SIMPROJET: AN INNOVATIVE SIMULATION PLATFORM FOR EXPERIENTIAL LEARNING IN PROJECT MANAGEMENT

Dominique Jaccard and Stefano Riboni
Haute Ecole d'Ingénierie et de Gestion du Canton de Vaud (HEIG-VD)
Western Switzerland University of Applied Sciences, Avenue des Sports 20, CH-1401 Yverdon-les-Bains, Switzerland

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Abstract: Considering the variety of formal and human skills implied in effective project management practice, and the difficulties at building proper educational programs, this paper describes the innovative concept developed by HEIG-VD, built around a web-based project management simulation platform. After motivating the need for newly built educational programs in project management, we point out the requirements for such a platform, and present our achievements, concluding with future developments opportunities and further research areas of interest.

1 INTRODUCTION

The development of the service industry, the reduction of products' life cycles and the increased speed of innovation, in almost all economical sectors has brought to a continuous and fast growth of project management, and to its rising importance as a top management concern. An increasing number of institutions are moving from traditional divisional structures to project-based organizations (Whitley, 2006). The demand for skilled project managers is therefore dramatically increasing. Project management becomes an essential part of any higher education syllabus in management as well as in engineering, from undergraduate to executive master programs. To quickly cope with this increasing need for project management professionals, companies are more and more demanding for project management training courses for their employees, who are requested to manage projects but only have a technical or administrative educational background.

But current mainstream project management education is often seen as inadequate for today's complex projects (Crawford et al., 2006). Programs are often limited to the transmission of the conceptual Project Management Body of Knowledge (PMBOK) edited by the Project Management Institute (PMI) (Project Management Institute, 2009). A recent initiative ran in the UK called "Rethinking Project Management" (Winter et al., 2006) (Crawford et al., 2006) pointed out that "the current conceptual base of project management continuous to attract criticism for its lack of relevance to practice" (Winter et al., 2006, pp 638), and argued project management educators to move away from the delivery of standard solutions and techniques-oriented pedagogy. Project management training and education therefore needs new pedagogical support materials and methodologies to be effective and provide project managers with both the hard and the soft skills needed to face the complexity of today's projects.

In this context, the trend for experiential learning (or learning-by-doing) seems very interesting. Simulations, by creating virtual situations, can provide the project manager with an environment where this combination of hard and soft skills can be practiced, tested, and acquired.

In order to provide project management educators with an innovative tool to support their training programs, the HEIG-VD has developed a flexible, web-based simulation platform called "SimProjet". Based on a pluri-annual experience in project management education in various environments (undergraduate and master levels, technical and managerial syllabuses, academic and professional institutions) SimProjet has been designed and developed with a particular focus on the scenario-definition capabilities, allowing educators to customize the simulation to the learning objectives and to the teaching environment.

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In use since 2008, SimProjet has demonstrated its value, but also shown some limitations and evolution potentials. Its usage opens for further reflection and research topics in project management education and computer-based business simulation tools.

2 PARTICULARITIES OF PROJECT MANAGEMENT EDUCATION AND TRAINING

Project management is a particular area of business management where variety is the only constant rule: variety in projects' size (budget, number of persons involved or duration), variety in projects' complexity (technical, social and relational, level of uncertainty and risks) or variety in projects' nature and objectives (delivering a product or a service, product innovation, theoretical research or experimentation). That is certainly what makes project management so unique and particular in the field of business management.

Skills needed for the project manager results from the specificity of the project management area. Both 1996 Wirth's (Wirth, 1996) and 2003 Zika-Viktorsson, Hovmark and Nordqvist's (Zika-Viktorsson et al., 2003) research show evidence that, except in some industries where project's object is very clearly defined and designed (like construction or industrial equipment/machinery), the psychosocial aspects are key to the project's success. The more complexity and uncertainty in the project, the more soft skills are required: communication, leadership, motivation, coordination, conflict-resolution, problem-solving, team building, flexibility, creativity or trustworthiness. So, on one hand, the set of methods and tools specific to project management is well known and quite limited (WBS, PERT, Gantt, EVM), but, on the other hand, managing projects successfully is less dependent on the knowledge of these tools than on the capacity of applying the right tools, mixed with the project manager's soft skills (Pant et al., 2008). These findings highlight the inadequacy of current project management education programs based on PMBOK-type knowledge, whereas these references are recognized as providing theoretical knowledge but not a real practical application of the theory.

Therefore, a new way of thinking project management education is necessary to broaden existing approaches. Meaning education and training programs should combine classic lectures with practical activities giving the learner the opportunity to experiment real project management situations. In this way, experiential learning, where one learns through reflection on doing, seems to be a very interesting approach. The interest of experiential learning has been proven in various other domains where technical skills are essential, but not sufficient to succeed if not completed by particular psychological and behavioural capabilities (medical, aeronautics or organizational) (Aldrich, 2005).

In the professional environment, experiential learning can be done by putting junior project manager directly on the job, with some senior coaching, and completing the education with classical training about the formal aspects and tools of project management. But real projects rarely give the opportunity to the learner to individually experiment and make mistakes (risk and cost of such mistakes might be too high to be acceptable). Actually, the coach is most of the times telling in advance to the learner how to act, moving away from real experiential learning, and therefore limiting the knowledge acquisition, avoiding the junior professional to really understand the reason for acting in a certain way.

This confirms the need, in both academic and professional environments, for giving project management learners experiential environments where to freely act, being really in charge of the given tasks, with no supervision or coaching, feeling free to make their choices and their mistakes. This can be done through creating virtually realistic project management situations, where to facilitate learning according to Rogers' recommendations (Rogers, 1969): "(1) the student participates completely in the learning process and has control over its nature and direction, (2) it is primarily based upon direct confrontation with practical, social, personal or research problems, and (3) self-evaluation is the principal method for assessing progress or success."

Project management simulations are the ideal educational way to complete classical teaching, confronting learners to real situations adapted to the pedagogical objectives. Simulations (if sufficiently customizable) can reproduce a wide variety of project management issues and situations. They offer instantaneous and asynchronous feedback to the learner on the consequences of his decisions and actions. And feedback is essential in a "learning-by-mistake" process, which is the best (if not the only) way to acquire psychological, behavioural and social capabilities.

3 PROJECT MANAGEMENT SIMULATION PLATFORM REQUIREMENTS

There are different ways to build simulations: (1) board games, (2) role plays and (3) computer-based simulations, each of them presenting advantages and limitations. The latter is certainly nowadays very effective, allowing:
- realism, as most of today's business tasks are actually achieved using computers (e-mail, chat or video-conferencing communication, data and information access);
- adaptability, as scenarios development allows to adapt these to the situation we want to simulate, and to the pedagogical objectives of the educational program;
- accessibility, as software can easily be diffused, and in case of web-based simulations, instantaneously accessible with no distance or time limitation.

Having chosen this latter option (computerized web-based project management simulation), we had to identify the key requirements for having it corresponding to what we considered was missing in traditional project management education programs.

First of all, the simulation needs to be in line with the defined pedagogical objectives.
- Technical knowledge (hard skills): planning using PERT and Gantt, evaluating financial outcome using net present value and internal rate of return, controlling using earned value management, ...
- Psychosocial knowledge (soft skills): building and managing a team, and a variety of relationship with other stakeholders, communicating, motivating, taking decisions, solving problems, handling conflicts, ...

Therefore, the simulation should not be limited to learner-computer interactions, but also imply collaborative team work, making learners experiment interpersonal issues, through some role-play aspects.

Second, the simulation has to be adaptable to different contexts of use: academic (undergraduate, postgraduate and executive programs levels) as well as professional environments. The original idea was to use it in an undergraduate project management course, taking 16 sessioons of classroom presence spread over several months. But we considered from the beginning the need to have it designed to fit also shorter, more intensive 2 or 3 days long training programs. The simulation should also allow teachers to have it running a complete project, from initiation to conclusion, or to have it focusing more on one or the other project phase (initiation, planning, execution, closing).

Third, the simulation should be based on project-types where the learners could feel in an understandable environment, in line with their technical knowledge domain. IT students will feel more comfortable working on a software development project, mechanical engineers working on a manufacturing project, and future architects working on a construction project. We therefore considered essential to the simulation software to be able to handle any kind of freely definable projects' scenarios.

Fourth, the simulation should allow to define different types and levels of complexity in the projects' scenarios. The scenario definition tool should allow a combination of deterministic branching stories (Aldrich, 2004), as well as probabilistic actions and behaviours. Many authors have shown that neither the complexity nor the realism of a simulation is a factor of successful learning of the participants (Hall and Cox, 1994) (Frazer, 1980). Our experience tend to confirm this point: participants facing too much complexity and too much variables at the same time often take a "try to click and look the result" approach, observing how the simulator reacts, instead of trying to analyze all the data and understand the links between them. Moreover, increase in simulation complexity also increases the time and cost of development, as well as the time needed for the participant to understand how to use the simulation. On the other hand, if the simulation gives a simplified image of the reality, it makes it understandable for participants, gives them the possibility to analyze available data, and leads to more thoughtful decisions. Globally, the main simulation development challenge is to find the appropriate complexity level to create a sufficiently realistic environment (participants can believe in the simulation), but understandable enough (participants are not overwhelmed by the complexity and can understand what happens in the simulation).

4 SIMPROJET CONCEPT AND PLATFORM DESCRIPTION

4.1 SimProjet Concept and Principles of Usage

SimProjet has been designed to support project management education programs, creating a virtual environment for experiential learning. Considering the above-mentioned criticality of interpersonal as-

pects of project management, SimProjet is not intended to be used individually, but as a support to team work, with ideally 3 to 4 learners per team. SimProjet is not an exclusively computer-based simulation, but requires "off-the-PC" activities like producing and delivering documents, as well as giving oral presentations. Thus, the whole concept of SimProjet combines team work, computer-based simulation and role play. More than a computer-based platform, SimProjet is a complete project management educational concept.

Whatever the context (academic or professional education), the SimProjet educational program is fundamentally the same. The course is divided in 4 stages, corresponding to the 4 phases of any project's life cycle: initiation, planning, execution and closing. Each stage follows the same process:

- Teacher introduces the phase and teams are requested to reach an objective and produce deliverables,
- Teams work in order to produce the requested documents or oral presentations,
- Teacher gives a feedback to the teams.

Phase 1 – Project Initiation: Teacher introduces the course explaining that participants, by teams, will have to conduct a project, in a simulated/virtual organisation. Information about the organization and the project, as well as interactions with it (communication with management and colleagues, decisions, actions, news) are available and made through the SimProjet web-based platform. Each team plays the role of a project manager in charge of proposing, planning and then conducting a project. The project initiation phase starts with an idea (product innovation, problem-solving, ...) being submitted to the team. The team must develop the idea and transformed it in a project proposal. To do that, each team will find on the platform decisions to be taken (amongst proposed options), and will also be proposed to make optional actions. Decisions and actions may give the team the needed information to establish the project proposal (project goals and objectives, tasks, duration, costs, constraints, risks, financial outcome). The platform provides team with indicators of both organization's management and project's stakeholders satisfaction, which evolve according to the decisions taken and conducted actions. Teams dispose of limited time, restricting the possible number of decisions and actions to be taken. Each team must end up the initiation phase with delivering a written project proposal, and an oral presentation to the projects' selection committee, played by the teacher, who then gives a feedback to each team about how they performed.

Phase 2 – Project Planning: Assuming the project proposal has been approved, teams will be requested to establish a detailed planning of the project. The platform will provide them the list of project's tasks, the potential human resources, as well as decisions options and potential actions. Teams will have to produce a written project planning report (containing WBS, PERT and Gantt diagrams, and a budget estimation for the project). On the platform, they will also have to confirm the planning of the project's tasks (in a Gantt visual), to book the chosen resources, and to sequentially assign them the project's tasks. Teacher will provide feedback through a formal project planning report review.

Phase 3 – Project Execution and Control: The execution phase takes place mainly through the simulation platform. Time's progress will generate deterministic or probabilistic events affecting the project (change request, extra costs, unexpected resource absence, ...). Tasks' execution rhythm depends on the number, availability, motivation and competence level of the assigned resources. Period per period, teams are informed of the work's progress, and of the evolution of costs, time and quality indicators. Twice during the execution, teams are requested to present a project status report to the steering committee, played by the teacher.

Phase 4 – Project Closing: During this phase, learners are requested to step back and conceptualize the learnings from their concrete experience at managing the project. In order to formalize knowledge and capabilities acquired during the simulation, a project closing report may be requested.

All along the simulation process, teacher has the choice of when and how to provide theoretical elements of knowledge or reflection. The goal being to achieve effective experiential learning cycle, all along the four phases of the simulation.

Thus, SimProjet allows to implement Kolb's Experiential learning cycle.

(1) Concrete experience is made by taking decisions, making actions, and establishing the requested deliverables according to the available information. (2) Individual and team reflection is based on the observation of the reaction of the simulation platform to the choices made and actions taken. (3) From what they observed, teams try to extract conceptual learning, through self-evaluation of their actions and decisions consequences. Inputs from the educator will help this step of the learning process. (4) Teams will then try to experiment the knowledge newly acquired in the next stages of the simulation.

This educational method, combining "learning-by-doing", "learning-by-mistake", team work, role

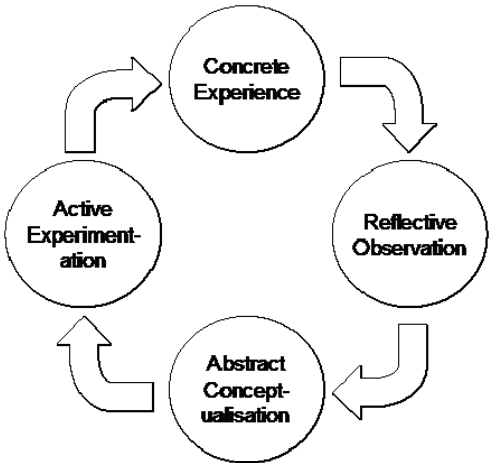

Figure 1: The Experiential Learning Cycle, according to Kolb (Gibbons et al., 1994).

play and simulation, added with classical teachers' lectures, should generate a virtuous cycle allowing acquisition of a variety of hard and soft skills.

4.2 SimProjet Platform Description

The SimProjet simulation platform is structured in three different users' profiles interfaces: Scriptwriter, Moderator and Player.

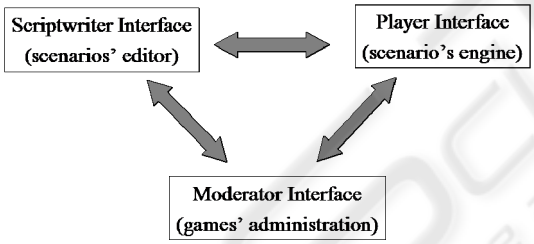

Figure 2: The SimProjet Simulation Platform Structure.

1 – Scriptwriter Interface: Authorized Scriptwriter can here access Basic Scenarios (non-editable scripts, provided by HEIG-VD), Shared Scenarios (editable, written and shared by SimProjet platform users), and Private Scenarios (editable, not shared, specific to a particular user). Scenarios can be copied, modified, or created from scratch. Scriptwriter can define project's phases names and duration, project's tasks and sequence, available resources with their characteristics and different performance indicators. The most powerful part of the scenario editor is the possibility to freely define decisions and actions the players will have to take or perform during the various phases of the simulation. Decisions will propose different possible options the players will have to choose from. Every option will generate an answer to the player, and might influence the indicators. Players can also made some optional actions that will also generate feedback and might influence indicators. The sophistication of the whole "scriptwriter module" lies in the possibility to define triggers that can generate events on a deterministic or probabilistic basis. They can be linked to a decision or action (testing if decision A = 1 and decision B =2, then impact = X, whereas if decision B = 3, then impact = Y), or just to particular situations of the game (if period > 3 and < 8, then impact resource 1 = 1 week unavailability, with probability = 15%), generating events that may impact tasks, resources, decisions, actions and/or indicators. The scriptwriter interface provides also an automatic logical checking engine, verifying that all the branching story events are logically linked (no closed loops or missing sequences). All of these tools allow to define customized projects' scenarios with the desired degree of details and realism.

2 – Moderator Interface: Teacher can manage games from this module, by creating new games, based on available scenarios, and assigning teams to games. He can follow the teams by seeing their choices, actions and indicators. The teacher can also communicate with teams (edit news, send e-mails) and influence the simulation by generating events affecting one team or another.

3 – Player Interface: The player's screens allow teams to access all the needed information (project description, tasks, resources, news and mails), to take decisions upon the proposed choices, to act upon other proposed initiatives, to plan tasks, book and assign resources, and to access to the history of the project and their actions. Through this interface teams can concretely experience project management, and observe impacts of their decisions and behaviour.

5 EXPERIENCED BENEFITS AND LIMITATIONS IN USING SIMPROJET

Experiences were made in quite different contexts: bachelor, master and executive courses, as well as in-house training programs for business professionals. Participants with various project management experiences (from no experience in bachelor to more than 10 years in executive courses) found that the simulation was a good pedagogical tools. It was used in courses of different length, from 4 to 16 sessions of 4 hours, and also in 2 to 4 days seminars.

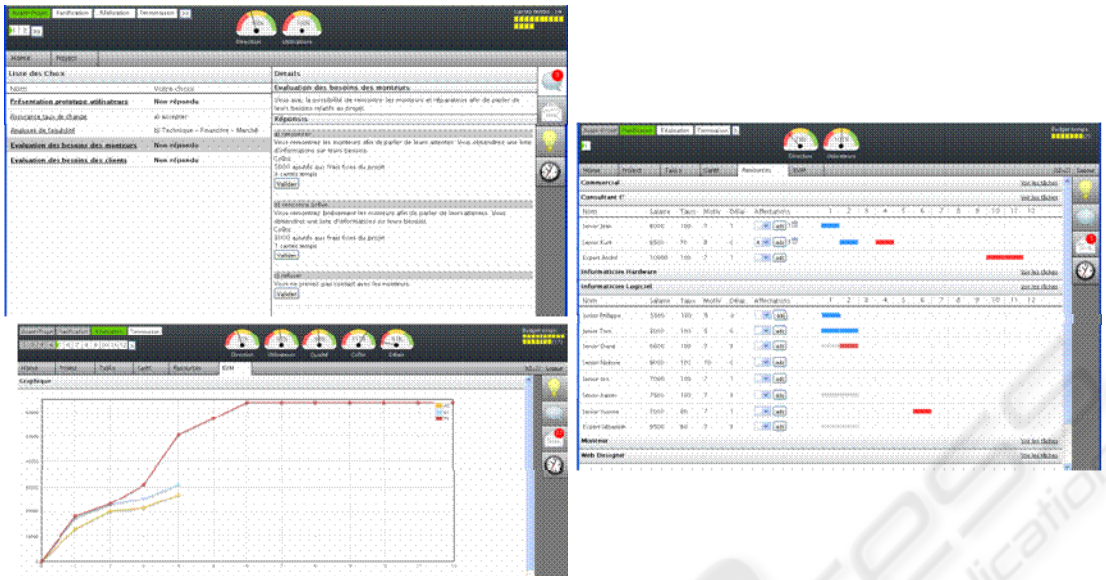

Figure 3: Screenshots of the Player's Interface: Decisions, Resources Planning and EVM Reporting (clockwise).

In academic usage, SimProjet has given very positive results, with increased interest and participation of students. Even if not formally measured, the feeling is that it allowed learners to much better understand the value and limitations of formal project management tools and techniques such as PERT, Gantt and EVM. It surely increased students awareness of the complexity of relational issues affecting a project, therefore making them acquire some ability in approaching the kind of situation they will meet in their future careers as projects workers. Experience seems to indicate that the theoretical knowledge level at the end of the course is the same that with the former course without the simulation (the results at the theoretical exams are similar). But it seems that the ability to apply the acquired knowledge has significantly improved. The limitations we saw so far stand in the deep motivation of each individual: the gap in knowledge acquisition between motivated and less-motivated students is probably even larger than in classical teaching methods.

In professional environment usage, the flexibility in custom scenarios definition proved to be a great asset. It allows to very finely adapt the training program to the aimed learning objectives, through tailored situations where trainees can focus on the wished issues. Several corporations who tested the SimProjet concept are studying the possibility of creating their own scenario, with their specific tasks, events and difficulties. One of the difficulties has sometimes been to convince that a "gaming approach" is not just a game, but would result in acquisition of knowledge and competencies. We found convenient to speak about "project management simulation" instead of "project management game". We also observed that in today's world, it is difficult to get people for a 3 or 4 days course. It is necessary to convince that knowledge and capabilities acquired through experiential learning are much more deeply integrated and therefore long-lasting than in a half a day seminary. When convinced, organizations that have tested the concept of SimProjet were satisfied and decided to continue to use it.

Independently from the environment of use, one of the very positive aspects of the SimProjet concept stands in the absence of judgment from the simulation itself. Learners have to estimate by themselves if the impacts of their actions and choices were positive or not, and conceptualize on their own the nature of knowledge that could be picked-up from the experience. They therefore not only acquire knowledge, but go further, learning to learn, which is the ultimate goal of experiential learning, according to Rogers (Rogers, 1969).

Due to its technical nature (computerized web-based simulation), the SimProjet concept imposes some limiting constraints: the time needed to learn how to use the simulation platform and interface (1 to 2 hours), the material requirement (good internet access, appropriate internet navigator, screen definition), the limitation of the number of participants (experience with 36 participants in 9 teams show to be a maximum) to allow the trainer to give valuable feedback to all teams.

6 CONCLUSION: PERSPECTIVES OF FUTURE DEVELOPMENTS AND RESEARCH

SimProjet future developments are already planned: (1) enrich the player's interface with the possibility to dynamically draw a PERT diagram of the project, (2) provide the educator additional reporting and monitoring information about the teams playing a game, (3) try to establish historical statistics about behaviours over several games played using the same scenario, and (4) redesign the scriptwriter interface to make it more visual to design branching stories (the sequence of tasks, events, decisions, ...), with flow-chart-like drawing capabilities. We work on a multilingual interface (including English and German, in addition to French existing one). We are also building new scenarios, as the real strength of the platform and concept is this openness and flexibility in designing appropriate storylines according to the educational context and pedagogical objectives. Some other enhancements are still in discussion within the development team: would it be useful to have an automatic advancement scheduler ? would it be worth having a more animated player interface (with characters, sound, ...) ?

Globally, for both the platform development and scenarios writing, we implemented only functionalities that either (1) were necessary to support a particular pedagogical objective, or (2) were needed to provide the necessary level of realism to have players stick to the story. We will try to keep this philosophy in future enhancements.

Further research will be made on the impact of the SimProjet teaching concept on learners, and on the best way to balance experiential learning with classical lectures. A comparative study could probably be made to assess knowledge acquisition by different populations of learners as undergraduate, graduate and professionals.

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