	HRM	Comm	Risk	Proc	Deliver	Stk Exp	Integ	G Mean	N Value		
Scope	1	0.25	0.25	1	1	0.5	1	2	1	0.5	2	0.7579	0.053	0.5957	11.289
Time	4	1	1	4	4	2	4	6	4	2	6	3.2875	0.229	2.2785	9.954
Cost	4	1	1	4	4	2	4	6	4	2	6	3.2875	0.229	2.2785	9.954
Quality	1	0.25	0.25	1	1	0.5	1	2	1	0.5	2	0.7579	0.053	0.5957	11.289
HRM	1	0.25	0.25	1	1	0.5	1	2	1	0.5	2	0.7579	0.053	0.5957	11.289
Comm	2	0.5	0.5	2	2	1	2	4	2	1	4	1.6245	0.113	1.1914	10.533
Risk	1	0.25	0.25	1	1	0.5	1	2	1	0.5	2	0.7579	0.053	0.5957	11.289
Procurement	0.50	0.17	0.17	0.50	0.50	0.25	0.50	1.00	0.50	0.25	1	0.3745	0.026	0.3169	12.154
Deliverables	1.00	0.25	0.25	1.00	1.00	0.50	1.00	2.00	1.00	0.50	2	0.7579	0.053	0.5957	11.289
Stake Exp	2.00	0.50	0.50	2.00	2.00	1.00	2.00	4.00	2.00	1.00	4	1.6245	0.113	1.1914	10.533
Integration	0.50	0.17	0.17	0.50	0.50	0.25	0.50	1.00	0.50	0.25	1	0.3745	0.026	0.3169	12.154
												14.3623	1.000	10.552	11.066

Figure 5: Consistency check

The consistency in the analysis results as shown in ***Figure 5*** reveals the participant's perception on various knowledge areas and the same is consistent with their performance scores. Performance score here refers to their performance scale that gets updated based on participant's decisions and actions while playing in the virtual environment.

6.2 Results of AHP & Findings

On evaluating the matrix by AHP method, following results were achieved.

a. Few PM areas were found to be more prominent and often reflected in the game.

b. Many of the participants opined that they were able to appreciate the concept of time and cost to a greater extent followed by communication and stakeholder's expectation.

c. It is interesting to note that many of the project managers were not able to appreciate the reflection of attributes such as HR, scope and risk etc.

The instructors are of the opinion that the participant's inability to appreciate the above factors during the planning phase had actually resulted in challenges in meeting schedule and cost requirements during execution phase in the project. The results of AHP analysis reveal that all knowledge areas of PMBOK are not reflected equally in the present simulation game that is used as case study. This difference can be attributed to the game structure, participant's perception and the way they played the game. While time & cost attributes are reflected at 30% level communication & meeting stake holder expectation was seen at 13%. Many of the other knowledge areas such as scope, quality, HR, Risk, Procurement and Integration were much below 5% as can be seen in ***Figure 6.***

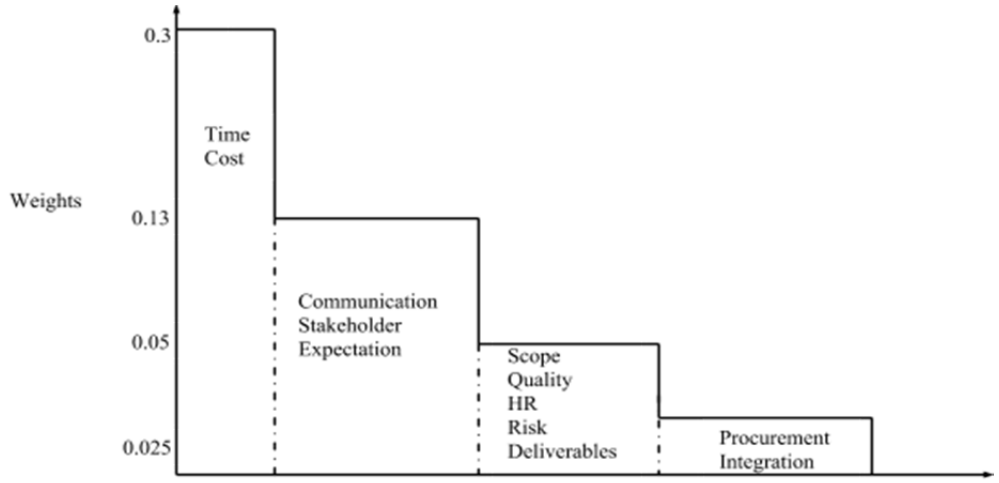

Figure 6: Level of reflection of PM Knowledge area

AHP analysis results reveal that project managers need more training in the area of functional and leadership roles before being presented with simulation based training. Participants found many challenges during execution and the same was attributed to lack of integration of behavioural and functional based inputs in managing the projects.

6.3 Observations on game features & team performance

Participants were given literature sheet that briefed project related information as reference material at the starting of the game. It is found that the participant's motivation level increased with the introduction of simulation game. The trainer's role reduced gradually during the training. However the trainers were focusing on various aspects of the play and behavior of team members during the training and few interesting observations are discussed in the following section.

- Each team tried to interpret the scope with the help of literature provided to them followed by a discussion with the team members.
- While scheduling the task, some of the teams used paper pencil, others resorted to tools such as Excel or MS Project.
- Activities were scheduled as per the technical requirement with very little scope for buffer durations.

It was interesting note that the teams focused more on schedule, cost, communication and stakeholder's expectation and in the process ignored other aspects such as employee training, motivation and their personal requirements (HR functions). Teams also did not consider factors such as engaging all team members, identifying standby requirements etc in the planning stage (HR functions). It was also observed that the inadequate planning lead to risk of losing control over factors such as scope, time and cost in the execution phase.

Participants found the way in which the project schedule and cost scale were reflecting their project scenarios is close to reality and are able to better appreciate knowledge areas concerning time and cost more compared to other knowledge areas. The learners were able to better connect 3Rs when it comes to cost and time. However communications and stake holder management were not clearly coming out through the games. Participants were not able to appreciate the link "Reliability" the way they appreciated time and cost factors. Scope, Quality, HR, Risk, deliverables were found to be even less reflected.

Annexure B shows consolidated response of participants indicating the need for a content centric training coupled with simulation game. While content centric training shall create interest in the game as the participants know what they are expected to do, the simulation game can create motivation by allowing them to transform their learnings. It is therefore clear that *theoretical sessions are effective but incomplete if not complemented with experiential learning techniques such as simulation game*.

The game made participants to appreciate the role of HR functions, leadership capability, and motivation, risk of inadequate planning, ability to convince management in decision-making etc in a project and correlate the same with their current project environment when the game was over. A good level of motivation and participation of team was observed throughout the training. *This kind of learning environment is difficult to articulate in a typical classroom session and hence supports the proposition that experiential learning is essential and not just desirable component in professional training.*

Following section summarizes the trainer's evaluation of the teams and the ability of teams to integrate and convert their learning into actions under real time conditions.

- While the participants gave more emphasis on meeting project needs during all the phases, they showed little attention on employee need. (For example HR Role such as employee motivation, training needs, employee availability etc.)
- Teams scheduled their tasks as per the literature information on project which explains only the estimates of duration by the technical teams and as a result ended up with having no provision to accommodate time contingencies arising out of managerial decisions.
- Critical activities were identified in terms of schedule during the planning phase and the participants realized that activities became critical in terms of resources in the execution phase.
- Mechanically assigning resources based on their availability or cost criteria does not ensure project delivery. Though theoretically one is correct in assigning resources that are available during a particular point in time, productivity may not be up to the mark. This may be attributed to factors such as poor motivation of the resource.
- Allocating a poorly motivated staff in the initial activities can potentially delay the whole project. For example activity 1 in the case example is delayed due to poor motivation thereby delaying subsequent activities. There are two adverse outcomes that are possible
- The project can suffer as the resources were idle for the planned period of subsequent activity. Same resources may be required for some other activity that was scheduled during the delayed period.

- Project managers should also know that selecting highly motivated individual alone cannot solve the problem but there should be continuous effort in keeping them motivated and making them available for the project.
- While selecting a highly motivated resource can facilitate smooth project execution one should also appreciate the fact that highly motivated ressources may also be wanted by the management for the very same reason that they are highly motivated!
- Participants were logical in sequencing their activities and using scheduling software. However the success lies in allowing floats not as per the information available but based on brain storming possible scenarios. But none of the teams did this and it resulted in teams performing poor in those cases where no provision for buffer time was kept. Although theoretically they were correct, practically they were not able to meet the schedule targets.
- Planning should also involve provision for alternate resources. There are possibilities that resources are moved from project and the project manager has few options when it comes to the authority of retaining resources.
- It is also to be noted that the project manager has the responsibility of managing the project team by engaging each member of the team. It is the responsibility of teams who play the game to check whether all individuals are assigned some tasks and no one is idle for the whole duration of the project. However it was found that the teams never attempted to see whether all the manpower is utilized. While project can progress by allocating resources in a theoretical sense unutilized resources can become a potential threat to the project environment. It also reflects poor capability of project manager in engaging human resource available to him and can adversely affect the progress.
- Functional & Leadership classification of resources were clearly reflected in the team's performance. While most of the teams performed well on the functional aspect a similar level of performance was clearly missing on the leadership capabilities.
- The learner's knowledge about learning (meta-cognition) and self-regulation skills also reflected through the games and thereby making them more effective in an adult learning environment.

7. Recommended frame work of a professional training session

The study makes it evident that concept based learning need to be complemented with application based simulation software. In project management pedagogy of planning, while the content centric conventional scheduling techniques answer the question of "How" the simulation when introduced can answer "How effectively" there by adding completeness to the training. This confirms the idea that "*Theoretical sessions are effective but incomplete if not complemented with experiential learning techniques such as simulation games*". For example, conventional training emphasizes on resource allocation with resource availability while the simulation-based games allow participants to look at other dimensions such as resource motivation, resource optimization and other issues concerned with project interface thereby enhancing the understanding of learner.

Design and evaluation are complementary in developing a simulation game and there should be sufficient scope for both the academicians and designers to continually evaluate the game for its relevance, reality and reliability. This shall be enabled by a strong delivery and feedback mechanism between those who design and those who take it forward in a class room environment.

A good simulation game training shall have the following features

- Sound theoretical concept orientation and discussion prior to simulation training
- Game should focus on covering all knowledge areas to the extent possible.
- Motivate and help project managers in understanding the knowledge and application requirements in a project and thereby connecting hard and soft skills.
- Both academic relevance and professional practice in terms of reliability embedded in a game shall allow the learner to connect the concepts well to their projects and make the game more motivating for the learners. *(Relevance and Reliability)*
- Games must have a provision to create more scenarios that suit their specific business environment of those undergoing training (*Reality*).
- Simulation game design therefore must reflect *3Rs of a project scenario. (Reality, Relevance and Reliability)*

Figure.7 explains the recommended framework for professional training program.

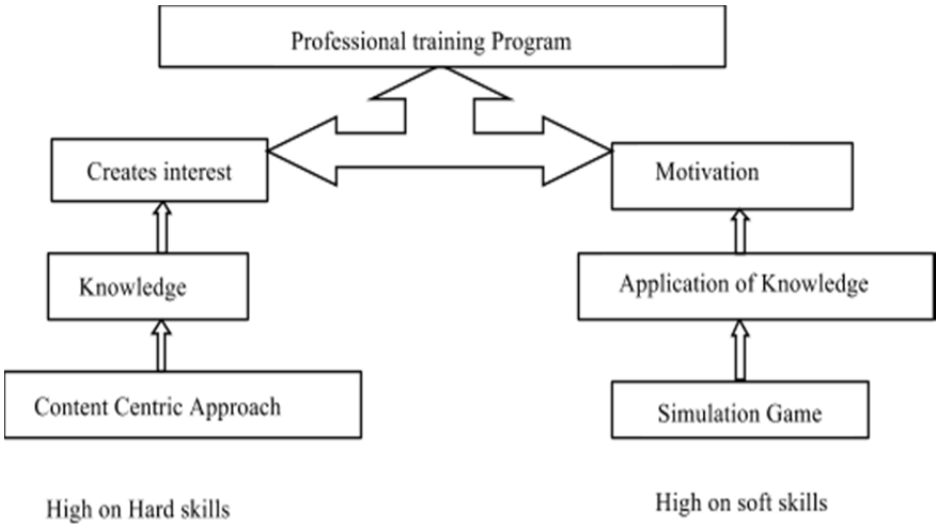

Fig.7: Recommended framework for professional training program.

8. Conclusion

Findings of the research lead to the development of simple framework that shall be referred while designing a simulation based training. The design of such framework should link the simulation with others elements of training. While the participants agree that the game can contribute in improving the interest levels and motivation to participate they also look for provisions to create more scenarios that suit their specific business environment. This confirms the discussion put forward by the authors that 3R's of simulation based pedagogical practice. i.e. Reality, Relevance and Reliability are equally significant in success of a simulation based project management training.

A simulation is not good or bad in itself, but its effectiveness depends on the learning environment and how it is linked with the training context. The paper presents the learner's and instructor's perspective on effectiveness of the game as a training tool and suggests a framework that may be of interest to both trainers and professionals who are engaged in designing and developing the simulation games. Based on the study it is concluded that professional training in project management requires theoretical inputs supported with simulation based learning. Structure of the game should cover all knowledge areas of PMBOK to the extent possible. *Designers of simulation games shall note that there is good scope for simulation based pedagogy in the developing soft skills, negotiation, contract administration and leadership competencies.*

With the introduction of more simulation games created to the requirement of specific scenarios, there is a good scope to integrate various aspects of project management that can strengthen the learning process and improve the effectiveness of project management pedagogical process in the years to come.

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References

1. Alonso, Jose Antonio, and M. Teresa Lamata. "Consistency in the analytic hierarchy process: a new approach." *International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems* 14, no. 04 (2006): 445-459.
2. Cano, J. L., & Sáenz, M. J. (2003). Project management simulation laboratory: experimental learning and knowledge acquisition. *Production Planning & Control*, *14*(2), 166-173.
3. Clark N Quinn, "Engaging learning: Designing e-learning simulation games", JohnWiley Publications, 2005.
4. Dantas, Alexandre R., Márcio de Oliveira Barros, and Cláudia Maria Lima Werner. "A Simulation-Based Game for Project Management Experiential Learning." In *SEKE*, vol. 19, p. 24. 2004.
5. Djaouti, Damien, Julian Alvarez, Jean-Pierre Jessel, and Olivier Rampnoux. "Origins of serious games." In *Serious Games and Edutainment Applications*, pp. 25-43. Springer London, 2011.
6. Dominique. J.,Stefano. R., SimProjet: an innovative simulation platform for experiential learning in project management, CSEDU Conference 201, pp. 471-477.
7. Doyle, J.K., Ford, D.N., Radzicki, M.J., Tress, W.S., Mental Models of Dynamic Systems http://www.wpi.edu/Academics/Depts/SSPS/Faculty/Paper s/27.pdf. [01/07/2003].
8. Drappa, A., Ludewig, J., Simulation in Software Engineering Training. In: Proceedings of the International Conference on Software Engineering, pp. 199-208,Limerick, Ireland, June, 2000.
9. Dudziak, William, and Chris Hendrickson. "Simulation game for contract negotiations." *Journal of Management in Engineering* 4, no. 2 (1988): 113-121.
10. Egenfeldt-Nielsen, Simon. "Review of the research on educational usage of games." (2004).
11. Colin Beard, John P Wilson, Experiential learning A handbook for education, training and coaching , KoganPage Publications.
12. Feinstein, Andrew Hale, and Hugh M. Cannon. "Constructs of simulation evaluation."*Simulation & Gaming* 33, no. 4 (2002): 425-440.
13. Forrester J.W., System Dynamics and the Lessons of 35 Years, http://sysdyn.clexchange.org/sdep/papers/D-4224-4.pdf, 1991. [05/02/2004].
14. Henry Ellington , Higher Education Academy Imaginative Curriculum Guide, Using Games, Simulations, Case Studies and Role-Play to stimulate students' creativity.
15. Hussein, B. A. (2007). On using simulation games as a research tool in project management. *Organizing and learning through Gaming and Simulation. Proceedings of ISAGA*, 131-138.
16. Hussein, Bassam A. "On using simulation games as a research tool in project management." *Organizing and learning through Gaming and Simulation. Proceedings of ISAGA* (2007): 131-138.
17. Hemmasi, Masoud, and Lee A. Graf. "Educational effectiveness of business simulation gaming: A comparative study of student and practitioner perspectives." *Planning* 4, no. 4.91 (1991): 2-67.
18. Knowles, M., Andragogy in Action, Jossey-Bass, SanFrancisco, CA, 1984
19. PMBOK, 5th Edition
20. Ruben, Brent D. "Simulations, games, and experience-based learning: The quest for a new paradigm for teaching and learning." *Simulation & Gaming* 30, no. 4 (1999):498-505.
21. Steve W.J. Kozlowski, Eduardo Salas, Learning, training and development in organizations Publication of the society for Industrial and organisational psychology,2012.
22. Veshosky, David, and Johannes H. Egbers. "Civil Engineering project management game: teaching with simulation." *Journal of Professional Issues in Engineering Education and Practice* 117.3 (1991): 203-213.
23. Woodward, John, Douglas Carnine, and Russell Gersten. "Teaching problem solving through computer simulations." *American Educational Research Journal* 25, no. 1 (1988):72-86

Annexure A: Core Features of Simulation Game & their grouping under 3R Model

Concept	Definition	Reference	Core Feature (As reflected through concepts)	Response
Accuracy	Does a simulation game accurately mirror the reality it is supposed to represent?	Dukes and Waller, 1976	Closeness to Reality	As per 81% of respondents the Game reflects 50 to 80% of real time project scenario. Participants also suggested that the game requires some modification to suit the specific scenario.
Conceptual Validity	Does the model adequately represent the real-world system?	Pegden, Shannon and Sadowski,1995		
Criterion (predictive) Validity	Does the model effectively predict real-world situations?	Babbie, 1992, Carmines and Zeller, 1979		
Event Validity	The degree to which a simulation's predicted responses correspond to actual data from the organization being simulated	Mihram, 1972		
Empirical Validity	Does a simulation game exhibit a closeness of fit to other measures of the phenomena it is designed to simulate?	Boocock, 1972		
External	Does the simulation model represent actual external phenomena?	Cook and Campbell,1979		
Plausibility	Does the simulation model appear to represent real-life Phenomena?	Boocock, 1972		
Realism	Does the simulation represent the business environment it is designed to simulate?	Norris, 1986		

Verisimilitude (face validity)	Does the simulation model appear to represent real-life phenomena?	Kibbee, 1961		
Educational	Does the simulation provide a valid learning experience?	Feinstein, Andrew Hale, and Hugh M. Cannon,2002	Educational Relevance	57% participants say that simulation based learning can replace classroom theory sessions to a certain extent (ranging from 20 to 50%) 100% of participants felt that the simulation game can be useful as a training tool subject to due modification to suit their business needs.
Algorithmic Validity	Does the model return appropriate values? Representational validity.	Wolfe and Jackson, 1989	Reliability of Simulation Game	While some respondents agree that the evaluation scales are closer others think that the actual scales are better than what is reflected.
Believability	Does the simulation model's ultimate user have confidence in the model's results?	Pegden, Shannon and Sadowski, 1995		
Construct Validity	How correctly are the variables in the model related to each other to form strategic and environmental constructs?	Babbie, 1992, Carmines and Zeller, 1979		
Content Validity	How complete is the simulation model, relative to the demands imposed by the purpose for which the model was developed?	Babbie, 1992, Carmines and Zeller, 1979		

Convergent Validity	How well do simulation performances results compare with other measures of comparable competencies?	Cannon and Burns, 1999		
Operational Validity	Are the model-generated behavioural data characteristics of the real-world system's behavioural data?	Pegden, Shannon and Sadowski,1995		
Internal Validity	Do a model's relationships represent true causality?	Cook and Campbell,1979		
Representational Validity	Does the simulation provide a valid representation of a desired phenomenon?	Pegden, Shannon and Sadowski, 1995		
Verification	Does the model do what it intends to do?	Pegden, Shannon and Sadowski, 1995		

Annexure B: Details of Questionnaire response

Summary of Participants response
Qn: Have you played a simulation game for project management in the past? If yes, then please specify name of the game? Ans: *Out of 23 participants only one had played a PM Game Earlier. Transversal Project – Global remote assistance system from Transversal Project team*
Qn: Was the duration (one day) sufficient for you to complete the PM- game? Ans: *74% of respondents say that the duration of one day was sufficient. However they responded more time could have improved their performance*.
Qn: What was the tool that you used for planning while playing the game? Ans: *60% of participants used MSP as tool for their scheduling. It was noted that the team that used MSP planned their resources better compared to those who used Excel or paper pencil.*
Qn: Do you think some project management conceptual inputs are required to be briefed to participants before they start the game? If yes then specify few. Ans: *60% of respondents say that some Project management conceptual inputs need to be briefed before starting the Game*
Qn: Do you think a game of similar nature can substitute theory lectures completely or partially? If yes then please specify to what percentage? Ans: *57% participants say that simulation based learning can replace classroom theory sessions to a certain extent. (ranging from 20 to 50%)*
Qn: Does the game depict the actual project scenario? If yes, then to what extent? Ans: 81% participants say that simulation game depicts the real time scenario. While 81% participants agree that it is close to 50 to 80% of real time scenario, 19% are of the view that it only captures 20 to 50% of real time scenario
Qn: Which of the PM knowledge area relevant to real time application you think is more emphasized during the game? Ans: *Schedule, Cost etc are covered as per all the participants. Procurement Management is one area, which the participants say is not covered.*
Qn: Do you think the scales of performance that you got in the end are reflecting your team's actual ability? If no then what are your self-assessment scales for all five-performance measurements. Ans: *There are contradicting views. While some respondents agree that scales are closer others think that the actual scales are better than what is reflected.*
Qn: Did you focus on all parameters during all the phases of project management? (Parameter refers to schedule, cost, Management, User & quality of decisions) Ans: *While 50% of respondents said that they focused on all scales, 90% of respondents focused more on schedule and cost scales*

Qn: How many members should be in a team typically to play the game more effectively? Ans: *81% participants say that a 2 member team should be fine.*
Qn: Do you think your team's scale is same as your scale or how do you compare your performance with your team's performance? Ans: *While 70% of respondents agree that the individual scale is same as team scale, 30% of respondents said their scales can be different from team scales.*
Qn: During which phase of the game you were more interactive with other member of the team? Ans: *Planning & Execution*
Qn: Which of the Five scales was more realistic in projecting your actual PM capability? Ans: *More varied response*
Qn: Do you think this simulation game can be effective if taken further to suit your business scenario through new scenario development? Ans: *100% of participants felt that the simulation game can be useful as a training tool subject to due modification to suit their business needs.*