Blended learning in Project Management
Experiences on business games and case studies

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Abstract: This paper reports on results of experiments in the classroom with students following Project Management (PM) courses using a blended learning approach. It discusses the impact of communication on the student performance on business games as well as the advantage of the use of integrative case studies and their impact on the learning experience of these students. While the performance of students is obtained by marking their quantitative output on the business game or case exercise, their learning experience is measured through an analysis of the course evaluations filled out by these students. Diversity among the test population is guaranteed by testing our experiments on a sample of students with a different background, ranging from university students with or without a strong quantitative background but no practical experience, to MBA students at business schools and PM professionals participating in a PM training.

1 INTRODUCTION

Project management is the application of processes, methods, knowledge, skills and experience to achieve the project objectives. A project is a unique endeavour undertaken to achieve predefined planned objectives within the given network and resource restrictions.

Dynamic Scheduling (Vanhoucke, 2012) is a sub-discipline of Project Management and focuses on the quantitative aspects of planning and scheduling, the analysis of the inherent risk that typifies projects as well as the monitoring of the project progress to take corrective actions when necessary. In order to highlight the importance of the integration of these quantitative aspects, it is also known as "Integrated Project Management and Control" (Vanhoucke, 2014a). While the Project Management discipline originates from the chemical plant industry just prior to World War II (Morris and Hough, 1987), it has nowadays found its way in various sectors, ranging from huge construction projects to small daily operations in the service sector. Consequently, this growing attention of PM has resulted in the appearance of courses in the curriculum of almost all business programmes, both at universities, business schools and company trainings. This paper will report on results of a set of experiments done with Project Management students from various classes and different backgrounds, using an integrative teaching process carried out under different settings. This teaching process is best known as blended learning.

Blended learning is a formal education program in which a student learns through delivery of content and instruction via a mix of media and tools, ranging from digital and online media to the use of case studies and business games. It requires some degree of student control by the lecturer and often assumes active participation of the students along the teaching process. In this paper, all experiments are carried out in classes with students following a Project Management course. The course name differs among the school and is called "Project Management", "Integrated Project Control", "Dynamic Project Planning" and even "Quantitative Methods for Project Control", but regardless of the course name, it always focuses on an integrated approach of planning and scheduling, risk analysis and project control, previously labelled "dynamic scheduling".

The purpose of this paper is to report on results and experience of communication experiments using

exercises, case studies and a business game to measure the impact of these experiments on the learning experience and student results. Through a number of experiments with students at different universities, two business schools and in companies, the impact of various degrees of communication under controlled settings is tested on both the performance of students as well as on their learning experience and satisfaction.

2 BLENDED LEARNING

This section gives an overview of the topics discussed in the Project Management curriculum of Ghent University and Vlerick Business School in Belgium and University College London in the UK. Its main focus lies on the quantitative part of the course with a focus on the previously mentioned Integrated Project Management and Control. The material used consists of a mix of tools and methodologies and the corresponding teaching approach can be described as blended learning. The content of each topic discussed in class is based on results from numerous research studies mixed with practical experience. The majority of the research on Project Management has initially focused on the scheduling of project activities within the presence of resource constraints. However, in the last decade, this research has expanded to its integration with risk analysis and project control, known as the Dynamic Scheduling or Integrated Project Management and Control methodology. This methodology has been embedded in the curriculum of Project Management courses in universities and business schools, in order to learn how to plan, monitor and control projects in progress such that they can be delivered on time and within budget to the client.
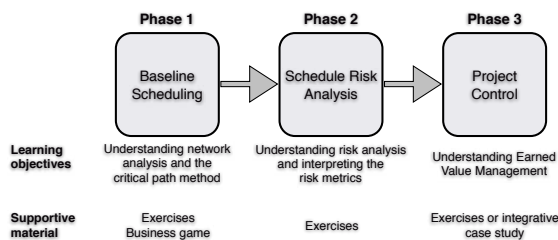

Figure 1: Three phases in the PM curriculum.

Figure 1 gives an illustrative overview of the three main phases of the PM course, which are known as the baseline scheduling phase, the schedule risk analysis phase and the project control phase. The figure also displays the learning objectives as well as the support material used in the lectures, which will be

discussed in the next sections. First, a brief overview of the purpose of these three topics is given in the next section.

2.1 Learning topics

In this section, the three dimensions of dynamic scheduling known as baseline scheduling, risk analysis and project control are briefly outlined.

Baseline scheduling is the act of determining start and finish times of each project activity within the activity network and resource constraints and results in an expected timing of the work to be done as well as an expected impact on the project's time and budget. The research on the resource-constrained project baseline scheduling problem dates back to the development of the critical path method (CPM) and the Programme Evaluation and Review Technique (PERT) (Kelley and Walker, 1959; Walker and Sawyer, 1959; Kelley, 1961), and has received huge attention of academia, leading to a vast amount of algorithms and tools for resource-constrained project scheduling problems. Ever since, the research results on baseline scheduling have been valorized into commercial software tools and integrated project management systems and the underlying methods and techniques have taken a central place in the academic curriculum of most Project Management courses. The main reason is that constructing a baseline schedule is a crucial step in the dynamic scheduling methodology since the project baseline schedule will act as a point-of-reference for your schedule risk and project control steps, as discussed hereunder.

Schedule Risk Analysis is a Project Management methodology to assess the risk of the baseline schedule and to forecast the impact of time and budget deviations on the project objectives (Hulett, 1996). Given the knowledge that the construction of a baseline schedule is a deterministic exercise for preparing the project progress in a stochastic world, prior knowledge of the impact of unexpected behaviour on the project objective is crucial for the project manager and puts the value of the baseline schedule in the right perspective. The importance of analyzing the risk of the baseline schedule comes from the need of any project manager to restrict his/her attention to the most influential activities of the project that might have the biggest impact on the initial time and cost constraints (Vanhoucke, 2010). It enables the project manager to take a better management focus and it supports a more accurate response during project progress that positively contributes to the overall project performance. The research on project risk analysis has been investigated using analytical

methods and fast and efficient Monte Carlo simulations and has quickly found its way into commercial software tools and into the Project Management teaching curriculum. These tools submit the baseline schedule to unexpected events and the outcome, presented as a set of risk metrics, can be used to identify the most crucial parts in this schedule that require the most attention during project control, as discussed in the next and last step.

Project control is the act of monitoring deviations from the expected project progress and controlling its performance in order to facilitate the decision making process in case corrective actions are needed to bring projects back on track. Both traditional Earned Value Management (EVM) (Fleming and Koppelman, 2010) and the novel Earned Schedule (ES) (Lipke, 2003) methods are used. The academic research on project control has grown rapidly during the last decade, including the valorization of academic research results into practical relevance by bringing together professionals as well as researchers on the project control topic in workshops and conferences across the world. Efficiently monitoring the performance of projects in progress and accurately predicting the final time and cost outcomes in the middle of their progress is crucial to timely take corrective actions to bring these projects back on track or to exploit their opportunities. Consequently, the baseline schedule and the risk metrics of the two previous steps are only preparatory and support methods to better take these crucial decisions during the project's progress. Controlling projects is therefore the ideal theme in any Project Management lecture, since it shows the relevance of the previous two phases to the students and enables them to translate their gained knowledge into their daily practice. Thanks to the growing attention of data analytics and big data, the interest in monitoring and controlling projects has increased dramatically, resulting in lectures focusing on using statistical techniques such as process control charts, multivariate analysis and advanced data analytics to determine the optimal timing and point of control to take corrective actions.

2.2 Learning objectives

The learning objectives of a dynamic scheduling course are described in the course outline of the curriculum and aim at gradually building up the knowledge to obtain an integrated view on project management and control. Therefore, the learning objectives differ in each phase and a summary is given along the following lines:

- Phase 1: The main goal is to obtain knowledge about the network and critical path analysis techniques, as well as to understand the importance of planning projects for their later progress.

- Phase 2: Understanding the relativity of a deterministic baseline scheduling phase within the presence of uncertainty, as well as understanding the importance of risk analysis prior to the project progress is the main goal of this second phase in the teaching process.

- Phase 3: Learning how to monitor and control projects in progress using the Earned Value Management (EVM) methodology is the primary objective of this phase. This requires that students are able to interpret risk analysis reports (phase 2) and use the baseline schedule information (phase 1) as guiding tools for taking corrective actions.

This gradual build-up of learning objectives aims at reaching an integrative view on the three phases and the support material discussed next contributes to the transfer knowledge to obtain a certain degree of integrative understanding in various ways.

An overview of the standard curriculum of a Project Management course is given in figure 2. In general, each session focuses on one or multiple educational components:

- Instruction: instruction either takes the form of the classic ex-cathedra classroom session or as an introduction to a case study or business game.

- Feedback: feedback can occur intermediately or to conclude a session. During feedback, the experiences of the students are captured and translated into lessons learned and managerial insights.

- Assessment: assessment evaluates the students on a number of criteria and is translated into a grade or a report covering the different aspects of the solution obtained by the students.

Typically, the course introduces students to Project Management by teaching network analysis and the PERT and CPM techniques. Once the concepts of start and finish times and slack are known, the participants are armed with sufficient knowledge to tackle the Project Scheduling Game. Here, they are confronted with multiple trade-off options. An introduction to the game is given in which the project and the goal of cost minimization are discussed. At a certain point in time, the game is paused such that the instructor can give some intermediate feedback, allowing participants to adapt their strategy for the remainder of the game. When the game has finished, the participants receive feedback on the pluses and minuses of following different strategies. The balance
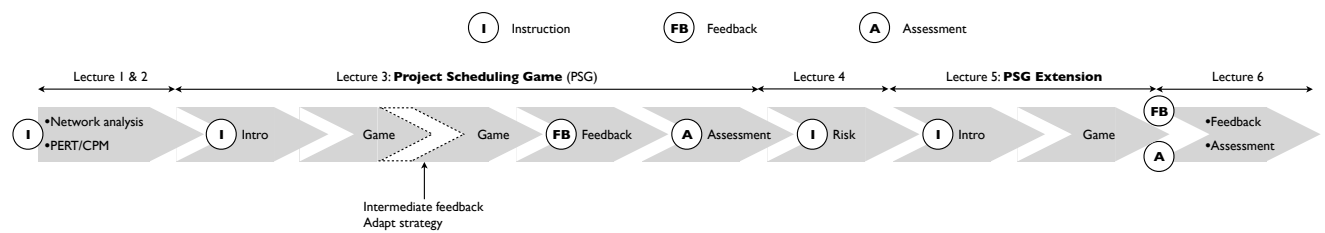
Figure 2: Overview of instruction, feedback and assessment throughout the PM curriculum

between low costs and high risk provides a segue for the session on risk metrics and analysis. The solutions of the game are assessed in a quantitative manner, by comparing costs across groups. After the students have learned about risk, an extension to the business game is proposed, in which each participant has a limited amount of effort (which can be expressed in units of time, money or a dimensionless unit). After the game, participants are asked whether they managed to please the client, the company they work for or both. The students are assessed by means of a report, commenting on their individual performance and how they compare to the other groups. A comparison with the results of the first business game session is made as well.

2.3 Support material

The sequential three-phased teaching approach, each phase with a clearly defined and different learning objective, requires that the support teaching material used to reach these objectives positively contributes to the performance and learning experience of students participating in such a teaching process.

The combined use of tools and techniques in a classroom to stimulate interaction, to improve the ability of learning and to enhance student satisfaction has been previously described as a blended learning process and a summary of this support material is briefly described below. A clear distinction is made between small exercises, integrative case studies and business games, as follows:

- Exercises are mainly used ex cathedra in class or possibly in small teams and require a certain degree of participation by the students by translating the theoretical concepts into the settings of the exercise. Exercises therefore mainly focus on only one phase of the course and have little to no integration between phases.

- Case studies are mainly used in small teams and focus on oral communication between the students and the lecturer. The use of case studies is possibly embedded in a problem based learning mechanism in which the team is responsible for both lecturing and learning, guided by the teacher. Unlike exercises, case studies require not a single solution approach, but rather aim at solving a management situation open for interpretation and therefore typically focus on the integration between phases.

- Business games: The use of business games is done to actively involve the student in the teaching process by making him/her responsible for a simulated project environment. Through the use of an interaction between the student and the computer, data is presented to the student in terms of schedule, risk and control information, which must be used to make decisions about the future project progress. In the course, the game that is used aims at optimizing the timing and costs of activities, while the computer simulates uncertain events that harm the initially constructed baseline schedule. If used in the first phase, it is the ideal preparation for the second phase of the teaching process, since it makes the student aware of the need of risk analysis, which is then discussed in the second phase. The game is known as the Project Scheduling Game (PSG) (Vanhoucke et al., 2005).

It should be noted that the purpose and scope of this paper is not to give a full overview on blended learning material in general or its use more specifically in Project Management courses. Instead, it aims at testing the impact of communication and integration using a mix of the previously described support material in different ways by a set of student experiments carried out over a period of 5 years. More details on how these experiments have been set up are given along the following sections. More information on the blended learning approach used in the Integrated Project Management and Control curriculum to enhance student learning and engagement can be found in (Vanhoucke, 2014b).

3 EXPERIMENTAL DESIGN

This section describes the settings of the experimental design in detail. In section 3.1, the student population is presented as well as the way the data is collected. Moreover, this section also reviews the importance of communication within learning in general and within the three-phased teaching process specifically. Section 3.2 then continues with formulating three types of communication experiments and shows how the outcome of these experiments is measured and validated.

3.1 Methodology

3.1.1 Data collection

The Project Scheduling Game is taught to groups with and without previous working knowledge. The last 5 years, approximately 300 people participated in a commercial training programme, while 175 MBA students engaged in Project Management as part of their curriculum. Alternatively, the PSG is part of the Project Management course for Master students at Ghent University (Belgium) and the University College of London (UK). The game is also rolled out at two business schools, namely the Vlerick Business School (Belgium) and the EDHEC business school (France). 380 students civil engineering and business engineering at Ghent University participated in the PSG, while 41 students at UCL participated in the game. Lastly, 24 Master students at the business schools played the PSG. While the participants are playing the game, log files record which action they take. These actions consist of changing trade-offs of activities, viewing the time/cost profile of an activity or advancing to the next decision period. The log files enable the people in charge to analyze the performance of the participants in detail. For each student group, a subgroup of approximately 10% of the total number of students was created for which the communication was changed. The manner in which a change to the regular stream of communication was made will be detailed in section 3.2.1.

3.1.2 Communication

Communication, be it in business, blended learning or an educational environment, plays a vital role. (Morreale and Pearson, 2008) argue that investing in communication is vital for self-development, turns people into responsable participants in the world and fosters success in one's professional career. (Elving, 2005) discusses the importance of communication in organisational change. Given the fact that more than half of all organisational change programs fail, the role of communication in establishing a community within an organisation and informing employees about their tasks and policies cannot be underestimated. Business communication has also been studied from an educational vantage point. (Zhao and Alexander, 2004) identified the short-term and long-term impact of students that followed a communications course and queried how the acquired skills benefitted the students in their senior years. It was found that the students attained good results for tasks involving written assignments, problem solving assignments, oral presentations and company reports. (Wheeler, 2007) investigated the influence of communication technologies on transactional distance in blended learning and comments that the future success of blended learning will rely on the skills and knowledge of tutors, as well as on technology-mediated communication. In a collaborative learning case study, (So and Brush, 2008) found that the communication medium was a critical factor in students perceptions of collaborative learning, social presence and satisfaction. As a result, it is safe to say that, regardless of the application domain, investing in communication through blended learning courses, pays off in the short-term (students become increasingly apt at communicating their ideas) and in the long-term (their future careers).

3.2 Research questions

In this section, the controlled experiments for testing three different classes of communication experiments are briefly explained. Moreover, the way in which the impact of the changed settings in communication on the learning experience is measured is also outlined.

3.2.1 Communication Tests

Three different classes of communication experiments in the teaching process have been investigated, as will be explained along the following lines:

Communication sequence: One of the primary goals and main advantages of a blended learning approach is the ability to integrate various ways of teaching into a combined and sequential process. The use of various exercises along the phases of the teaching process as a mechanism to test the knowledge of a student for a single topic in each phase of the course or the use of an integrative case study to test the student's overall understanding is a choice that must be made by the lecturer. The diffusion of these exercises along the different phases of the process and hence, the degree of integration depends on the timing of the different exercises along the process, gradually translating the lectured concepts into a practical learning experience. While one prefers an equal

spread of smaller exercises in each phase, another approach could be to postpone the exercises to the end of the three-phased learning process, by using an integrative case study covering the concepts discussed in the three phases.

Apart from determining the timing and integration of exercises, the sequence in which the support material is used is often crucial and determines how knowledge is built up along the different phases of the teaching process. In the experiments, the game has been used in two ways, hereby defining the way in which the various concepts of the course are presented to the students.

In a first test, the game is used as a support tool in phase 1 (see Figure 1) where the student has no knowledge on risk management. In this default setting, students are responsible for a project in progress and have to make decisions to optimize time and cost in a project within the presence of (unknown) uncertainty. The game tests the knowledge of the student on baseline scheduling and serves as the ideal preparation for the second phase of the teaching process where the risk analysis techniques are discussed. However, in a second game setting, the game is only used after the second phase in which students now have a theoretical knowledge about the available tools and techniques to analyze expected project risk. Consequently, they now play the game with a knowledge of risk metrics and how they should interpret these metrics to be better prepared for unexpected events. The learning by doing experience obtained through the game is therefore now postponed to phase 2 instead of phase 1.

Communication format: While the communication sequence determines the timing and integration of exercises and business games within the teaching process, various ways exist to communicate within a single exercise or case study. In our experiments, the business game was used to test this idea, since it involves an interactive approach between the student and the computer, and requires that students make decisions based on a simulated computer output. The way this computer output is displayed on the screen has been varied from project Gantt chart with a mainly visual overview but limited information, to data not well structured, or a table with numbers presented as risk metrics (risk analysis phase) and control (project control phase) metrics, or even by using graphical visualizations of these numbers to facilitate interpretations and possibly decisions. This experiment aims at testing how the way the data and information is communicated to the students influences their decision making process, both in terms of the final student performance as on their learning experi-

ence.

Communication expectations: Within the field of communication, the perceptions of an individual partly depend on his/her expectations. When the PSG is first presented, participants are faced with a slightly larger network in terms of number of activities than in the previous sessions. The inclusion of multiple ways in which activities can be executed further enhances the complexity and the number of choices that can be made. Consequently, the complexity of the exercise depends on the project network, the number of activities and the number of trade-off options for the various activities. On the other hand, uncertainty poses a threat. As the project progresses, some activities will be ahead of schedule, while others will be delayed. As a result, the project may deviate from the original plan. Uncertainty comprises the height and the number of delays that cause a deviation from the baseline schedule. In our tests, the nature of complexity and uncertainty were communicated differently to the participants of the game. In the first variant, the aspects of complexity and uncertainty were downplayed. The message was given to the students that as in real-life, the execution would result in changes but it was up to the individual to decide whether changes due to uncertainty warranted a change in the time or cost of the activities. In the second variant, the participants were made aware of the fact that they would operate in a highly dynamic environment. The project network was more extensive than the ones they faced previously. Additionally, Murphy would come along and would hinder a proper, on-time execution. Undoubtedly, it would be necessary to act and bring the project back on track. The goal for the participants would be to decide on the set of activities they would change and how severely they would crash or prolong project activities. The consequence of these two variants was that the expectations of the participants differed drastically.

3.2.2 Output measures

In order to provide an answer on the three research questions defined by the three communication experiments, two output measures have been used. A first quantitative measure is based on the results obtained by the students, expressed as marks on a test exam as well as the outcome of a business game (expressed as the final cost of the project after its finish which must be as low as possible). A second qualitative outcome measure is based on an analysis of the students' evaluations filled out after the course that expresses their satisfaction on the course process as well as their degree of learning.
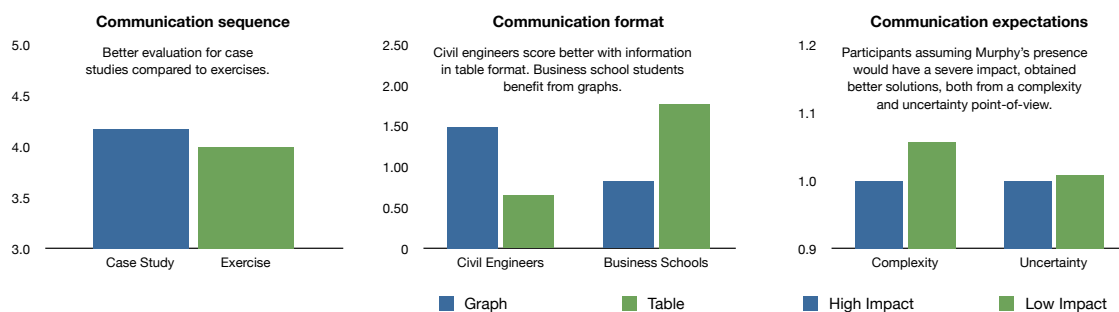
Figure 3: Overview of the main results of the communication experiments

4 RESULTS

In the next sections, results on the three communication experiments are described. The results are summarized in figure 3 and are elaborated in the respective sections.

4.1 Communication sequence

The timing and integration of exercises along the phases of the course showed a significant impact on the learning experience, certainly in terms of student satisfaction and to a lesser extent in their final performance. Integrative case studies contribute more to student satisfaction than separate exercises in each phase and evaluations have clearly shown that integrative case studies help in motivating students to work harder on the case study. The evaluations not only indicate a higher satisfaction, but also a more intense learning experience that better converts the various theoretical concepts into practical relevance. However, despite this positive effect on the learning experience, the impact on their final exam performance was not always clear. While more experienced students benefit more from an integrative approach, university students without practical experience did not perform better than using seperate exercises, despite their higher satisfaction. The mean score of the evaluations of the Project Management course are depicted in the left panel of figure 3. The y-axis shows the evaluation of the students, with a minimum value of 1 and a maximum value of 5. The mean score for the students who received a case study (4.17) throughout their curriculum was based on 62 evaluations, whereas 33 student evaluations made up the mean score for the exercise sessions (4.00).

The results on the two different game settings came somewhat as a surprise while measuring its impact on the learning process. The default setting which assumes that the game is used in phase 1, prior to the lecture on risk management, has led to a better learning experience. Students clearly indicated that an intermediate practical exercise after phase 1 using the business game clearly allowed them to better grasp and understand the concepts discussed in phase 1 and to better prepare them for the second phase of the course. Despite this higher satisfaction, the results were somewhat lower than the students who played the game after phase 2. Indeed, the students who played the game in phase 1 had no knowledge whatsoever on the risk analysis technique and therefore underperformed compared to the student who had this extra information and played the game after phase 2. This illustrates that having knowledge about risk analysis techniques (phase 2) clearly had a beneficial impact on the decision making process for optimizing time and cost trade-offs in projects. Although this should not be seen as a big surprise and only illustrates the relevance of the teaching phases and the positive contribution of the business game, it was somewhat unexpected that this better student performance was not related to a higher student satisfaction. Apparently, student performance and the learning experience and corresponding satisfaction do not always go hand in hand.

4.2 Communication format

The experiments clearly revealed that the format of communication has a significant impact on the timing of the decisions. It has been observed that more graphical formats lead to quicker decisions than numerical communication. This has been tested by playing the business game under various restricted time horizons, which revealed that time pressure has a more negative impact when using numbers than when graphical charts are used. Obviously, it is much easier to interpret graphs and dashboards, while metrics and quantitative support tables need a thorough analysis and therefore consume more time.

Surprisingly, the format of communication had no significant impact on the learning experience and stu-

dent satisfaction since no significant differences in evaluation could be found between the various experiments using different communication formats. Despite this lack of relation between the format of communication and the students' satisfaction, the performance of the students on the game, measured by the final cost of the project when the game is finished, depended on the background of the students.

When the engineering university students were presented with numerical information, they tended to make the right decision. When the business school students were presented with the numerical information, they underperformed compared to the engineering students in their decision making, despite their higher level of experience. However, when the business school students were presented with the graphical information, they performed on par with the engineering students who received numerical information. This experiment clearly shows that the communication format is crucial in the teaching process and defines the quality of decisions made by people. The results are shown in the middle panel of figure 3. The y-axis represents the cost deviation obtained by the students. A division is made between civil engineering students and students following a business education. On average, civil engineers benefit from information presented in a table format, while business school students achieve better results with graphical information. These results are in line with the concepts presented in the book "reinventing communication" (Phillips, 2014) which discusses the importance of communication in a professional project management environment.

4.3 Communication expectations

The experiments with regard to the expectations of the game participants revealed that it is better to err on the safe side. Participants who assumed Murphy would come along and that they would have to react to a highly dynamic and uncertain environment performed better than those participants where the nature of complexity and uncertainty was not emphasized. This could be established in the cost deviations the players achieved and is shown in figure 3. In the figure's right panel, the cost deviation when students assume complexity and uncertainty have a high impact is set equal to 100%. The bar charts indicate that the costs increase (> 1.0) when complexity and uncertainty are not deemed to have a high impact. Incidentally, the number of trade-off changes and inspections of time/cost profiles could be monitored using the log files. Participants for which the dynamic and uncertain character of the game was highlighted,

investigated much more alternative courses of action and dedicated more effort to making changes to the activities' durations. Consequently, a relation could be drawn between the amount of effort invested by the participants of the game and the attained solution quality. In general, a higher amount of effort, measured in terms of the number of trade-off changes and the inspection of the profile of the trade-offs, leads to a better solution quality.

5 CONCLUSION

This paper reported on results of a set of students experiments using various ways of communication in a blended learning process of Project Management courses. It illustrates how the use of computerized business games and integrated case studies have a beneficial impact on the learning experience and student performance. However, the way in which this blended learning methodology is implemented is influenced by the sequence, format and accuracy of communication used using exercises, case studies and business games.

Timing and integration of communication is crucial in the learning process of students and positively contributes to the learning experience and sometimes to the student performance. The communication format has a significant impact on the students' performance and differs along their practical experience and background. However, no relation could be found between the format and the satisfaction of students during learning. Expectations are also an integral part of communication. In the final experiment, it was shown how highlighting the complex and uncertain nature of the environment can affect the achieved results. It was found that participants invested more effort and attained better solutions when the importance of reacting to uncertainty was stressed. If the decision on whether a change is desirable was left to the students, considerably less effort was put into the evaluation process and a larger cost deviation was the result. The results of the three experiments are summarized in table 1.

Obviously, this study suffers from a number of drawbacks. First, the student population has not been controlled carefully and has been taken randomly from an existing pool upon availability. In addition, the settings of the experiments have been often set ad hoc and none of the parameters have been carefully controlled. The main reason of this drawback was of a practical nature, since it is hard to put students under experiments during learning. We therefore opted to change the communication settings on a

Experiment	Main findings
Communication sequence	Integrative case studies lead to higher satisfaction. Risk knowledge has beneficial impact on decisions.
Communication format	Results depend on previous education. No impact on learning experience and satisfaction.
Communication expectations	Better expectations of the environment lead to more effort. More effort leads to better solutions.

Table 1: Overview of the communication experiments and their main findings

small sample of students, often without their knowledge that they experienced a different learning process than their colleagues. Finally, the outcome of the experiments has been measured by an analysis of student evaluations and exam results and significant differences could be caused by unknown and uncontrolled factors other then the varying settings in the communication parameters.

However, despite these shortcomings, it is believed that the student population as well as the time horizon of these tests is big enough to exclude randomness and to guarantee a certain degree of relevance of the findings of these experiments. Obviously, more controlled experiments are necessary and more research in the relation between communication can and will be done in the future. Three future research avenues are therefore under construction.

More research on the impact of knowledge about risk management on the quality of decisions made by students responsible for projects in progress, as well as an analysis of their behaviour in these uncertain environments is carried out using other experiments. The results of this study have been written down in a working paper which is currently under submission in a Project Management journal (Wauters and Vanhoucke, 2013). In this study, the authors derive solution strategies from participants of the Project Scheduling Game. The authors tested the time and cost strategies on a large data set and outlined the circumstances in which each strategy performs best. It was found that the cost-based strategy yields the best results for low penalty environments and networks counting many trade-off options. In highly uncertain environments and projects where exceeding the deadline is heavily penalized, the time-based strategy performs particularly well. Moreover, a new study is currently in progress which will extend the experiments on the timing and sequence of communication. To that purpose, an extension of the business game will be presented to the students to formally test and validate whether the first business game contributed to the learning experience and student performance. Finally, more studies on communication in Project Management are undoubtedly interesting research avenues in order to find out whether better communication ac-

tually leads to better decisions and a higher project success rate. These studies are currently in a premature testing phase using real life data constructed by (Batselier and Vanhoucke, 2015).

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