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Empirical Research Paper

How might serious games trigger a transformation in project management education ? Lessons learned from 10 Years of experimentations

Dominique Jaccard [a,*], Knut Erik Bonnier [b], Magnus Hellström [b,c]

[a] Media Engineering Institute, School of Management and Engineering Vaud (HEIG-VD), University of Applied Sciences of Western Switzerland (HES-SO), Switzerland
[b] School of Business and Law, University of Agder, Norway
[c] Faculty of Science and Engineering, Åbo Akademi University, Finland

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ABSTRACT

While many studies have been published about project management serious games, most of them mainly describe characteristics and features of the games themselves. In those studies, little is found on the pedagogical implementation of serious games and on how they have impacted project management education. In this article, we both discuss how serious games have impacted project management education and how they are implemented from a pedagogical perspective. We used an empirical research approach, based on qualitative observations. Observations included authors' own usages of a project management serious game (the PM-Game) complemented with a synthesis of 10 years of observations and discussions with other teachers who had used this same PM-Game. Results showed that serious games may lead to educational changes such as moving toward active pedagogies, developing new competencies such as soft skills, and changing teachers-students relationship. For the pedagogical implementation, results showed that the serious game was implemented as an integrated concept including hybrid simulation modalities, and combining virtual and augmented learning aspects. In conclusion, serious games have the potential to trigger a change in project management education. But to fully benefit from the potential advantages of this change, they have to be designed, developed and implemented as an integrated gaming and learning concept.

1. Introduction

1.1. Background

With the increasing projectification of western economies (Schoper et al., 2017), project management education is more important than ever. Project management (PM) has thus been included in many academic programs, from bachelor to postgraduate studies, in faculty such as management, engineering or health. Meanwhile, the interest in serious games has increased at all levels of education. And as the COVID-19 crisis has accelerated the digitalization of education, the use of digital resources such as serious games is expected to increase even further in the coming years (Remtulla, 2020).

In this article, we use the term "serious games" for all types of digital learning games and simulation games created for educational or training purposes (Loh et al., 2015). In order to improve readability, we use the term "teachers" for all types of teachers, lecturers, professors, or professional trainers. The term "students" is used for all types of students in academic programs, participants to postgraduate studies or professional attending to professional training sessions.

1.1.1. Serious games and higher education

Higher education is confronted with a global pedagogical change. Firstly, there is a movement from passive pedagogies, such as ex cathedra lectures, toward active pedagogies (Klein et al., 2020; Prince, 2004). Secondly, as teachers are not anymore the unique source of knowledge, digitalization leads to a change in students' relationship both with teachers and knowledge (Ammenwerth, 2017). In this context, serious games are effective tools to support learner-centered teaching practices (Boyle et al., 2016; de Freitas and Oliver, 2006; Gentry et al., 2019). The positive impacts of serious games, such as knowledge acquisition, content understanding, and motivation have been documented in earlier research, for example (Boyle et al., 2016; Connolly et al., 2012). Serious games often have the form of virtual

* Corresponding author. University of Applied Sciences of Western Switzerland, HEIG-VD Media Engineering Institute Avenue des Sports 20 1400, Yverdon, Switzerland.
E-mail addresses: dominique.jaccard@heig-vd.ch (D. Jaccard), knut.e.bonnier@uia.no (K.E. Bonnier), magnus.hellstrom@uia.no (M. Hellström).

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environments, providing experiential situations to students. They can also be complemented with monitoring tools, such as trainer dashboards, thus corresponding to what can be called an augmented learning environment (Sheehy et al., 2014).

1.1.2. Serious games in PM education

PM includes both soft and hard skills, yet the emphasis has traditionally been on the latter. As a result, there is an apparent lack of soft skills development in traditional university education (Jena and Satpathy, 2017; Pant and Baroudi, 2008; Ramazani and Jergeas, 2015). With the increased interest both in serious games and in project management education, it is not surprising that many serious games have been developed for PM education and published in numerous studies (e.g. Calderón and Ruiz, 2015; Rumeser and Emsley, 2018). Most of those PM serious games are of the simulation type, offering students a virtual environment that reproduces the reality of project management (Rumeser and Emsley, 2018). Those serious games may offer both an environment for the development of practical competencies and soft skills. Previous research has shown that the use of serious games in the area of PM education improves students' learning and performance (Davidovitch, Parush and Shtub, 2009). In the broader context of game-based learning in PM education, Jääskä and Aaltonen (2022) focused on the perceived benefits and challenges, and showed that game-based learning approaches offer a broad range of benefits for both students and teachers.

1.1.3. Serious games implementation

However, research shows that serious games do not always fulfill all the targeted pedagogical objectives (Dankbaar, 2017; Djaouti, 2016; Ranchhod et al., 2014). To reach its objectives, a serious game needs to successfully integrate gaming and learning aspects. A number of general frameworks for integrating gaming and pedagogical aspects of serious games aspects have been presented (e.g. Aleven et al., 2010; Hlynka and Jacobsen, 2009; Jaccard et al., 2021b; Marne et al., 2012; Rooney, 2012), but implementation of game-based learning is still challenging for teachers (Jääskä and Aaltonen, 2022; Rodrigues et al., 2018).

Palaganas et al. (2014) present the use of serious games in medical training programs as a combination of three dimensions: (1) Purposes, corresponding to reasons why the serious game is used; (2) Modalities, corresponding to the characteristics of the serious game; and (3) Methods, corresponding to teaching and learning methods used during and around the serious game. Those dimensions can be used to analyze PM serious games. Purposes are related to the reason why teachers choose to include a PM serious game in their courses. Modalities are related to the PM serious game itself, including content (eg. the kind of project simulated) or functionalities (eg. possible actions for players, trainer dashboard). And methods are linked with how trainers implement PM serious games from a pedagogical perspective.

While studies about PM serious games (such as Calderón and Ruiz, 2015; Rumeser and Emsley, 2018), extensively describe their characteristics and features (i.e. "Modalities"), it is difficult to find information on why those serious games are used (i.e. "Purpose"), and how they have been implemented from a pedagogical perspective (i.e. "Methods") (Hellström et al., 2021). In medical education, which has a longer history of using simulations, it is possible to find more information on modalities. One interesting modality is the use of hybrid simulation, which combines software simulation with offline activities such as simulated patients, to develop the entire skill set that can only be specifically learned in one or the other type of simulation.

1.2. Objectives

Given the knowledge gaps and unresolved issues identified above, the objective of this research was, through observation of usages, to offer insights on how serious games could trigger changes in PM education (purpose), and how serious games are implemented into a global pedagogical concept (methods). We thus formulated to two following questions, with the corresponding sub-questions related to previous theoretical parts:

- How may serious games trigger changes in PM education?
  - How are they used to move toward active pedagogies?
  - How are they used to support soft skills development?
  - How are they used to change teachers-students' relationship?
- How may serious games be implemented into a global PM pedagogical concept?
  - How do teachers implement hybrid simulation modalities?
  - How do teachers include virtual and augmented learning aspects?
  - How do teachers adapt usages to teaching level and subject area?

1.3. Article structure

The remainder of the article is organized as follows. First, we present the method and the serious game that forms the basis for our observations. In the Results section, we present a synthesis of the observations of usages and difficulties, grouped into six main themes, related to our six sub-questions. For each theme, we present some theoretical background, provide practical examples on how the PM-Game has been implemented or has impacted PM education, and propose some recommendations for PM serious games development and implementation. We end the article with concluding remarks in the form of a synthesis of our findings and a short note on future research perspectives.

2. Methods and materials

2.1. Research approach

This research was conducted according to a constructivist (Fosnot, 2013) and subjectivist (Cohen et al., 2007) approach, with the hypothesis that PM teachers may differ both in motivations and ways they use serious games, and that the results of our observations will be more descriptions and explanations of particular cases rather than universal rules.

Our research approach was mainly based on observation. We chose observation as a strategy for data collection as it enabled us to directly observe how trainers used the PM-Game, providing more authentic data than with mediated methods (Cohen et al., 2007). Even if we had an observation agenda based on our questions and sub-questions, observations were not done in a predetermined manner. As we wanted to find out how different teachers might make different usages of the PM-Game, we did not define in advance what elements will be observed. We can therefore define our process as semi-structured observation (Cohen et al., 2007).

We made observations both on facts (such as if the PM-Game was used as a common thread during all the course or at the end of the course) and of qualities (such as teacher-students relationship). Because observation of qualities may depend on researchers' interpretation (Cohen et al., 2007), we confronted the interpretation of the first author with discussions with teachers who were observed. Those interpretations were then confirmed by the second and the third author. We noted whether these facts or qualities were predominantly observable or unique cases. The unique cases were reported in the observations if all authors agree that they showed a particular interest. In that case, they were indicated as unique or minority facts. When teachers used the PM-Game several times, we also sought to evaluate the evolution over time of the observed facts and qualities.

We first used an autobiographical approach, mainly based on qualitative self-observations of the authors' usages of a particular PM serious game, the PM-Game (Jaccard and Riboni, 2010). We then did a synthesis of 10 years of observations and discussions with teachers who had used the same PM-Game at european higher education institutions. The autobiography is mainly based on the first author's observations, who

also is the originator and project leader for the development of the PM-Game. Since 2008, he has used the PM-Game for bachelor, master and postgraduate project management courses. Since 2012, the PM-Game has been used by other teachers. The author accompanied most of the teachers in the handling of the game and observed the way they were using it. The other authors' role in the research was mainly to deal with the problems of the autobiographical approach, namely the risk of bias in the treatment of observations. The other authors have used serious games (among others, the PM-Game) in academic education since 2018. The autobiographical observations were compared to the uses made by the other teachers in order to highlight common trends and difficulties. The second and third authors compared the results obtained with their own experience with the PM-Game and other project management serious games. According to Gold's classification (Gold, 2017), researchers roles in those observations were thus mainly on the participation side (both *complete-participants* and *observer-as-participant*) rather than on the complete detachment side.

The entire research process has to be seen more as hypothesis generating rather than hypothesis testing (Cohen et al., 2007).

2.2. The PM-Game

2.2.1. PM-Game characteristics

Our observations were based on usages of the PM-Game in educational contexts. The PM-Game is a serious game of the type "simulation", that provides a virtual environment for experiential learning (Jaccard and Riboni, 2010, https://www.albasim.ch/en/our-serious-games/). The PM-Game is the result of a research project and is operated on a non-profit basis. The PM-Game is accessible through an online platform, enabling simultaneously students to play the game and teachers to monitor students' activities.

In the PM-Game, students, in teams, take the role of a project manager and have to manage a virtual project from the initial idea to its closure. During the simulation, students, as virtual project managers, interact with game characters such as stakeholders, customers or the project team. All along the simulation, they have to make decisions such as defining project scope, doing feasibility analysis, or dealing with change requests. They also have to plan project activities, assign resources, and monitor progress. Fig. 1 presents some screenshots of the PM-Game.

While students are playing, teachers have access to a trainer dashboard which enables them to monitor students' work and detect teams that may be in difficulty. Through the trainer dashboard, teachers may interact with students in the simulation (for example, impacting the "management support" or sending an email in the simulation) or directly communicate with students. (Fig. 2).

The PM-Game provides an authoring system that enables non-computer scientists, such as teachers, to edit existing simulated scenarios or to create fully new scenarios. Fig. 3 illustrates how text editors enable to directly modify the simulation content.

2.2.2. PM-Game usages and empirical base

The PM-Game has been used since 2008 by its authors. Since 2012, it has been used by other teachers. Since then it has been used for professional training in companies and for bachelor, master and postgraduate studies in universities like University of applied sciences of Western Switzerland (Jaccard and Riboni, 2010), University of Lausanne (Bonazzi et al., 2011), University of Marseille (Guiderdoni-Jourdain and Caraguel, 2018), University in Agder (Bonnier et al., 2020), University of Geneva, X Polytechnique Paris, Cnam, or Ecole Hôtelière de Lausanne. It was used in faculties such as management, engineering, environmental sciences, translation or medicine. To date, it has been used in 7 countries, by more than 50 teachers and twelve thousand students.

Appendix A presents a synthesis of sources of observation of usages. Observations of these usages have been complemented with data

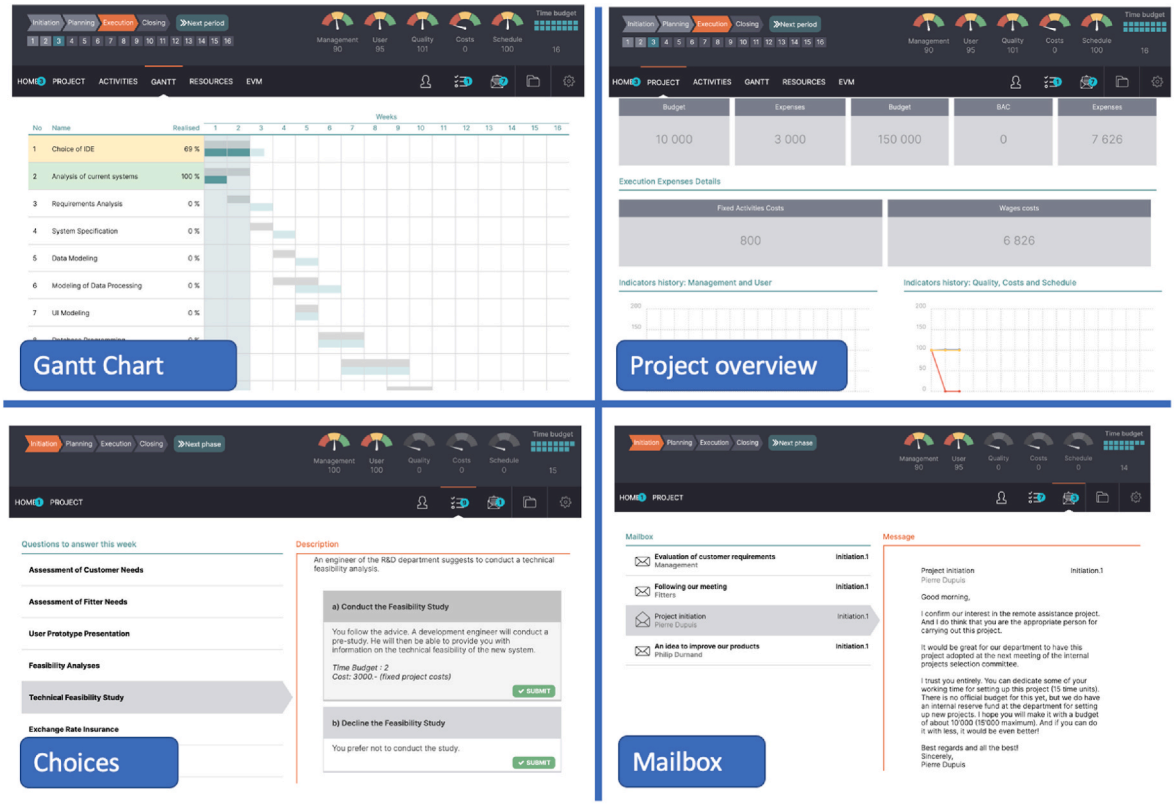

Fig. 1. Screenshots of the PM-Game.

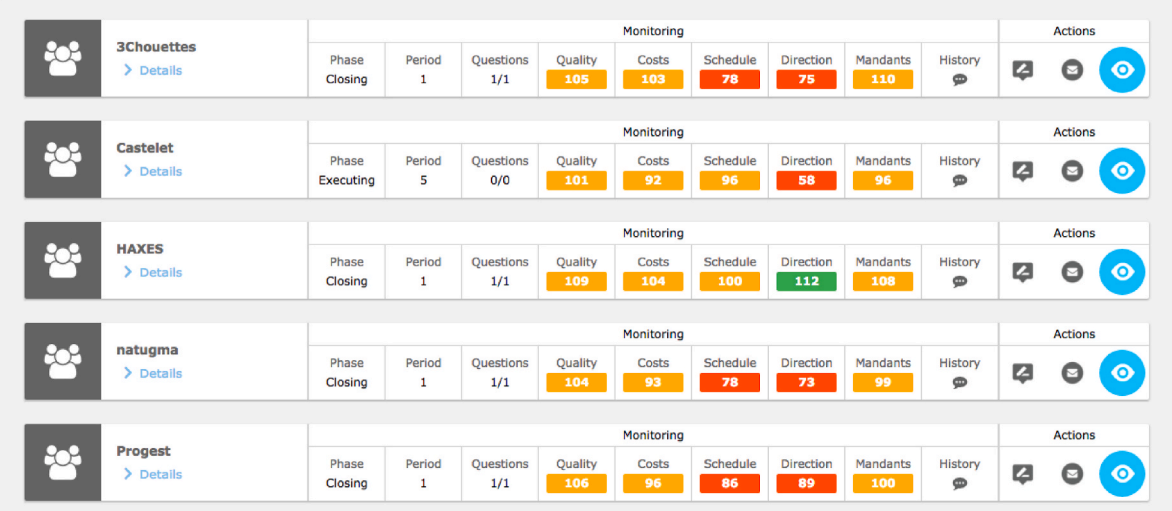

Fig. 2. PM-Game trainer dashboard.

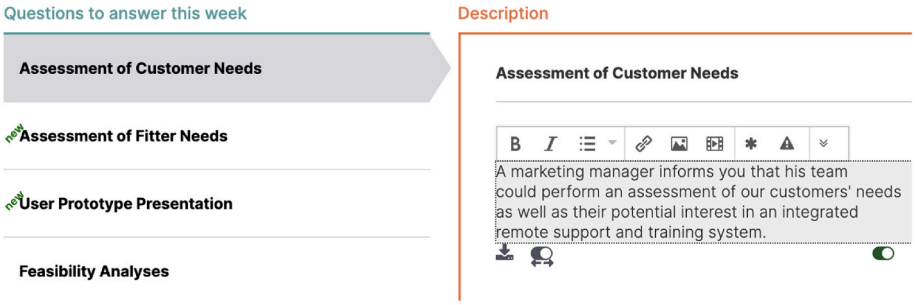

Fig. 3. PM-Game content edition with the authoring system.

collected (e.g. student surveys, classroom observations, game analytics, self-ethnographies) in previous studies about the PM-Game (mentioned above).

3. Findings

This section presents the synthesis of the semi-structured observations of empirical usages that were done for each theme linked to each sub-questions.

Each theme is introduced with a conceptual background, followed by a synthesis of observations of PM-Game usages and difficulties encountered by trainers. Each theme is finally complemented with some general recommendations for serious games development and pedagogical implementation.

3.1. Moving toward active pedagogies

3.1.1. Conceptual background

Higher education is confronted with a general pedagogical change, moving from passive pedagogies, such as ex cathedra lecture, toward more active pedagogies (Klein et al., 2020; Prince, 2004). In general, active learning can be defined as "a method of learning in which students are actively or experientially involved in the learning process" (Bonwell and Eison, 1991). Serious games are recognized as effective tools to support learner-centered teaching practices (Boyle et al., 2016; de Freitas and Oliver, 2006; Gentry et al., 2019) and may be used as a trigger to modify pedagogical concepts. They make it possible to move from ex cathedra lectures followed by exercises toward active pedagogies such as problem-based learning or flipped classroom.

But the choice of a pedagogical approach depends both on pedagogical objectives, course duration, and student's background. The serious game should thus let the teacher choose on the appropriate pedagogical approach and how to include it within the overall course pedagogical scenario.

3.1.2. Application in the PM-game and observation of usages

Overall, the PM game meets the definition of active learning by involving students in the learning process. However, no specific pedagogical approach was explicitly implemented in the PM-Game. Instead, the PM-Game was developed with the fundamental idea that it should enable as many pedagogical approaches as possible. This led to the development of functionalities that let teachers parametrize the game, depending on their pedagogical preferences. Those parameters included the possibility to have the game played alone or in teams, to activate or deactivate some automated functionalities inside the simulation (automatic project progress monitoring or resources planning) and to stop the simulation at any stage of the project (initiation, planning, execution or closure).

Observations of usages showed that most teachers began by introducing the PM-Game without any change in their overall course pedagogy. The PM-Game was used as an exercise, included in the middle or at the end of the course. Once having used it for one or more times, most teachers began to include it as a common thread of the overall course. This led to a course that alternate traditional lectures with a subsequent application of the learnings in the serious game. For example: 1a) lecture on project initiation, 1b) experiment project initiation in the serious game, 2a) lecture on project planning, 2b) experiment project planning in the serious game, etc.

The last step of pedagogical adoption of the serious game was the change of the overall pedagogical approach used in the course. Some

teachers have, for example, switched to a problem-based learning approach. In the PM-Game, students were confronted with a problem (for example doing an economic feasibility analysis during project initiation). In teams, with the teacher as facilitator, students made assumptions on how to solve the problem and define their own learning objectives. Students then individually learned by themself the principles of economic analysis. Then, in a team, they applied those principles in the serious game. Finally, at the classroom level, some teachers have included presentations of results and in-class discussion on topics learned.

3.1.3. Difficulties

The main observed difficulties are related to teachers' resistance to pedagogical changes. This resistance may be due as much to fears about the effectiveness of new pedagogical approaches as to an extra workload due to the updating of pedagogical documents or organization. Also, a certain resistance among students to move towards active learning could at times be observed. In this regard, serious games are, however, not different from other forms of active learning. In some cases, the resistance to change was also related to a fear of losing control of learning in relation to previously specified learning objectives or a specific curriculum, which obviously points at the key difference in active and passive learning.

3.1.4. Discussion and recommendations

Serious games have the potential to change pedagogical approaches toward active learning. When designed in a flexible way, they also allow the teacher to adopt new specific ways of pursuing active pedagogy and specific learning objectives. As the choice of the appropriate approach is linked with pedagogical objectives and students' background, it is better not to impose the pedagogical approach in the serious game. Instead, the serious game should offer some possible parametrization that enables teachers to adapt it to the chosen pedagogical approach.

When using a serious game for the first time, teachers may be careful and may not want to take the risk to change all the course pedagogy. To facilitate serious game adoption, it is better to let the teacher first test the game as a standalone exercise. Once the teacher is more confident, some guidelines can be provided, with ideas on possible pedagogical changes that may be triggered using the serious game. This also removes the uncertainty of increasing workload.

All those approaches include a change in the teaching-learning conception, moving from the idea of the teacher giving lectures in order to transmit the complete canon of PM knowledge toward an idea where students acquire PM techniques and knowledge based on PM problems they encounter in the serious game. Students should also develop the ability to define by themselves how to solve new problems encountered in the game. Those approaches, combined with in-depth discussions in the class on what were the best methods to solve the problems and what their limits are, enable a simultaneous development of PM knowledge, problem-solving orientation and critical thinking. Such an approach is also likely to mitigate student resistance to active learning (Tharayil et al., 2018).

3.2. Support for soft skills development

3.2.1. Conceptual background

Soft skills, both for project managers and project team members, are recognized as key success factors of project management (Azim et al., 2010; Crawford and Pollack, 2004; Pant and Baroudi, 2008). With soft skills we here refer to abilities of a social and subjectivist nature for dealing with people (Martin, 2000). Unfortunately, these seem to be lacking from current educational offerings in the area of PM (Ramazani and Jergeas, 2015). While it is difficult to acquire those soft skills in traditional lectures, serious games and simulation are often seen as a solution.

3.2.2. Application in the PM-game and observation of usages

The PM-Game was designed as a hybrid simulation, including both software simulation and role plays. At any time, teachers had the opportunity to stop the software simulation and switch to a role play, as an in-class activity, linked with what has been happening in the software simulation.

Observations of usage showed that most teachers have used role plays to develop soft skills such as communication, managing stress when presenting in front of many people, or quick decision making during a simulated steering committee. In few cases, some teachers filmed presentations and analyzed the resulting video during debriefing sessions. Some others invited experts in communication to listen to students' presentations and participate in the debriefing. Giving student teams opposing roles (such as project managers vs auditors) is another method that has been used.

3.2.3. Difficulties

The main difficulty observed was related to the number of students. When the simulation was used with less than 20 students, all teams were able to participate in role plays and more time could be devoted to teacher-student interaction. But that wasn't possible anymore when the number of students increased. Some teachers used teaching assistants to have all teams doing the role plays in parallel sessions. For PM courses with a large number of students (more than 100), some teachers asked each team to create a video of themselves presenting the project proposal to management, or project progress to the steering committee (observed in two cases). But when teachers were confronted with a large number of students and had access to only few or no teaching assistants, some of them have given up including role-playing games for soft skills development.

For adult students, which typically already have working life experience, the need for soft skills is more obvious and a part of their daily life. Therefore, we recorded some cases where these students felt gaming and role-plays were time-consuming and less relevant. Instead, they often lacked formal project management training focusing on hard skills (tools and techniques), which they consequently were looking for.

3.2.4. Discussion and recommendations

PM serious games may contribute to the development of necessary PM soft skills that are difficult to teach in traditional lectures. When offering teachers the possibility of combining the software simulation and role plays, nearly all of them have used this hybrid approach. Role plays are also elsewhere advocated as means for training soft skills in project management (Maratou et al., 2016).

Some soft skills may be easily implemented in a software simulation (such as organizing, time management, complex problem solving or critical thinking). Some other soft skills, such as communication or teamwork, are more easily developed in role play simulations. In order to make it possible to cover a wide range of methods for soft skills development, the use of hybrid simulation modalities, such as software simulation and role plays, has to be considered.

3.3. Changing the teachers-students relationship

3.3.1. Conceptual background

Nowadays, students have a widespread access to online study material, from short videos to complete massive online open courses (MOOC). Teachers are not anymore the unique source of knowledge, and teacher-student relationships should evolve correspondingly (Ammenwerth, 2017). Teachers have to change from a role of subject experts who control the learning content to a coaching role, where they act as facilitators of learning (Álvarez et al., 2009; Hlynka and Jacobsen, 2009).

Serious games offer new possibilities to support students-centered teaching practices (Boyle et al., 2016; de Freitas and Oliver, 2006; Gentry et al., 2019) and may induce a change in teacher-student

relationships.

3.3.2. Application in the PM-game and observation of usages

We observed that when using the PM-Game as a standalone exercise, teachers kept their subject expert role and the control of the content to be taught. But when teachers moved toward problem-based learning approaches supported by the simulation, they tended to change their role. In those approaches, teachers gave less ex cathedra lectures and took the role of coaching students in their learning process. Moreover, they were not anymore seen as the one who ask students to solve the problem they have assigned as an exercise, but more as resources that may help to solve problems encountered in the serious game.

Most teachers who have used the PM-Game in another way than a standalone exercise said that it changed their relationship with students. In a study done at University of Marseille, France, 65% (n = 103) of students said that the use of the PM-Game has changed their relationship with professors (Guiderdoni-Jourdain and Caraguel, 2018). To an open question on the reason for that change, students answered that teachers were more like coaches, that there was no longer a formal division between teachers and students, and that teachers were rather seen as a source of support, advice and assistance (Guiderdoni-Jourdain and Caraguel, 2018).

3.3.3. Difficulties

We did not observe any difficulties related to the change in the teacher-student relationship. Nor were such difficulties reported by teachers. But one challenge may appear in the case that neither the teacher nor the student wishes to change the relationship. In some cases, changing the teacher-student relationship and interaction pattern may also develop a fear for changing or complicating the assessment of learning. Instead of assessing conventional exams, the object of the assessment could change to project proposals, plans and reports made under the supervision of the teacher.

3.3.4. Discussion and recommendations

Serious games may be used as a trigger to foster some needed changes in the relationship between teachers and students. Instead of having subject expert teachers in front of students, teachers may move toward a coaching role, being beside students and helping them in their learning process.

In order to benefit from all potential changes in the teacher-student relationship, serious games have to be included in an overall pedagogical concept, moving away from ex cathedra lectures to more student-oriented and active pedagogies.

3.4. Use of hybrid simulation modalities

3.4.1. Conceptual background

In most studies, PM serious games and simulations are mainly described as software applications, e.g. (Calderón and Ruiz, 2015; I. Cohen et al., 2014; Zwikael and Gonen, 2007), for an overview see (Hellström et al., 2021). However, in medical education, which has a longer experience in using simulations, other modalities than software simulation have been developed, including simulated patients played by human actors or reproduction of the physical medical environment. Hybrid simulations (Chiniara et al., 2013) are combinations of different simulation modalities, such as a software simulator combined with a patient simulated by a human actor. This medical concept of hybrid simulation may be transposed to project management. PM serious games may be conceived as hybrid simulations, including software simulation combined with other simulation modalities.

This is important for PM education as there seems to be a gap between what current project management education offers and the real-life complexities of project work (Ramazani and Jergeas, 2015). Indeed, the recent review by Jääskä and Aaltonen (2022), reports that one challenge for students is that they perceive the game as artificial or unrealistic. Hybrid modalities are also likely to better correspond to the organizational perspective on PM (Andersen, 2016), which stresses the importance of engaging with different stakeholders and on socialization as a process for control.

3.4.2. Application in the PM-game and observation of usages

The PM-Game has been conceived as a hybrid simulation including software simulation, teamwork and role plays. It has been observed that most teachers complemented the software simulation with other simulation modalities. Those modalities mostly included role play sessions where students had to present their project proposal to top management of the company or to animate a simulated steering committee. Teachers and teaching assistants have been observed to take part as actors in those role plays, for example acting as the simulated company executive director. As the trainer dashboard made it possible to interact with the software simulation, it was possible to link all simulation modalities. For example, at the end of a role play that simulated the project steering committee, teachers had sent an email from the steering committee inside the software simulation. Thus, when students came back to the software simulation, it was linked with what has been done in the role play. In addition, teachers typically combined the simulation with the writing of reflective reports related to the simulation.

3.4.3. Difficulties

As with the training of soft skills, the inclusion of role plays becomes more difficult for large classes (more than 100 students) because it is too much time-consuming. Hybrid modalities may also add to the students' work load and cognitive stress as a certain reorientation is needed when one switches from one mode to another, but these observations may also relate to other pedagogical approaches.

3.4.4. Discussion and recommendations

When developing a PM simulation concept, depending on learning objectives, hybrid simulations involving software and other simulation modalities may be considered. When there is a possibility of using multiple modalities of simulation, most teachers use them. This is a likely way to at least partly overcome the challenge of reflecting real-world complexities in serious games (Jääskä and Aaltonen, 2022; Ramazani and Jergeas, 2015).

3.5. Inclusion of virtual and augmented learning

3.5.1. Conceptual background

Most serious project management games are of the simulation type, corresponding to a simplified reproduction of reality (Rumeser and Emsley, 2018). They are thus virtual learning environments that offer experiential situations for students. In a recent literature review, it was discovered that it is exactly this aspect of "reality" that most researchers bring up as the benefit of using serious games and simulations in PM teaching (Hellström et al., 2021). But those virtual environments may further be complemented by providing teachers with monitoring tools such as trainer dashboards (Plumettaz-Sieber et al., 2019; Verbert et al., 2014) or learning analytics (Chaudy et al., 2014; Jaccard et al., 2016; Mustafina et al., 2018). This virtual environment, combined with tools that allow us to better understand what is happening in student learning, corresponds to what can be called an augmented learning environment (Sheehy et al., 2014).

3.5.2. Application in the PM-game and observation of usages

The PM-Game has been developed for being used with a teacher. The trainer dashboard gives the teacher the opportunity to obtain information on how students are progressing in the simulation and thus lets the teacher decide on how to interact with students and learning activities.

Teachers have used the dashboard to detect teams of students having difficulties in the game. Some teachers then used the possible interaction with the simulation as a means to help those students. For example,

some teachers have sent an email inside the simulation, pretended to be a colleague from the simulated company (so students didn't know that the email was from the teacher), and given some advice on project management best practices.

3.5.3. Difficulties

The main difficulties observed are related to the appropriation of the trainer dashboard. During the first uses, the teachers concentrate on the direct, visual observation of the use of the serious game by the students. They do not want to add a cognitive load by having to take the trainer dashboard in hand. The use of the trainer dashboard only occurs when teachers have sufficient experience and confidence in using the serious game. Regarding the possibilities of interaction with the serious game scenario through the dashboard, some of the teachers were afraid of doing something that could make the software crash, which points at the importance of being able to trust in the software. In other cases, the lack of ideas or examples on how to use dashboards (or the learning analytics) was a barrier for a more extensive or sophisticated use of it.

3.5.4. Discussion and recommendations

Digitalization is sometimes linked with online learning without a teacher. But there is another way of using digital resources, to move toward an augmented learning environment that empowers teachers in their activities. When developing a serious game with its associated pedagogical concept, it is worth considering it both as a virtual and an augmented learning environment. The dashboards and the interactions with the serious games have to be as simple as possible. Tools proposed to teachers must be designed to be used by non-computer science teachers, who have to manage the students and the serious game at the same time.

3.6. Adaptation of usage to educational levels and subject area

3.6.1. Conceptual background

Developing a serious game is a long and costly process, even more so if the serious game is intended to be used by many teachers or commercialized. Thus, one would like to have a serious game that could be used in as many educational contexts as possible. Meanwhile, project management covers a wide range of knowledge areas and pedagogical objectives may depend on educational level, course duration or subject area. For example, bachelor programs in engineering may focus on project planning, while postgraduate programs for non-profit organizations may focus on project team building. Moreover, the same subject may be studied at different levels. For example, one may provide an overview of risk management in a bachelor program, but present advanced risk management techniques in a master program. Thus, if the serious game provides the theoretical content, it is quite difficult to ensure that this content will be adapted both on the knowledge area and on the expertise level.

Furthermore, project management may be used in different areas such as business, engineering, or public sector. Some teachers may want to adapt the content of the simulation to students' subject area, for example, construction project management for students in a bachelor of architecture. And when using the simulation for professional training, companies may want to adapt it to their own process or documents.

3.6.2. Application in the PM-game and observation of usages

No theoretical aspects were included in the PM-Game. The PM-Game only provided the simulation of a project, with all types of events that may happen in a real project (and offering to the player basic tools like a Gantt chart or an Earned Value calculation). Based on this simulation, teachers decided which theoretical aspects and content should be linked with the simulation, and how to do it.

We observed that depending on course objectives, level and duration, teachers adapted both the way they used the simulation and pedagogical objectives that were supported by the simulation. For example, in a semester bachelor's course in engineering, the simulation was used in alternance with theoretical lectures on fundamental project management techniques. Based on facts and numbers found in the simulated project, students were asked to produce reports outside the simulation. All along the semester they produced reports such as evaluating the project's economic feasibility, project planning optimization, or project progress reports.

In another example, in a three days postgraduate program, with all participants having both knowledge and experience in project management, one of the pedagogical objectives of the course was linked with project complexity. When using the simulation, the teacher asked participants to quickly do the project planning, but to spend more time during project initiation and project execution for reflecting on how and why complexity appears in the simulated project. Once the simulation was finalized, a debriefing was organized between all teams. Based on what was observed in the simulation, a discussion between participants and trainers focused on how to manage complexity in real projects such as those in which participants had been involved.

The PM-Game includes an authoring system that enables teachers to edit the game content and thus to create their own scenarios. We observed that specific scenarios have been created, such as hospitality project management, business project management, non-profit project management or public project management. A teacher developed a fully new scenario dedicated to internal training for a specific company. In this scenario, he included specific events and tasks found in this specific company' projects. Members of the company's project management office were asked to play the serious game and apply the new company project management process and documents to the simulated project. This enabled them to adapt those documents before presenting them to all the company's project managers. The simulation was then used to train project managers on how to use those new documents and processes.

3.6.3. Difficulties

Although rarely observed, some teachers would have preferred that the theoretical aspects were integrated into the serious game. It was observed that some teachers would have liked to develop a specific scenario for their classes, but did not have the necessary financial means to develop such a scenario. A fear of a lack of technical or game design skills has caused some teachers to refrain from creating their own scenarios.

3.6.4. Discussion and recommendations

A recent study showed that there is a lack of research on the role of teachers while using serious games (Hellström et al., 2021). Based on our experience, we propose a greater and an adequate role ought to be given to teachers when developing a PM serious game. They may have more competencies than what could be inserted in the serious game. They are pedagogical experts and know how to define activities around the simulation. They know how to create an overall pedagogical concept adapted to the courses' objectives and students' background.

The next step after letting teachers adapt the way they use the serious game, is to give them the opportunity to adapt the serious game content. As all teachers do not have computer programming skills, serious games should include an authoring tool that enables non-computer scientists to edit and create game content. The content editing system should be as simple as possible, although the assistance of a computer scientist or game designer may still be necessary.

In synthesis, not including theoretical aspects in the serious game and giving possibilities to adapt the serious game content led to usage that were not even imagined by the authors of the PM-Game.

4. Concluding remarks

4.1. Synthesis of our findings

Above we have inferred and discussed six key themes in relation to how serious games may trigger a change in PM education and how they can be used as a global pedagogical concept. In so doing, we have shared our experience and observation of the benefits and the difficulties of developing and using PM serious games as an integrated concept. As a synthesis of the observations we assert that the integration must be done at two different levels. At the first level, the serious game itself has to be designed and developed as an integrated concept, including hybrid simulation modalities such as software simulation and role plays, and providing both virtual and augmented learning environments. At the second level, this integrated serious game concept has to be embedded into an overall pedagogical concept. There is a necessity of having a coherence between the serious game itself and its associated learning design: the serious game and the overall pedagogical concept must be linked in a coherent way to pedagogical objectives, pedagogical approaches, and pedagogical scenarios.

In order to design such integrated solutions, we believe that there is a need for collaboration between teachers, computer scientists, game designers and educational scientists. Serious games collaborative design framework such as proposed by (Jaccard et al., 2021b; Verschueren et al., 2019) may facilitate that collaboration (Jaccard et al., 2021a). This collaborative and integrated design should foster the use of serious games as triggers for educational changes.

Serious games have the potential to trigger a change in project management education, both by enabling new pedagogical approaches, changing teacher-student relationships, and achieving other pedagogical objectives such as soft skills development. However, our observations do not enable us to argue that serious games will solve all pedagogical problems. Nor is it possible to argue that recommendations based on those observations are the only way to implement serious games. But we do believe that to fully benefit from the potential advantages of serious games, they must be designed, developed, and implemented as an overall and coherent concept of game and learning, which is confirmed by (de Freitas and Oliver, 2006; Jaccard et al., 2021a,b; Marne et al., 2012; Verschueren et al., 2019). Synthesis of our observations may thus be considered as a proposed step in the direction of future integrated development and implementation of serious games in PM education.

Finally, as some of the observed difficulties indicate, using a serious game in the proposed way is a time-consuming endeavor, both for teachers and students, especially given that there seems to be a learning curve involved before one can reach the full benefit of adopting an active learning approach using serious games. This is likely to be the case despite the efforts made to make the deployment and use of the serious game as easy as possible. Therefore, the benefits that we have pinpointed must be carefully weighed against the potential disadvantages, the time and resources one is willing to invest in the process, and compromises one is prepared to make in terms of pedagogical approach and philosophy.

4.2. Limitations and further research

One first limitation of this study was that it was based on observation of a unique serious game. But we argue that the observations of how different trainers had used the same serious game in different contexts, with different pedagogical scenarios, enabled us to better dissociate and understand effects linked with serious game implementation from those linked with the serious game itself.

A second limitation is linked with the fact that our results and recommendations are based on empirical observations and discussions with teachers, but not underpinned with quantitative data or a structured qualitative approach. Thus, we believe that some parts of this article may be seen more as an essay rather than a conventional research.

Despite these limitations, we hypothesize that what has been observed in project management education should be transposable for the use of serious games in education in general. We invite other researchers to further elaborate on and test this hypothesis.

Conflicts of interest

One of the authors is in charge of the research unit that develops and operates the PM-Game. The development of the PM-Game is financed by research funds and usage licenses. The research unit that operates the PM-Game is a non-profit research unit.

None declared conflict of interest for the two other authors.

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Appendix 1. Sources of observations

University	Country	Program	Teacher position
Autobiographical observations			
University of Applied Sciences of Western Switzerland	Switzerland	Bachelor in media engineering	Professor
University of Applied Sciences of Western Switzerland	Switzerland	Executive MBA	Professor
University of Geneva	Switzerland	Diploma of advanced studies in project management	Lecturer
University of Geneva	Switzerland	Master of advanced studies in health organization management	Lecturer
University of Geneva	Switzerland	Diploma of advanced studies in non profit organization management	Lecturer
University of Lausanne	Switzerland	Master of advanced studies in sustainable urbanism	Lecturer
Observation of usages by other teachers			
University of Applied Sciences of Western Switzerland	Switzerland	Bachelor in business management	Professor
University of Applied Sciences of Western Switzerland	Switzerland	Bachelor in business management	Lecturer
University of Applied Sciences of Western Switzerland	Switzerland	Bachelor in civil engineering	Professor
Ecole Hotelière Lausanne	Switzerland	Bachelor in hospitality management	Professor
University of Marseille	France	Master in translation	Professor
Cnam	France	Master in business administration	Lecturer
University of Lausanne	Switzerland	Master in business administration	Assistant professor
University of Lausanne	Switzerland	Bachelor of arts	Senior lecturer

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