

Using simulation games to enhance learning in project risk management.

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Abstract

Hybrid learning setting was developed to support the teaching of project risk management for an M. Sc. Course at NTNU. The course is also part of a master's level continuing education program in organizational management. The hybrid learning setting presented in this paper contains the elements of a competitive game, group work, case study and a computer simulation. Its main aim is provide effective environment for learning project risk management. The results obtained from the evaluation shows that the hybrid approach is more effective than the use of stand-alone simulation games. Functional requirements of the hybrid learning setting were developed on the basis of several interviews with experienced project managers in project risk managers. All in all, ten functional requirements were developed and validated. Feedback from the participants shows that majority of the participants supports the arguments that these requirements have been satisfied in the design and delivery of the learning setting. The evaluation of the learning outcome shows that participants' knowledge in all project risk management processes has been enhanced. The learning setting developed can also be used as a research tool to investigate the consequences of decisions taken during project risk management process.

1. Introduction

Project management has become a core business process for many firms both on strategic and operational levels. In fact, any activity that is perceived as significant and necessary from the customer perspective could be termed a project (Perminova, Gustafsson et al. 2008). The PMBOK (PMI 2004) identifies 44 processes that fall into five basic process groups and nine generic knowledge areas. Project risk management is one of the nine project management areas and focuses on describing the processes that are important in order to conduct proper risk management on a project.

The concept of risk in projects is still debated and therefore some scholars argue that project risk management should be referred to as project uncertainty management (Jaafari 2001). Interest in risk management has increased as the size and complexity of projects have grown and as competition between firms has intensified (Maytorena, Winch et al. 2007). As a result, numerous best practice standards, guides, and specialist tools and techniques have been developed focusing on a more effective project risk management process.

Colloquially, project risks are defined as uncertain events or conditions that may lead to positive or negative effect on at least one project objective, such as time, cost, health and safety, quality and so on. Failure to manage the occurrence of these events or their consequences at the right time during the project may result in project overruns, delays and poor delivery (Kerzner 2006). Project risk management therefore seeks to anticipate the evolution of projects and implement suitable responses early enough to positively influence the outcome.

The general consensus from the project management institute (PMI 2004) and risk management literature (Chapman and Ward 2003), (Turner 2009) and (Kerzner 2006)

is that the risk management process can be divided in four basic processes as illustrated in Figure 1.

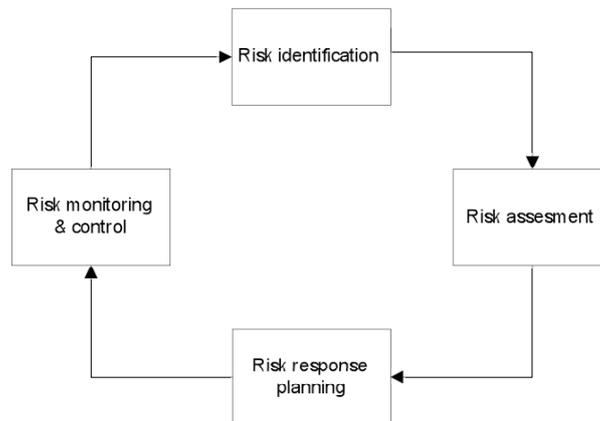


Figure 1. Project risk management processes

1. Risk identification: the process of identifying events or conditions that may occur during project execution and could impact at least one project objective
2. Risk assessment: the process of identifying the likelihood of the event and the magnitude of its consequences on project objectives. This task is done in two stages, qualitative assessment followed by quantitative establishment of numerical rating to prioritized risks on one or several project objectives (PMI 2004).
3. Risk response planning: the process of identifying measures for dealing with risks. This includes the choice of proper strategy to avoid, transfer or mitigate risks in case of having risks that could be perceived as threats. Risk response also includes identifying the strategies to exploit, share or enhance risks if they contribute positively to the project (risk as opportunity).
4. Risk monitoring and control: the process of monitoring, evaluating and updating the risk register. Risk mentoring tools include, re-assessment of risks and re-examining of risk response measures.

Current approaches in risk management training

The traditional way of teaching project risk management is done by presenting the theory, concepts and methods in a series of lectures combined with a case study, Monte- Carlo simulation or reviewing a project in an attempt to put the new knowledge into practice. No doubt that lectures and assignments is useful, but it only provide an aid to explain and study the techniques in project risk management. These methods fail to take into account the dynamics of the contextual conditions around and inside the project management effort. Using lectures, assignments and case studies often do not help students to develop an understanding of the difficulties involved in identifying, assessing, planning and monitoring risks (Baird and Flavell 1981). Therefore, developing competence in these processes requires different type of instructional methods that prompts understanding and appreciation of project complexity. Thomas and Mengel (2008) summarized the current methods for training the development of project managers to date; this has followed very linear approach focusing on the development and transfer of "know-what" aimed at improving the competence of project managers on "most projects most of the time". This type of education falls into the area of "training" which teaches people how to think and perform as instructed. This level of training does not prepare people to deal with unexpected difficulties or unique situations.

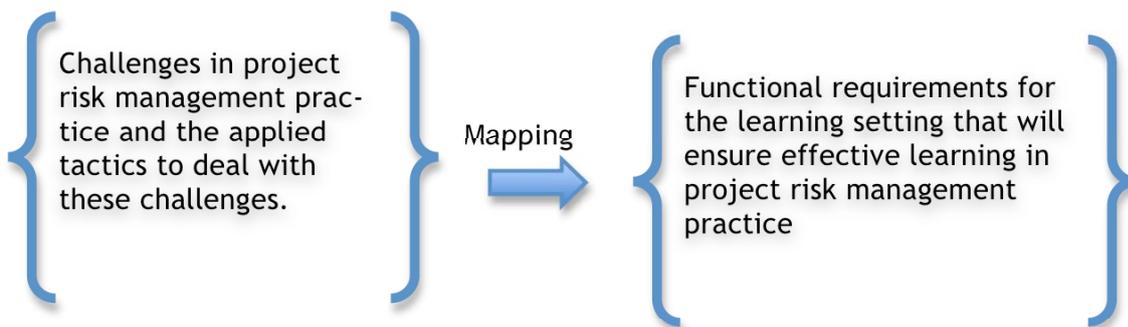
(Taran 2007) questioned the effectiveness of using lecture-based teaching to provide students with enough confidence and ability to apply risk management concepts after finishing the course, and has specifically pointed out the following shortcomings:

- 1- Concepts can be taught in class, but when they are not practiced continuously, they seem to be easily forgotten.
- 2- Lectures do not provide possibility to try out and experiment with the material being taught.
- 3- Time and schedule constraints force certain assignments to be delivered in haste, be shortened, or be taken out when faced with a large group setting.
- 4- Specific exercises and activities help, but are not providing an entire "project" picture
- 5- It is difficult to provide students with a way to experience "what-if" scenarios of following or ignoring risk management practices.

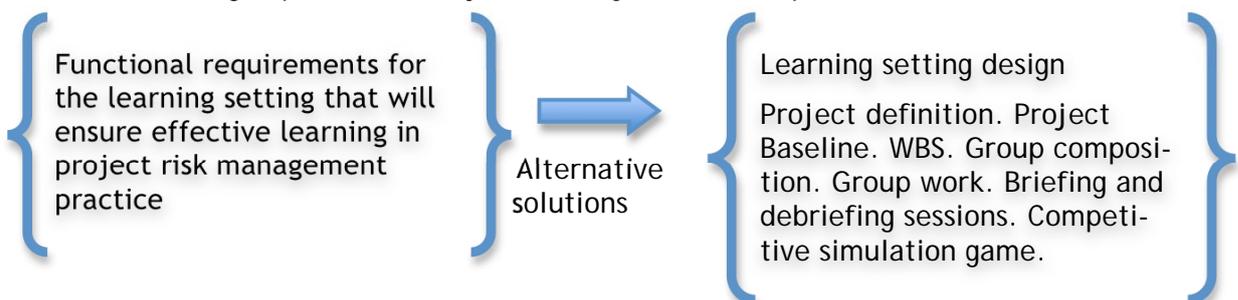
Research question

Our point of departure in this paper is that providing proper training in project risk management calls for a learning setting that is capable to capture, and allow the students to experience, the dynamic nature of project risk management processes. The question of the paper therefore is three fold:

1) The first part is concerned with establishing the challenges and the corresponding tactics that are adopted in order to conduct effective project risk management process in practice. To answer this question, interviews were conducted with senior project managers from several management consulting organizations. All in all 6 project managers were interviewed; the collective experience of these senior project managers is 45 years. From our point of view, understanding these challenges is essential in order to be able to build proper learning setting. The challenges and associated tactics are then used to develop a set of capabilities (functional requirements) that the learning setting should have in order to conduct effective learning experience.



2) The second part describes and tests a proposal to a learning setting that embodies all the capabilities developed in the first part. Testing has been conducted using two rounds of experiments. All in all, 50 continuing education students each one has a minimum working experience of 3 years have joined the experiments.



3) The third part of the paper examines and compares: a) to what degree the requirements have been satisfied, b) the learning outcome of the learning setting. The test subjects are participants of two classes taking the course in project management at NTNU. In the first class (Trondheim city) all the components of the proposed learning setting were implemented. While, in the second class (Oslo city) only the computer simulation was used. The hypothesis that will be studied is that Trondheim will give higher evaluation compared to Oslo. The test confirms the thesis and the results shows tangible difference between these two classes.

The rest of the paper is organized as follows: Section 2, the results of the empirical research that has examined challenges and associated tactics associated with managing project risks are presented and highlighted. These results are also presented in light of supporting literature and the implications on the proposed simulating environment. A list over functional and none functional requirements of the learning setting is given and discussed. Section 3 describes the overall design of the proposed learning setting that takes into consideration the conclusions and requirements described previously. Section 4 presents the results from the two experiments carried out to validate the design and to evaluate the learning outcome. Section 5 offers concluding thoughts about the contributions and insights from this research.

2. Method

The method consisted of semi-structured interviews to collect data related to challenges in conducting project risk management process as well as solutions to address these challenges. After exhausting the questions, informants were offered the opportunity to provide other insights regarding managing project risks. Each project manager was asked to identify at least two major challenges or issues during each stage in the project risk management process. These interviews yielded a framework of general issues and challenges and specific tactics to be used by project managers to address these. The list was then mapped into a list of functional requirements for the design of learning setting that will ensure effective learning. A functional requirement is defined as a capability a system must have in order to satisfy the needs of stakeholders (Young 2006). The learning needs are the focus of this paper. The interviews revealed the following results:

Project context

All the informants have stressed the importance of identifying and understanding project context as prerequisite for effective project risk management. This is achieved by using proper methods for gathering and distributing information about project goals, objectives, constraints, conditions and limitations. That could include time, and budget constraints or organizational and resource constraints, laws, ethics, financial and pricing structure. It was stressed that the project manager should make sure that information about these conditions and constraints are made available to and understood by those who will be responsible for risk management process. Similar conclusions was also made by (Kendrick 2009). After mapping these challenges into functional requirements for the learning setting, we could conclude that the learning setting should have the following requirements:

R1. Learners should be able to experience that availability of information about the project has an impact on the final outcome of the project risk management process.

R2. Learners should be provided with possibility of experiencing the dynamic nature of project context including changing constraints, stakeholder support and others.

Risk identification

In the risk identification stage, the informants stressed the importance of having the right persons with the right experience in the group that will be responsible for identifying major risk factors. They have also stressed the importance of including representatives of any stakeholder who has a stake in at least one project objective. Current literature supports this view as well, work by Maytorena, Winch et al. (2007) has shown that role and years in current job title are significantly correlated with the identification of risks.

Lack of time has been mentioned as a source of a challenge in this stage as well. The informants advised the use of structured and formal approach to risk identification stage. Informants have pointed that historical information and knowledge that has been accumulated from previous projects and from other sources of information are very helpful in speeding up the identification stage. In order to encounter these issues, the informants suggested using several identification techniques such as brainstorming, cause-effect relations and others. These techniques are described by (PMI 2004). (Lester and Lester 2007) gives the advantages and disadvantages of the usual risk identification methods such as brain-storming, prompt list, checklists and other methods. Mapping these challenges into the learning setting, we could conclude that the learning setting should have the following requirements.

R3. Learning setting should provide the learners with possibility of experiencing the importance of having the right people with the right competence in the group.

R4. Learning setting should allow the learners to experiment with various formal techniques to identify risks that could occur in projects.

R5. Learning setting should take into account the challenges in real life including; time limitation and human factors. These factors are usually omitted and cannot be considered by using the traditional lectures and assignments

Risk Assessment

The informants identified two main challenges associated with risk assessment stage

- 1- Lack of experience with project risk assessment. This involves assessment of probability and the impact of risks on project objectives. The strategy identified to tackle this problem by the informants involves selecting proper compositions of persons with relevant experience in project domain as well as supporting the assessment with historical data from previous projects.
- 2- Failure to prioritize risks. Project risk management practice indicates that it is neither possible nor recommended to mitigate or eliminate all risks in the project. Monte- Carlo analysis is frequently used for assessing the probability of achieving project objectives such as cost and time in the presence of risks

(Lester and Lester 2007). Risk prioritization is performed by grouping risk factors into categories depending on the magnitude of impact and probability of risks (Kendrick 2009). Informants have identified the causes for failing to prioritize risks appropriately, these includes:

- a. Inability to define proper boundary conditions for these categories
- b. Trying to fit collected data into predefined models rather than adapting the models to collected data. Informants have stressed the importance of adaption of existing models in order to be able to prioritize risks. In addition to the know-how in using analytical techniques for assessing and prioritizing risks it is evident that former experience and familiarity with risk category is a precondition for completing this stage (Chapman and Ward 2003).

Mapping these challenges into the learning setting, we could conclude that the learning setting should have the following requirements:

R6. Learning setting should allow the learners to access historical information and data from previous projects, their own experiences, and checklists in order to assess project risks.

R7. Learning setting should provide the learner with possibility to experience the impact of failing to assess the consequences of risks on project objectives.

R8. Learning setting should give the participants the possibility to experience the impact of failing to prioritize risks probably on project objectives.

R9. Learning setting should assist the learner to understand the importance of through analysis of project risks as well as the context as a precondition for assessing and prioritizing risks (Importance of making informed decisions)

Risk response planning

Risk planning involves selecting proper measures in order to reduce or mitigate the probability of risk or to reduce its consequences. Risk planning could also include measures intended to remove the conditions that cause this type of risks. Informants have in the interviews stressed that all the agreed upon measures must have measurable results. Work by Fan, Lin et al. (2008) confirmed that a proper risk-handling approach should take into account unique project characteristics, risk situation, and implications on project objectives. Acquiring information and improving communication are preconditions for developing proper risk response measures. Mapping these considerations into the learning setting gives the following requirement:

R10: Learning setting should give the participants the possibility to experience the impact of failing to implement proper measures to deal with risks. Thus using the simulation as a forecasting tool to investigate possible risk response strategies for dealing with risks

Risk monitoring and control

Informants have identified that the major challenge in this stage is information gathering and distribution, the availability of new information about changing project conditions, information about the results from risk response planning, information about key performance indicators, variance and trend analysis. Information about the technical information measures are crucial inputs to risk monitoring stage (PMI 2004). Mapping these considerations into the learning setting gave the following requirement:

R11. The learning setting should illustrate the importance of effective communication between the participants in order to be able to make informed decisions

Functional requirements

The empirical investigation and literature review about project risk management illustrates that effective learning in project risk management requires a learning setting that has the following capabilities:

1. Should illustrate that availability of project information has an impact on the final outcome of the project risk management process (R6 and R1)
2. Should illustrate the dynamic nature of projects
3. Should illustrate the importance of experience and competence in the project domain
4. Should illustrate the importance of using various formal techniques to identify risks that could occur in projects.
5. Should take into account challenges in real life process including such as time limitation and human factors.
6. Should help to experience the impact of failing to assess the consequences of risks on project objectives.
7. Should help to experience the impact of failing to prioritize risks suitably on project objectives.
8. Should help to understand the importance of through analysis of project risks as well as the context as a precondition for assessing and prioritizing risks (Importance of making informed decisions)
9. Should help to understand the impact of failing to implement proper measures to deal with risks.
10. Should help to understand the importance of effective communication between the participants in order to be able to make informed decisions.

In this paper, we shall assume that all these requirements are equally important to the outcome of the learning goal. The author is aware that this assumption needs more investigation and verification. However, because of space limitation, the investigation of this assumption has not been done. This will be the subject of further research.

Non-Functional requirements

A part of the learning setting shall be a competitive game simulation. We shall therefore present major factors that are important in game design and would result in increased learning (Hussein 2006):

- 1) N-R1. Easy playing. Easy to play, control and adapt to match the dynamic nature of real life projects.

- 2) N-R2. Time limited: Simulation should be executed in a condensed timeframe. The simulation's value would be significantly reduced if learning and playing the game took too long (Randel, Morris et al. 1992).
- 3) N-R3. Engaging: the challenge in the game should be closely matched to the skill level of the player(s). This is essential in order to allow the participants to explore concepts and methods. (Kiili 2005) stress the importance of keeping a player in a flow state game.
- 4) N-R4. Fair: the should be fair so that the main determining factor for the success of a player is the player's skill level. Although random events are possible, a better player should perform better in the long run.
- 5) N-R5. Fun: while this goal will be secondary to some of those above, it is certainly important that the players would want to play the game. The fun of the game will be a large part of what will make the lessons learned more memorable (Ferrari et al., 1999).

Test and acceptance criteria of the learning setting design

Two tiers of assessments containing in total 20 questions are developed and distributed to the participants at the end of each class. The first tier assess to what degree the simulation satisfies the functional and non-functional requirements (design validation). For this purpose, two rounds of experiments will be conducted, each with roughly around 30 students. In the first round (Trondheim Class), all the instructional methods described in section 3 will be used in the experiment. In the second experiment (Oslo class), the students will be allowed to conduct only game simulation (only stage 2). The results will then be compared. It is expected that there will be a tangible difference between the assessments of the two classes.

In the validation test, the scale given was from 1 to 6. Where 6 means strongly agree, 5; agree, 4, tend to agree, 3 tend to disagree, 2 disagree and 1 means strongly disagree. The target acceptance criteria for the simulation in class Trondheim) was quite ambitious and was formulated as follows; at least 75% of the respondents shall evaluate the degree of satisfaction equal or higher than 4.

The second tier of assessment shall evaluate the degree of the learning outcome from the learners' point of view (Learning verification). For this purpose, two rounds of experiments will be conducted (Trondheim, complete design) and (Oslo, only stage 2) as described above. The results will then be compared. It is expected that there will be a tangible difference between the assessments of the two classes.

The scale given was from 1 to 6. Where 6 means considerably high, 5; high, 4, tend to high, 3 tend to low, 2 low and 1 almost none. The target acceptance criteria for the experiment in Trondheim was quite ambitious and was formulated as follows; at least 75% of the respondents shall evaluate the degree of learning outcome equal or higher than 4 (tend to high or better)

3. Overall design

(Martin 2000) indicates that some things cannot be easily be learned by reading, writing or thinking about them. You may have to do them as well. Applying the hybrid setting should help eliminate the shortcomings of using the lectures and assignments alone, or computer simulation and help the learners to experience at first hand the dynamic nature of project risk management process.

The mechanism proposed in this paper uses a combination of several instructional methods linked by a concrete real world project definition. The project chosen was the construction of medium size house for a private owner by a construction com-

pany as a turnkey contract. The project is described at a high level 18 work packages. The possible risk factors are not developed in advance but left for the participants to develop during the briefing and preparation phase. This mechanism should prompt proper risk management best practice. The participants in the simulation (the players) form project groups of 4-5 persons and are supposed to develop and control a risk management plan for the project according to the requirements defined by the project owner. The project has 2 key project objectives;

- 1) The project has limited budget and the total costs should be kept within the budget
- 2) The project should be completed on time

Project teams must strive to follow proper risk management practices in order to avoid any adverse consequences that might cause them to fall behind their opponents in the race to complete the project and satisfying all project objectives.

Tasks

The setting is executed over three main stages as shown in Figure 2. We distinguish between these stages on the basis of the outcome of each phase as well as the type of interaction between the setting and the participants

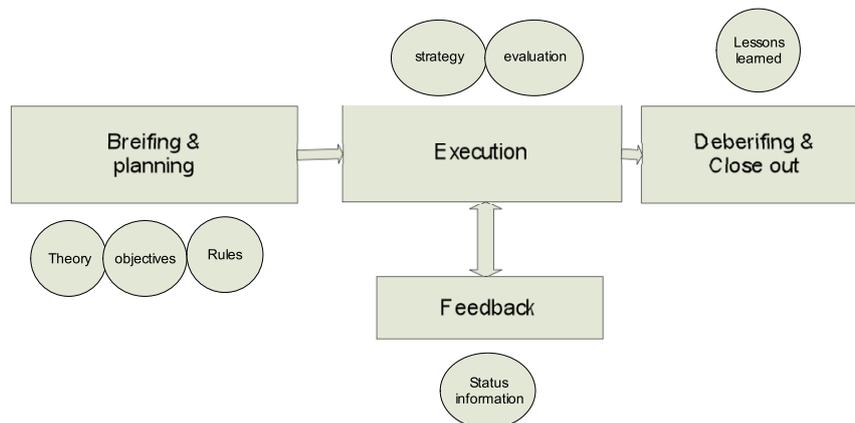


Figure 2. Main stages of the learning setting

Stage 1: Briefing and planning stage

- 1) Setting the stage: the objective of this stage is to introduce the participants the underlying theory behind project risk management, process, and the outcomes. A brief introduction to the impact of proper project risk management process on achieving project objectives is given. The concepts of risk register; risk matrix, brainstorming, qualitative and quantitative risk management, risk planning and risk monitoring techniques are also explained to the participants. The duration of this session is around 30-45 minutes. At the end of this stage, the groups are formed and a real-world project definition is distributed to the groups. Project definition includes; project scope, product description, cost and time constraints, project success criteria defined by the project owner, and other project assumptions and requirements. The WBS for the project is also given together with the workload requirements and resources use for each WP. A list of major project stakeholders are also defined and included in project definition
- 2) Group work: Based on the description given in the project definition, groups are asked to identify and develop a complete risk register for each work package in the project. The risk register includes information about, the

events or conditions that can contribute positively or negatively to the project and an assessment of the impact and likelihood of the event. In addition, assessment of possible measures that must be implemented to meet the challenge. Each group then refines and presents its solution in plenum to other groups. The objective of this stage is to train the participants in the first 3 processes of risk project management process and also it prepares them to the challenges that the groups will have to deal with in the next simulation phase.

- 3) The instructor collects and groups the risk registers, the duplicates are omitted and refined. The final list is fed into a simulation environment. The simulation environment is a computer game that contains the network diagram of the project with the associated resource need and workload needed in order to complete the work package.

Stage 2: Actual simulation

- 1) Familiarization stage: this includes the time needed by the participants to familiarize them with the simulation environment, understanding the layout and the game control parameters as well as acquiring information from the facilitator. The participants in this phase have tendency to rush to actual playing/simulation of the game. The facilitator should try to make sure that the participants have understood the rules and in particular the project context. In the end of this stage, each group should have a concrete understanding of the game and its control parameters
- 2) The execution phase: Includes the actual execution of the simulation and the responses taken by the participants. The role of the facilitator in this phase is to be available for questions and advice. During execution, the participants will be able to get updates and information about the status of their project objectives. This type of feedback is provided to the participants through a global map. The status information provided by simulation environment will then be used to evaluate the performance, changes the strategy or the focuses of the group. The global map is useful tool for the group to keep an overview over the whole network. Among the information presented on the toolbar the user can find the duration so far in the project, resources left, percentage completion of the project and actual time the group have used. The information gathered from the global map about project performance can thus be used as a basis for reflecting on the plans that was previously mad as well as on the decisions regarding mitigating risks that was taken in the previous phase.
- 3) The reflective observation of the feedback may lead to the construction of abstract concepts and enable the discovery of new and better solutions to the problems at hands, this is may be in the form of re-allocating the resources or to think different during mitigating the risks associated with the next work package.

Stage 3: debriefing phase

- 1) The final phase is the rounding up and debriefing phase: The debriefing phase takes places at the end of simulation conducted by the facilitator or the groups. And includes evaluation of the performance, explaining alternative execution strategies, linking the results to the project management theory and finally to identify lessons learned. The debriefing phase can take the form of open discussion to all the groups or to the individual groups separately.

4. Validation and evaluation of the design and the learning outcome

All in all 50 participants in the two rounds of experiments have taken part in the validation and evaluation. The feedback forms were distributed right after the end of the experiment. Participants were then asked to use few minutes to answer these questionnaires. It was emphasized that the results of the evaluation are important for the further development of the experiment and the setting. Around 80% of the participants agreed to deliver their response. The participants of both experiments are students taking continuing education course in project management on master level at NTNU. Around 30% of these participants have reported that they have knowledge and former experience in project risk management. The rest of the populations have identified themselves with no former experience in project risk management. Table shows the distribution of level of experience among class Trondheim. In Trondheim class the participants was divided into 5 groups. The first and second group contained majority of students that have reported that they former experience (middle or high). The rest of the groups were strictly composed of students who have reported that they have marginal or almost none experience. This arrangement was not used in Oslo class.

Table 1. Former experience among class Trondheim

Level of experience in PRM	No. of participants
Almost none	17
Marginal	3
Middle	3
High	4

Reliability of the questionnaires

Cronbach's alpha measures how well a set of variables measures a single unidimensional latent construct. Technically speaking, Cronbach's alpha is not a statistical test - it is a coefficient of reliability (or consistency). A reliability coefficient of .70 or higher is considered "acceptable" in most social science research situations. The reliability test of the questionnaires gave a coefficient of 0.940 suggesting high reliability.

Reliability Statistics

Cronbach's Alpha	N of Items
.940	20

Validation

The first tire of questionnaires was used to assess if the design have satisfied the functional and non-functional requirements that were developed and presented in the previous sections. Participants from the first group (Class Trondheim) were asked to identify to what degree they believe the design satisfies these requirements. The scale given was from 1 to 6. Where 6 means strongly agree, 5; agree, 4, tend to agree, 3 tend to disagree, 2 disagree and 1 means strongly disagree. The target is that 75% of the respondents should select the degree 4 or higher.

Results non-functional requirements

The results from validating the non-functional requirements at the first experiment are shown in Figure 3, and Figure 4. The results strongly suggest that the majority of participants Agree that the intended requirements are satisfied. With the exception of the third requirement (Fair), the mode of all the other results is 5. Suggesting *strong agree* or *agree* to the argument.

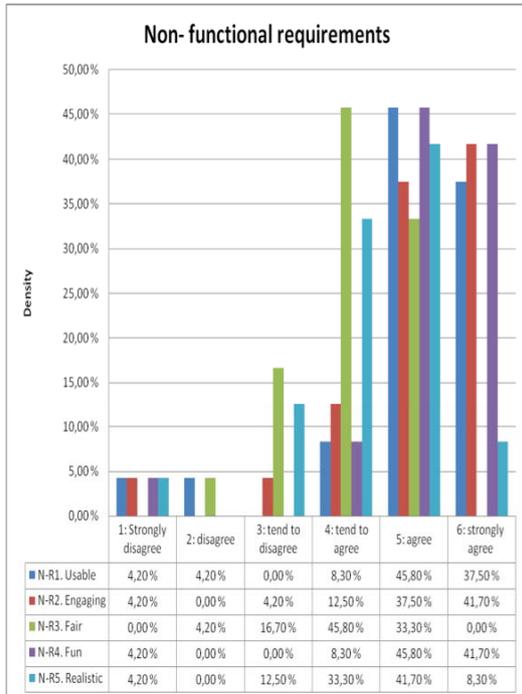


Figure 3. Evaluation of the non-functional requirements (Trondheim Class)

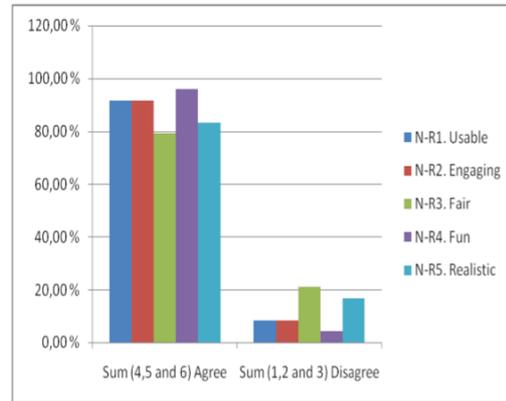


Figure 4. Agree versus disagree (Trondheim Class)

The author have also examined the correlation between the final grade the students obtained and the evaluation of Fair requirement shows that there was no any correlation between the grades obtained and the evaluation of Fair requirement. Hence we could assume that the evaluation of the requirement was not affected by the grades the groups obtained in the experiment, as shown in Table 2.

		Grades obtained	Fair
Grades obtained	Pearson Correlation	1	-.042
	Sig. (2-tailed)		.847
	N	24	24
Fair	Pearson Correlation	-.042	1
	Sig. (2-tailed)	.847	
	N	24	24

Table 2. Correlation between grades and evaluation of N-R3

Results about mean, mode and variance from Oslo class are also shown in Table 3 compared to the results from Trondheim. Results show no indication of any tangible differences between the two sets of results.

Non-functional requirements	Trondheim class			Oslo Class		
	Mode	Mean	VAR	Mode	Mean	VAR
N-R1. Usable	5	5	1.57	5	5,3	0.6
N-R2. Engaging	6	5	1.43	5	5,3	0.52
N-R3. Fair	4	4.1	0.69	4	4,3	1.14
N-R4. Fun	5	5.2	1.19	5	5,3	0.52
N-R5. Realistic	5	4.3	1.19	4	4,2	1.08

Table 3. Results for Oslo and Trondheim classes

Results for functional requirements

The questionnaire contained 10 functional requirements to be evaluated. The question the students were asked to answer is to what degree they believe the learning setting satisfies each of the functional requirements. The results from validating the functional requirements for class Trondheim are shown in and Figure 5.

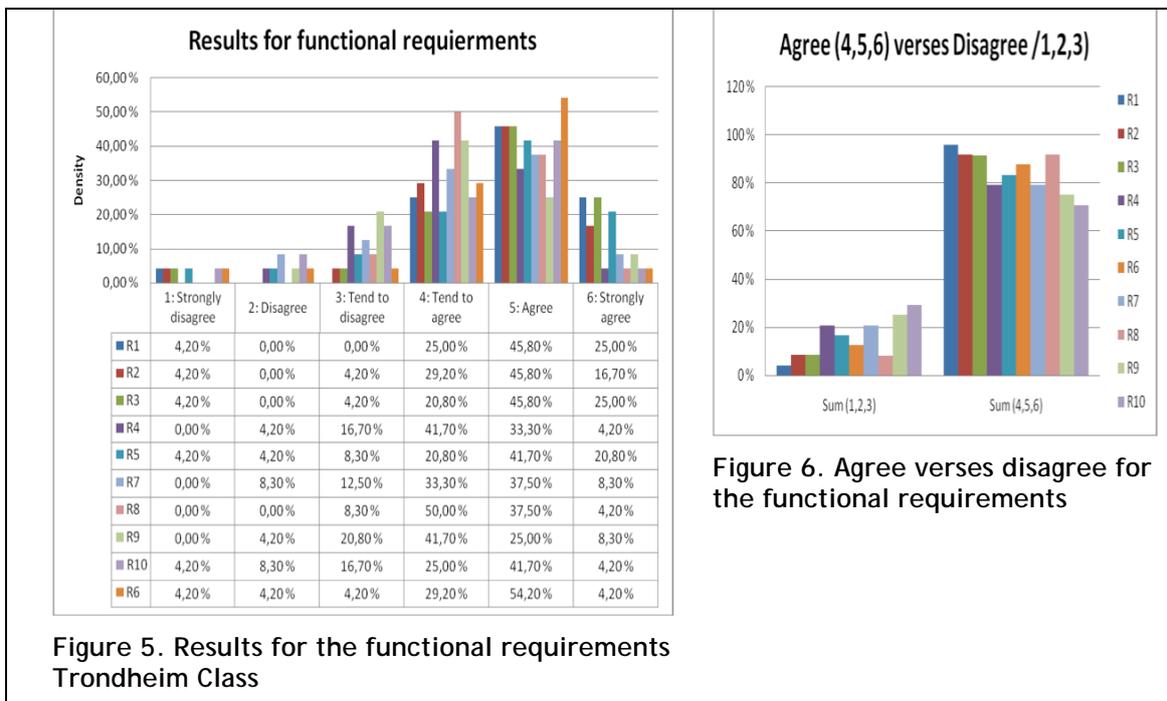


Figure 5. Results for the functional requirements Trondheim Class

Figure 6. Agree versus disagree for the functional requirements

The results suggest that the majority of participants Agree that the functional requirements are satisfied. With the exception of R10, all other requirements have attained the acceptance criteria of 75%. We can therefore conclude that R10 has not been satisfied. This suggests that the design should give higher focus for group dynamics problems and communication in teams.

Data about the mean, mode and variance of both Oslo and Trondheim shown in Table 4, confirms the assumption that Trondheim class will show higher degree of satisfaction compared to Oslo class. The difference is very evident in R3 and R4

R3. Should illustrate the importance of experience and competence in the project domain

R4. Should illustrate the importance of using various formal techniques to identify risks that could occur in projects.

	Functional Requirements	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
Trondheim	Mode	5	5	5	4	5	5	5	4	4	5
	MEAN	4.8	4.6	4.8	4.2	4.5	4.4	4.3	4.4	4.1	4.0
	VAR	1.19	1.20	1.30	0.84	1.65	1.20	1.15	0.51	0.98	1.52
Oslo	Mode	5	4	4	4	5	5	5	4	5	5
	Mean	4,9	4,4	4,1	3,6	4,8	4,4	4,0	4,1	4,0	4,0
	VAR	0.61	0.64	1.13	1.24	0.49	1.09	0.81	1.13	0.96	1.73

Table 4. Comparison between the mean, mode and variance for Oslo and Trondheim classes.

Results of evaluation of the learning outcome

The second questionnaire was used to assess the learning outcome of the design in relation to project risk management process. The questionnaire consisted of 5 questions. After the experiment the students were asked to identify to what degree they believe the experiment enhanced their skills in each of the project risk processes and in overall compared to prior attending the experiment. The scale given was from 1 to 6. Where 6 means considerably high, 5; high, 4, tend to high, 3 tend to low, 2; low and 1; almost none.

The results of the evaluation for Trondheim class are shown in Figure 7 and Figure 8. The results indicate that A1, A3, A4, and A5 have obtained the minimum acceptance criteria of 75%. Weaker results (67% and 71%) are obtained for A2 and A3 respectively.

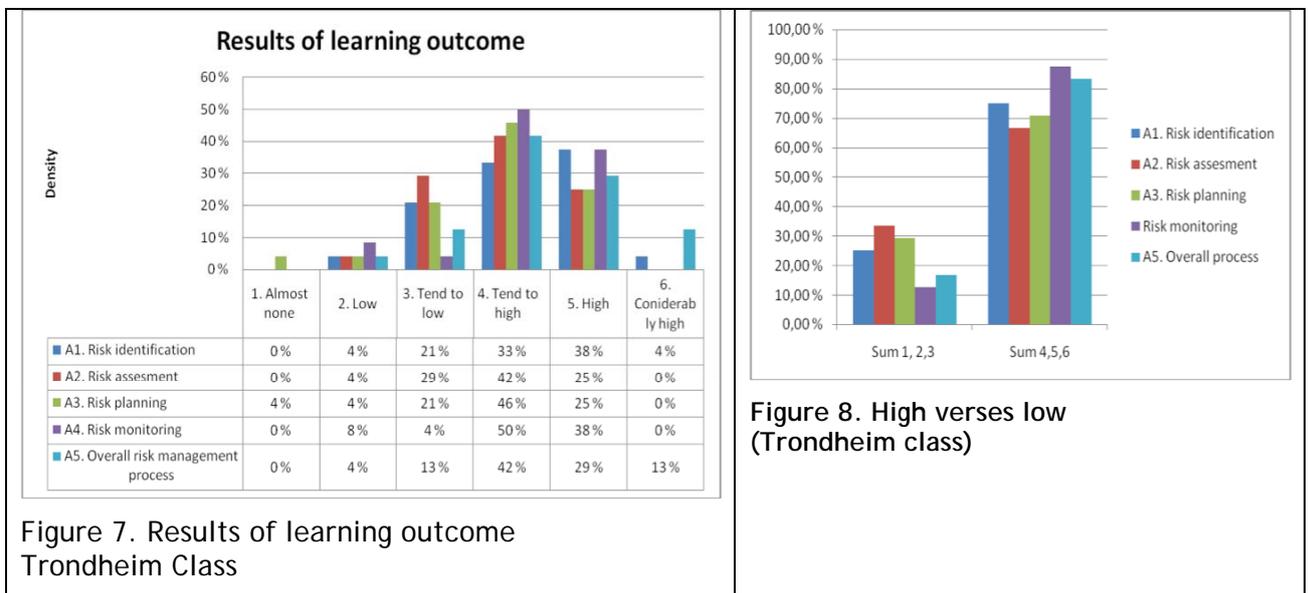


Figure 7. Results of learning outcome Trondheim Class

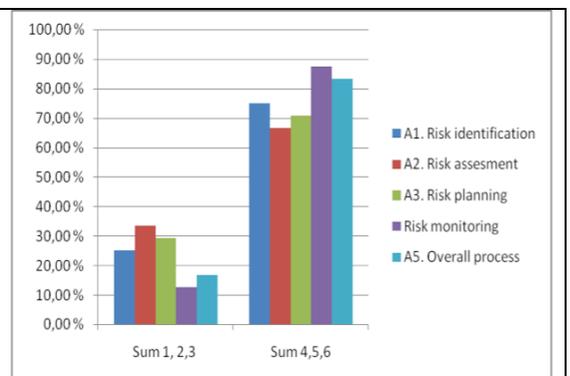


Figure 8. High versus low (Trondheim class)

Oslo Class was only involved in the computer game simulation, without participating in the initial groupe work. A comparison between the learning outcome for both classes is shown in Table 5 and Figure 9. Results obtained shows that the evaluation of learning outcome for Trondheim Class is considerably higher (between 10% and 19%) compared to Oslo Class. This supports the argument to use a wide spectrum of

instructional methods in order to attain a higher degree of learning in project risk management.

	Statistical indicators	A1. Risk identification	A2. Risk assessment	A3. Risk planning	A4. Risk monitoring	A5. Overall risk management process
G1 Trondheim Participated in the entire experiment	Mode	5,00	4,00	4,00	4,00	4,00
	Mean	4,17	3,88	3,83	4,17	4,33
	VAR	0,93	0,72	1,01	0,75	1,01
G2 Oslo Participated only in the Simulation stage	Mode	3	4	4	4	4
	Average	3,7	3,5	3,7	3,6	3,8
	VAR	1,14	1,18	1,75	1,10	0,93

Table 5. Comparison between the mean, mode and variance of the learning outcome for Oslo and Trondheim classes.

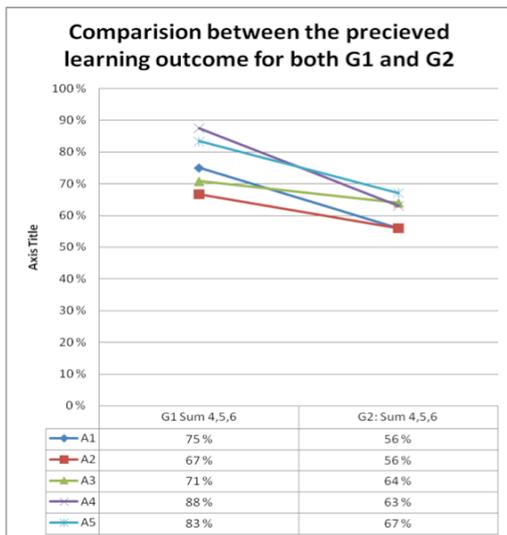


Figure 9. Comparison between learning outcome for both classes

5. Conclusions

In this paper, we presented, validated and evaluated the learning outcome of a hybrid learning setting to learn project risk management. The learning setting uses a combination of several instructional methods, including lectures, case study, and group work and computer game simulation. The learning setting was designed on the basis of 15 functional and non-functional requirements. The non-functional requirement identifies characteristics or attributes of the learning setting. The functional requirements describe intended capabilities that the learning setting must have. The functional requirements of the learning setting were developed on the basis of several interviews with highly experienced project managers combined with literature synthesis. The empirical investigation and literature about project risk management illustrates that effective learning in project risk management requires a learning setting that has the following capabilities:

1. Should illustrate that availability of project information has an impact on the final outcome of the project risk management process.
2. Should illustrate the dynamic nature of projects
3. Should illustrate the importance of experience and competence in the project domain

4. Should illustrate the importance of using various formal techniques to identify risks that could occur in projects.
5. Should take into account challenges in real life process including such as time limitation and human factors.
6. Should help to experience the impact of failing to assess the consequences of risks on project objectives.
7. Should help to experience the impact of failing to prioritize risks suitably on project objectives.
8. Should help to understand the importance of through analysis of project risks as well as the context as a precondition for assessing and prioritizing risks (Importance of making informed decisions)
9. Should help to understand the impact of failing to implement proper measures to deal with risks.
10. Should help to understand the importance of effective communication between the participants in order to be able to make informed decisions

A complete learning setting was then presented. The third part of the paper was concerned with conducting experiments and collecting data in order to validate the design and to evaluate the learning outcome from the participants' perspectives. Two layers of questionnaires were conducted in 2 rounds of experiments. The results obtained from the validation strongly suggest that both the functional and non-functional requirements were satisfied. In particular, the participants gave strong support to the argument that the learning setting is Usable, Engaging and Fun. Participants gave also strong support that the learning setting embodies the following capabilities:

- Illustrates that availability of project information has an impact on the final outcome of the project risk management process.
- Illustrates the dynamic nature of projects.
- Illustrates the importance of experience and competence in the project domain.
- Takes into account challenges in real life process including such as time limitation and human factors.

The results also indicate that there is less support for the argument (only 69% Agreed)

- Helps to understand the importance of effective communication between the participants in order to be able to make informed decisions

This suggests that the design should give higher focus for group dynamics problems and communication in teams during simulation exercises.

The evaluation of the learning outcome gives support to the arguments that the learning setting enhance participants knowledge in all project risk management processes and in particular A1 (risk planning), A3 (Risk response planning), A4 (Risk monitoring) , and A5 (overall process). Less support was given for A2 (risk assessment).

On using the learning setting as a tool to investigate or test the consequences of decisions taken during risk management process on project objectives

Although the main objective of the learning setting is to provide effective training and enhance learning in project risk management process, the simulation offers the learners with the possibility of using the simulation as a tool for examining the con-

sequences of decisions taken on project objectives such as cost, time, quality or any other criteria.

Roughly speaking, the decisions taken by the players in the game can be grouped into either to do something with the risks (which will in turn will affect budget, time, quality or even reduce the likelihood of other risks in the project.) or to accept the risks (which means that if it happened, it will impact, time, cost or it will generate other type of risks that were not counted for). The participants have therefore the opportunity to experience and live with the consequences of each decision they made at each work package as the simulation goes on.

6. Author information

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