



## **An Authentic Learning Strategy for Engineering Students to acquire Integrated Management Competencies**

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### **INTRODUCTION**

Students and staff of the minor 'Management in a High-tech Context' at Delft University of Technology reported a lack of integrated learning opportunities in the programme. The minor offered separate courses on financial management, human resource management, innovation, etc., but was not successful in integrating the different courses into a meaningful whole. As a result students lacked the opportunity to coherently understand and apply the competencies taught in the programme. For that reason an integrative course was developed. The design and experiences from three editions of the course are presented in this paper.

The problem at stake is: what learning strategy is suitable to integrate the different competencies as acquired in the different courses of the minor 'Management in High Tech Contexts' into a meaningful whole? In this paper we study the authentic learning strategy [3], since it provides learners with a meaningful environment to coherently understand and apply knowledge and skills. The intention was not to develop a formal test to see if this integration had taken place in a satisfactory way, but to use a qualitative approach and build on the perception of the students as the main source of information.

In the remainder of this introduction we present the essentials of the minor programme and the pedagogical design of the integrative course.

#### **1.1 The minor 'Management in a high-tech context'**

The minor 'Management in a high-tech context' is offered to students in the first semester of their third year of undergraduate study. The goal of the minor is to provide an introductory and general view of topics in management practice in a high-tech context. A set of individual courses cover issues such as corporate finance, high-tech marketing, human resource management, innovation management, and strategy. The minor is intended for engineering students of the Delft University of Technology (and from other universities) who are

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interested in management-related aspects of technology and is a good preparation for a later specialization into the Management of Technology M.Sc. programme.

## 1.2 The pedagogical design of the integrative course

The aim of the integrative course was to enable students to combine and apply the gained knowledge in such a way that they would obtain a better and coherent understanding. As discussed by Lombardi [4] this course should provide the conditions needed to *experience* this understanding. To collect requirements for the course all teachers of the individual courses were asked to indicate the three most important issues of their course and what they would like to see happen in the integrative course. This was added to the set of requirements used for the development of the pedagogical model, including prior knowledge, study field, working experiences, personal learning demands, the number of students, the time period, and others. Most important though in this phase was the selection of an approach that would allow for active and collaborative learning in an engaging learning environment. The authentic learning approach qualified itself as the most appropriate pedagogical model for the aim of the integrative course [4]. Authentic learning is an approach to teaching and learning that allows for blending different kinds of learning and to give students opportunities to think and act like professionals but in a learning or training context. In a physical sense it is easy to organize, but in a pedagogical sense it needs a clever design to deal with the tasks and the limitations imposed by the curriculum and institutional constraints.

## 1.3 Research approach

The pedagogical design was built on several learning theories and new insights related to the use of media for learning. The authentic learning approach is the context in which this design has been materialized, hoping that the approach would allow for the different competencies to develop into a meaningful whole. It was not the intention to formalize this integration, because students have very different backgrounds, pre-knowledge and personal learning demands. Also the question is how to qualify integration in relation to the fact that no standard or what so ever is available. Therefore it was decided to judge the level of integration from a more qualitative approach and built on the perception of the students as the main source of information.

The data used to assess the integration are from three consecutive years (2009 - 2011), as there is the yearly Institutional evaluation, which is a general assessment of the quality of the course, including structure, content and teacher performance.

## 1.4 Survey of the paper

After this introduction the paper continues with a description of the authentic learning strategy as applied in the integrative course with includes details on the two learning cycles that are used, the consultancy and the management cycle. The next step is a check on the compliance of the integrative course design with the characteristics of the authentic learning environment. Chapter three is on the outcome of the data being collected in which the perceptions of the students play a major role. The final chapter comprises conclusions and some issues for discussion.

## 2 THE AUTHENTIC LEARNING STRATEGY APPLIED

The aim of the integrative course is to let the students experience the use of their acquired knowledge in a case based setting which impersonates an authentic learning environment. To simulate a real life context it was decided to use job roles (consultant and manager) to give students the opportunity to think and act like professionals with tasks and assessments that are based on these roles. The course consisted therefore of a consultancy learning cycle



(consultancy report) and a management learning cycle (management game). The consultancy case focuses on an assignment from a real technical company that is negotiated with the firm and covers concrete problems or demands. For this we have built up a good relationship with Thales Netherlands. The management case is impersonated by a management game, for which we chose the TopSim General Management Game from Tata Interactive based on a list of requirements [7] [8].

For the ease of information exchange, communication and collaboration we have been using Blackboard mostly as an agenda and library, other tools like SMS, Google-mail and Google-docs have been used for collaboration. In the final year Yammer, an enterprise social network, was used to augment the transparency of activities and achievements during the course by concentrating the information exchange between all participants through this medium which was available at no cost at university level.

The minor normally is booked out, which means sixty students coming from different faculties or even from other universities. The authentic learning strategy requires participation of the students on all levels of the course to mitigate the authenticity and the learning that needs to take place. So there is no lecturing and students are equally responsible for what is happening as members of teams and not as students in a class. Students work in teams of four to five members randomly chosen and staying together throughout the course. Teachers mainly operate as coach. In the next sections the structure and processes of the learning cycles is being described and analysed.

## 2.1 The consultancy learning cycle

The integrative course is planned in the 2nd quarter (November - February) of the academic year and the consultancy part covers the first six weeks till the Christmas holidays. There is one plenary meeting of two hours each week and multiple contacts of students and teachers using media and office hours throughout the week. Students have the responsibility to organize these gatherings and supply the structure and content. The learning cycle (see figure 1) is the overall structure to clarify the different steps needed in the process and is composed of five phases that range from exploration to the presentation of the final results.

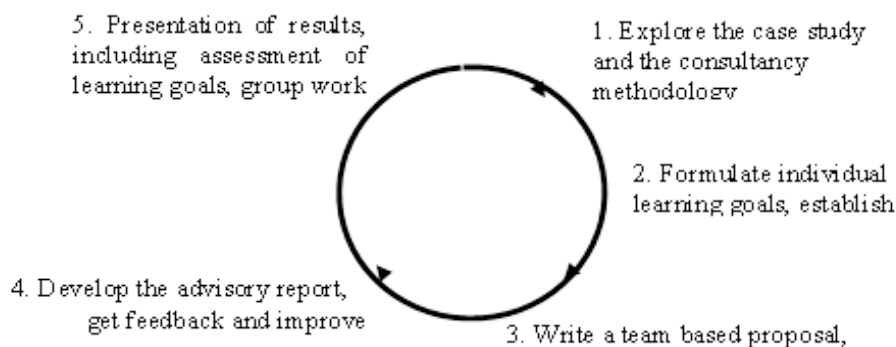


Fig.1. Learning cycle consultancy

The exploration phase comprises the introduction to the case and the consultancy methodology. This is done using a participatory systems approach in the sense that the students are involved in all activities. An example: for the introduction on consultancy we use the book by Block 'Flawless Consultancy'[5]. Student groups prepare a summary and presentation of one or more chapters and discuss this in class, while making the material available online before the meeting so others can prepare. At the same time related material is collected and put online for further reference and a direct link is made with the case study to



see what is needed to deal with this task from the consultancy perspective. The same approach is used for all other phases. In the first four weeks the focus is on analysing the problems from different angles. Student teams make an internal task division to analyse the problems in the different departments to develop a clear analysis of the problems the organization is facing. They present their findings as individual groups and discuss and negotiate with their peers and coach for further development and improvements (contact moments in weeks 2 and 4). Also the expert from the company might be involved using a Q&A format. The final three weeks are used to formulate a consistent proposal for the company to deal with the problems and present this during a plenary session with company representatives. The assessment is an on-going process due to the participatory approach in combination with self-assessment by the students concerning group performance, the quality judgment of the proposal by the company and the overall qualification by the coaches.

## 2.2 The management game learning cycle

The management game is hosted in the week after the Christmas break. The students work teams of about five and act as the managing board of a fictitious, technical, multinational company. As such they need to make decisions on sales, product development, production, purchasing, finance, and strategic planning. The learning cycle is shown in figure 2.

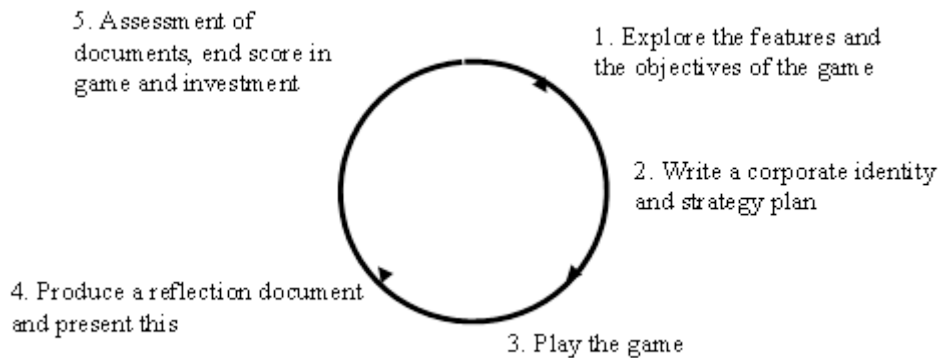


Fig. 2. Learning cycle management game

The TopSim software calculated the consequences of the decision taken by the teams and produced elaborate management reports. The game is played in eight rounds divided over one full week (8 – 10 hours a day). The level of complexity is gradually increased during the game: the number and difficulty of decisions increase in consecutive rounds. In between game rounds the participants received group assignments such as writing a corporate identity plan and strategy plan, and preparing and presenting a stakeholders meeting to reflect on the process and decisions taken. The assessment of the management game was based on the documents produced and augmented with a possible bonus for winning the game.

## 2.3 Design of the authentic learning environments

To make sure that the set-up of the integrative course complies with the authentic learning strategy a framework was constructed by [3] [6] of ten characteristics to check the validity (see table 1). In the first column an overview of the characteristics with in the second and the third column the justification from the point of view of the consultancy learning cycle and the game learning cycle.



Table 1. Authentic Learning Characteristics

Authentic learning characteristics	Consultancy learning cycle	Management game learning cycle
1. An authentic context that reflects the way the knowledge will be used in real life.	The consultancy role impersonates the work many students will be confronted with when they leave the university.	The assignments and in-game activities were situated in the context provided by the management game.
2. Authentic activities	The assignment is a demand from a real company in which experts are involved who judge the proposal on the usability	The assignments and in-game activities represented authentic activities of a management board.
3. Complex tasks, which should collaboratively be executed over time as in a community of practice.	Students work in groups collaboratively, having different tasks, discussing achievements with their peers, coaches and representatives of the company.	Students played the game for a week, full-time in groups and collaborate to take meaningful, coherent decisions.
4. Different roles and different perspectives.	Students work in groups, have a different background and have different tasks. Collaboration is needed to fulfill the different roles (technical, financial, business, pr).	Students assume the roles of different members of a management board and will discuss conflicting issues amongst each other. Also, they learn to analyse a company from an investor's point of view.
5. Collaborative construction of knowledge.	Proposals very much differ in solutions offered, quality, and usefulness as a result of a collaborative construction of knowledge.	During debriefing sessions the players collectively formulate lessons learnt based on the outcomes of the decisions they took.
6. Opportunities for reflection.	Reflection is done in the group, during the meetings where other group review the outcome and during the sessions with the coach.	Debriefing sessions and the writing of a reflection document provide opportunities for reflection.
7. Application of experience and lessons learned in different situations.	Students are recommended to use prior experience while coming from different backgrounds. This is very helpful to qualify the different perceptions in the group.	The management skills that are learnt in the game apply to a range of different types of companies and levels of management.
8. Coaching and support.	Is integrated in the structure of the learning cycle with the teacher who operates as coach and the students groups as peers.	All teams are supported by a game facilitator and teacher who coaches them during the game and the work on assignments.
9. Authentic assessment: the development of a genuine product instead of an unrecognizable semi-finished product.	Students are assessed during the development and by the companies' experts on the usability and quality of their proposal.	The assessment is based on genuine products such as a business plan, a stakeholder report and meeting, etc.
10. Room for different solutions and end products.	Proposals often differ very much in the kind of solution, the approach, the viability suggested.	Different approaches and strategies exist to win the game. These approaches and strategies are also reflected in the teams' products such as the business plan.

### 3 RESULTS

#### 3.1 Institutional evaluation report

The course was evaluated by the faculty's education office. Every year, students received a questionnaire immediately after the course had finished in which they were asked to score the



course in terms of usefulness, the connection to prior knowledge, and others. The average scores and standard deviation are shown (fig. 3) for five key performance indicators averaged over the three years in which the course has been taught (n = 127).

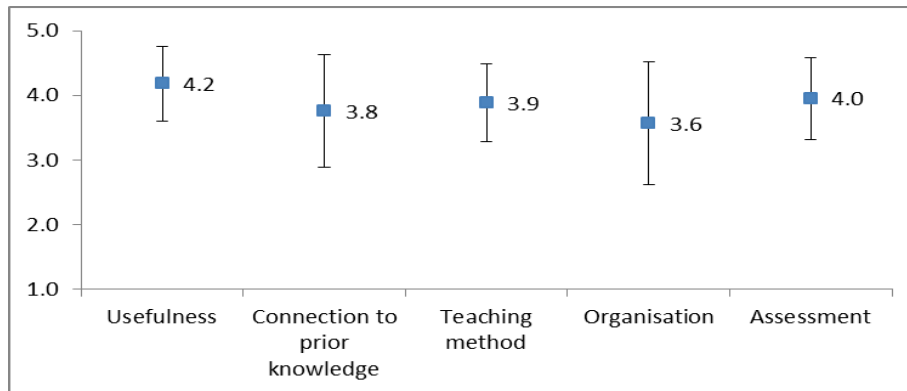


Fig.3 Institution’s evaluation of the integrative course: average scores and standard deviations for five performance indicators (n = 127).

Students gave high scores to the course’s usefulness (4.2 out of 5 points on average). Also, the course connected well to prior knowledge (e.g. the other courses taught in the minor: 3.8 out of 5 points). The employed teaching and assessment methods were appreciated by the students (3.9 and 4.0 points, respectively). Finally, the lowest score was given to organisation. However, we find this score is still well above the average of all possible scores.

In table 2 an overview of the perception of students in relation to the characteristics of the authentic learning environment. According to these reactions the students feel that the course very much complies with the intended real world experiences as an important carrier for the knowledge integration.

Table 2. Students perception of the integrative course

Authentic learning characteristics	Student perception Consultancy learning cycle	Student perception Game based learning cycle
1. An authentic context that reflects the way the knowledge will be used in real life.	<ul style="list-style-type: none"> <li>Plenty of examples</li> <li>Theory mixed with consultancy report</li> <li>Visit to factory, meeting the managers</li> </ul>	<ul style="list-style-type: none"> <li>Implementation of gained knowledge in an attractive way</li> <li>Top learning experience</li> </ul>
2. Authentic activities.	<ul style="list-style-type: none"> <li>Practical side of consultancy work</li> <li>More involvement of the company and more examples</li> </ul>	<ul style="list-style-type: none"> <li>Practical side of management</li> <li>Personal involvement</li> <li>Management game play</li> </ul>
3. Complex tasks, which should collaboratively be executed over time as in a community of practice.	<ul style="list-style-type: none"> <li>Learning by doing</li> <li>Mixed groups</li> <li>Consultancy trajectory</li> <li>Need for less assignments and more specific one</li> <li>Quality of presentations by students not good enough</li> </ul>	<ul style="list-style-type: none"> <li>Highly interactive</li> <li>Less intermediate assignments</li> <li>Game week amazing</li> <li>Feedback of game exercises faster, better for improvement</li> <li>Less assignments, planning and deadlines</li> </ul>
4. Different roles and different perspectives.	<ul style="list-style-type: none"> <li>Mixed groups</li> <li>Different tasks</li> <li>Team work</li> <li>Gain real experience</li> </ul>	<ul style="list-style-type: none"> <li>Working in project groups</li> <li>Different roles in game group</li> <li>Gain experience in management</li> </ul>



5. Collaborative construction of knowledge.	<ul style="list-style-type: none"> <li>• Presentation of chapters from the Consulting book</li> <li>• Need to focus on core issues</li> </ul>	<ul style="list-style-type: none"> <li>• Gives knowledge a practical background</li> <li>• Learned a lot</li> <li>• Interaction needed for the job</li> </ul>
6. Opportunities for reflection.	<ul style="list-style-type: none"> <li>• Learn how it goes in real life</li> <li>• Less reflective essays</li> <li>• Increase interaction between coach and groups</li> </ul>	<ul style="list-style-type: none"> <li>• Allows to see everything you have learnt</li> </ul>
7. Application of experience and lessons learned in different situations.	<ul style="list-style-type: none"> <li>• Includes facets from other courses</li> <li>• Combination of the different course topics</li> <li>• Bringing into practice what you have learned</li> </ul>	<ul style="list-style-type: none"> <li>• Game subjects should be studied before hand</li> <li>• Includes all issues from other courses</li> </ul>
8. Coaching and support.	<ul style="list-style-type: none"> <li>• Online support 24/7</li> <li>• Information often too late</li> <li>• Yammer for interaction and Blackboard for administration</li> </ul>	<ul style="list-style-type: none"> <li>• Game week – team work</li> <li>• Instand feedback</li> </ul>
9. Authentic assessment: the development of a genuine product instead of an unrecognizable semi-finished product.	<ul style="list-style-type: none"> <li>• Feedback sessions / client</li> <li>• Peer evaluation to stimulate performance</li> <li>• Lots of effort, but rewarding</li> </ul>	<ul style="list-style-type: none"> <li>• Peer reviews</li> <li>• Debriefing</li> <li>• Instant feedback</li> </ul>
10. Room for different solutions and end products.	<ul style="list-style-type: none"> <li>• Consultancy trajectory for most new and not integrative</li> </ul>	<ul style="list-style-type: none"> <li>• Game ultimate integrative course</li> </ul>

#### 4 CONCLUSIONS

The first objective was to develop an integrative course and did we succeed? The quantitative and qualitative evaluations show that the students think the course offered them ample opportunities to integrate acquired knowledge while using it in practice.

The second objective was to design a course that would comply with the characteristics of an authentic learning environment? The qualitative evaluation shows that students recognize the characteristics of Authentic Learning Environments (ALE) in the course design and the implementation.

For the on-going discussion it is important to define some of the strengths and weaknesses of the pedagogical model used. Although we have gained more experience, the time investment is still considerable. Another issue is the general applicability of the approach (ALE for integration courses). Our conviction is that the approach would be widely applicable if the preconditions are met, such as 40h full-time time investment for the game week; self-organisation, group work, trust in the effectiveness of the consultancy and game learning cycle and collaboration with company connections.

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