LEAN GAME DEVELOPMENT

Final Report

1 Introduction

The purpose of the project was to showcase our successful research led teaching, enhance the methods it is being taught and to ensure its widest possible dissemination.

Currently the programme reaches approximately 400 students per year. This material would reach each of those plus any additional markets created by the dissemination of the facilitation resource required.

1.1 Background

Through the UK LAI programme, a highly successful business lean-simulation game was developed. It is currently a desk based game supported by electronic presentation material and a set of notes, the output of research. The game has been designed to play over a day of presentation and consists of a lecture, lasting about 1.5 hours and three sub-games that last for 40 minutes each. After each game has been played, time is taken to reflect on what went well and where improvements can be made. The subsequent games use this learning to hopefully improve performance, simulating a 'continuous improvement' business culture. The game has evolved into a robust, scalable, multinational game.

1.2 Aims

This project was aimed at developing two significant areas of research-led teaching.

- Conceptual – Develop, record and disseminate the process of turning research outputs into effective education material
- Practical – Develop, record and disseminate the process followed to make effective use of digital technologies to support the dissemination of research via education delivery.

The main achievement of the project was to develop freely available, learning material in order to support and underpin existing teaching material. The potential physical outputs were intended to be Apple iTunesU and 'App' style learning (and possible generic equivalent).

The development of the conceptual process of turning research outputs into teaching material is seen as a novel approach to this project; a process that can often be overlooked at the end of research projects.

The project will continue to reach full-time and part-time WMG MSc students. It is anticipated that with the development of the available tools that the business simulation can reach global course trainers. This supports the development of a global, accredited trainer scheme.

1.3   Intended outputs of the proposed project

Extended lean community through accredited trainer route.

Digital Outputs:
- Apple ITunesU
- Warwick Youtube Channel
- Warwick Knowledge centre
- Apple App (and/or equivalent Android App, dependant on feasibility)
- Software package available to download and update

The digital outputs are designed to offer up-to-date teaching material

2   Activities

Three interns were recruited to carry out the work and gelled well to create a team that was rich in IT, project management, communication and innovative attitude. They had staggered start dates from October 17th 2011 and have supported the delivery of the existing game.

2.1   Technology Development

2.1.1   iTunesU

We filmed three presentations of the game, (a Chinese cohort and two full time runnings) which formed the main content to create the iTunesU and Youtube videos.

2.1.2   Further digital opportunities

We met several times with Robert O'Toole and twice with Mike Roberts, both from central IT support and through these collaborations were able to come up with a list of potential opportunities, some of which we explored. The opportunities were categorised as follows:

- Video Demonstrations
- Collaboration tools
- Website Opportunities
- Social Media
- Online Presence Opportunities
- Visual Tools

2.2 Evaluation

Questionnaires were distributed to the Full time student cohorts and to an executive running in Singapore to determine the effectiveness of conveying the lessons learnt to participants. This is the first time questionnaires have been implemented as a part of the game and the purpose of the questionnaires was to identify the actual learning provided by the game. The intention was to expose which learning points had been missed or absorbed.

2.3 Dissemination

Three conferences were identified as appropriate to present our development work and findings at namely; Ednet, INTED and EurOMA. Subsequent to this two papers were submitted and presented at the INTED conference in Valencia on the5th and 6th of March, both with excellent feedback. The final abstract that was submitted to EurOMA was successful and a paper has been prepared for the conference, July 2012 at Amsterdam. See Appendix A.

2.4 Project Management

A top level plan of our intended activities was created and can be found in Appendix B. As part of our project management we maintained regular contact with IT support Services, via frequent meetings with Robert O-Toole, who was extremely helpful, and evaluation meetings with Mike Roberts. We also met with Paul Taylor on one occasion, in order to ensure we were harmonised in terms of our key deliverables. We had regular meetings with, Dr. Celine Martin, originator of the game and developed a weekly reporting system to ensure all team members more up to speed. Following on this we also held weekly target meetings in order to measure our performance on keeping to targets and set weekly objectives, see Appendix C

3 Final report on budget/resources

The project required 144 days of internship time to deliver.

4   Final Outcomes

4.1   Technology Development

The main deliverable from this section was the creation of a technologies evaluation table. This table is critical as it demonstrates are success in meeting our objective to use various technologies to enhance the means the game is played. The technology evaluation table can be seen in Appendix D. In addition to this user guides were designed to show how certain generic tools could be applied in the playing of the game, see Appendix E.

4.1.1   iTunesU and Youtube

Video editing was completed and the content selected was used to produce a *15* minute video clip. The intent is that this video production will help in demonstrating the game environment; enable understanding and providing an overview of the game. Based on initial observations, participants showed actual learning by applying knowledge they acquired from previous stages of the game. The video was interspersed with slides as well as voiceovers at the introduction and conclusion of the video. This was done in order to enrich the content, clarify the learning points and ensure the material was engaging. This content has already been widely disseminated, apart from Youtube and iTunesU, a copy has been given to the Marketing team at WMG. Hopefully this should add to attractiveness of WMG programmes to prospective students. See Appendix F for a link

4.1.2   Further digital opportunities

The specific tools that were selected to enable both dissemination and enhancement of the game, are shown in this list. These tools belong to five main categories:

1. Video Demonstrations

   The Warwick iTunesU and the Warwick Youtube channel have been selected as the main avenues of distributing the video.

2. Collaboration tools

   Document Sharing tools such as SharePoint and Google Docs & Video Conferencing tools such as Skype, WebEx are discussed as potential options of enhancing the knowledge transfer and communication between the teams, suppliers and customers.

3. Website Opportunities

   Feedback Forums, Wikis, Online Ordering & Glossaries are being considered as viable ways of sharing information and communicating within the game and disseminating the game.

4. Social Media

Facebook, Twitter & LinkedIn have been selected for testing as means of distributing the game and providing an alternative medium for feedback.

5. Online Presence Opportunities

   Prezi and Warwick Knowledge Centre are being considered as possible platforms for creating an online presence.

6. Visual Tools

   Mind Map and Cartoon illustrations have been chosen to enable a more structured project management process and communicate the student learning journey respectively.

4.2 Evaluation

The questionnaires filled by students, before and after participating in this game, indicate a marked transformation in their perception of the critical factors that are involved in a successful new product introduction (NPI) process.

As a next stage, the questionnaires were evaluated with the use of SPSS, the results and analysis showed some marked improvements in understanding of critical factors of lean NPI, from playing the game. The aim of this analysis was to provide a better understanding of the available data and any correlation between them. See Appendix G.

4.3 Dissemination

As mentioned in section 2.3, a total of three papers were submitted to two conferences, INTED and EurOMA. The first two papers were presented at the INTED 2012, Valencia, and the third at EurOMA 2012, Amsterdam. Our abstract was double blind reviewed, as is procedure with EurOMA, and got accepted.

Paul Taylor also expressed a desire in our disseminating the experiences we gained from our project execution to other departments within the university, via a workshop.

4.4 Visual Illustration Tools

We used a cartoon depicting the learning journey from one students' perspective, as a visualisation technique to show what the game teaches. The aim was to present the teaching and learning progression, before, during and after the game but from one specific angle. We chose to get inside the students head and reveal the thoughts and experiences. This we considered a different means of disseminating the main factors of lean NPI taught by the game.

4.5 Project Management

The reporting system as evidenced in Appendix C was used and later adapted slightly to suit the changing needs of the project. We detailed our project management approach in order to effectively capture the knowledge generated, lessons learned, mistakes made, measure any changes against primary objectives and our overall experience; on paper. The aim was to make all these factors explicit for use in future projects and to share with other departments. This will form the basis of any workshop material which we could potentially share with other departments.

Appendix A

Teaching/Disseminating Educational Material Globally using New Media and Internet Technology

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Abstract

The Lean NPI design game originally developed by UK Lean Aerospace Initiative in 2003, currently reaches over 400 students per year. The game has been presented around the world for cohorts of players from ten to over one hundred. It can be taught to people at many different levels of experience. There is potential to exploit various platforms that would enable the game to be enhanced and disseminated on a wider, and more virtual, scale; using a number of online and new media technologies. In the process research led teaching can be made accessible with the potential of being adopted.

Keywords: technology collaboration, research to education, lean product development

1.0 Introduction

An educational game developed by a research team, and based on teaching the application of lean principles to the design process, currently reaches over 400 students per year. The game is fully scalable, runs on a global level and can be taught to people at many different

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levels of experience and showcase how successful research led teaching, converted into educational material, can be widely disseminated.

The intention is to give an opportunity to new and experienced players of the game to have access to the learning process

Increase the number of participants, consumers and instructors of this experience. An anticipated objective of the dissemination is to create a lean community of accredited instructors who can facilitate this game. Along with this is the desire to develop a knowledge sharing community on lean new product development

Furthermore the game will be made accessible to different people, with different skill sets and in different locations.

The intention is to enable transformational learning by ensuring the game, is not limited only to the players, but tools that allow instructors to work with students will be considered. This would also serve as an opportunity to improve teaching skills.

Objective

The primary objective of this project was to embed the findings of research by enhancing the learning experience. In addition to this, certain tools were selected to ensure global dissemination and improved accessibility. Figure 1.0 Knowledge Dissemination, below, illustrates how the core learning within the game is embodied in different ways as it disseminates.
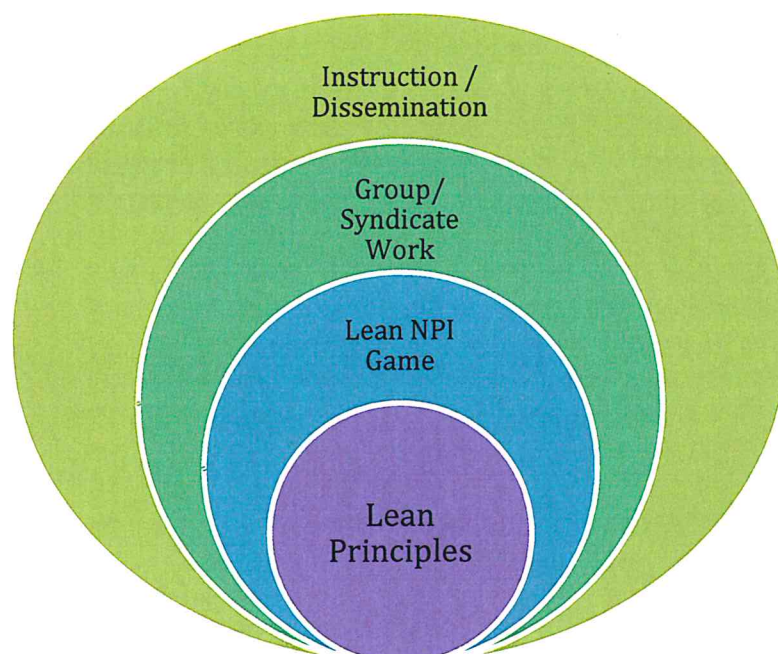

Figure 1.0 – Knowledge dissemination

2.0 Literature Review
Review of Learning Theories
In carrying out this project the relevance of using structured learning styles when designing educational material was considered. In the first instance the game was designed based on problem based learning style, however it was imperative to consider other generic learning

paradigms in order to determine the potential of dissemination, as well as draw a distinction between teaching and learning.

There are several ways to explain what learning is but Sheull's definition of learning as a means to acquiring new skill (Shuell, 2001) is most relevant in this context.

The understanding of how learning occurs has progressed from being seen as solely behavioral, to solely cognitive and finally, as a combination of both. Contemporary learning theories still view knowledge acquisition as an intellectual endeavour, but one that occurs within a social context (Shuell, 2001).

A study of a variety of learning models by Coffield et al, has led to a broad classification of the research approaches to the development of different learning theory models. The study implies that learning is first instructional, then progresses to informational and finally becomes cognitive. However, according to Shuell, learning styles are classified as behavioral, cognitive or social. The plethora of learning theories, models and approaches might suggest incompatibilities within the field. Alternatively it might be an attempt to provide robust perspectives to a somewhat complex subject matter (Shuell, 2001). In addition, although on the surface appearing contradictory, the various theories point to quite distinct and rational classifications that have been developed due to decades of study.

A knowledge base of learning paradigms (Learning Theories Knowledgebase, 2011) provides more detail as to how learning styles can be grouped and applied.

The constructivist learning theories, which consider learning to be achieved by doing, above instruction (Learning Theories Knowledgebase, 2011), were the first to be reviewed as the game is played through problem-solving techniques. As a desk-based game, the constructivist and to a smaller extent cognitivist-instructional based-learning style were the most applicable. Abhijit uses Bloom's taxonomy for iPads as a graphical tool to illustrate how cognitive learning could progress over six phases namely; creating, evaluating, analysing, understanding and finally remembering (Abhijit, 2011).

However, once attempting to introduce dissemination technologies and platforms, the possibilities of broadening the scope of learning had to be considered. Behaviourism theories consider learning to be achieved through stimulation and reinforcement, relating them to motivational styles that add on instruction and application (Learning Theories Knowledgebase, 2011). Kolb's experiential theory belongs to the motivational family and sees learning as cyclical and further improved by reflection (Coffield, et al., 2004). Pavlov's research on embedding instruction through conditioning is considered better classified as a behaviourist style of learning through repetition and consistency (Coffield, et al., 2004)

Activity based learning styles see learning becoming embedded in physical objects, processes or people as an inevitable result of objective learning. Thus internal knowledge is externalised through this embedding process..

Affordance learning styles imply that the environment and external objects stimulate the learning process, both consciously and subconsciously (Learning Theories Knowledgebase, 2011).

The design based model effectively describes how various techniques can be used to transfer research outputs to practical and teachable material. So in this instance teaching is the emphasis, however there is an evaluation element in this model to measure how effective the knowledge transfer might have been..

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Affordance and Elaboration styles rely heavily on observation and sequential presentation to achieve uptake of the knowledge (Learning Theories Knowledgebase, 2011).

The dissemination tools investigated were based on their accessibility and usability, which are the basis for dissemination.

As concluded by Coffield et al, and expounded above, styles are not confined to their specific groupings but frequently include elements of other styles, especially ones that are in the same family (Coffield, et al., 2004).

Ultimately, the ability to translate learning styles into a measurable method or strategy requires reliable measurement, rigorous testing and validation (Sabieh, 2009).

Technology as a Teaching Medium

Results of surveys and studies recorded in various literatures support the conclusion that technology, which can be used to disseminate educational material, can also enhance said material. However deeper investigation exposes the factors that need to be considered to achieve effective dissemination.

Technology, within the context of educational learning, is a medium for communication and links the material to the student, or learner, as defined by Sabieh. The technology, though acting as a conduit, cannot remain passive but must be able to engage its audience in order to transfer the learning. On the balance, the educational content needs to be adapted and contextualized in order to be suited for the technology medium through which it is being transmitted. It is vital that the technology be effectively exploited while the content itself be clarified in order to achieve the learning outcomes. This emphasis in ensuring the message and the medium are designed so as to be uniform is to ensure the knowledge is not 'lost in transmission'. However, as Sabieh explains, a process of evaluation might be necessary in order to determine the effectiveness of delivery (Sabieh, 2009). E-learning can be one-way, where the material is merely transmitted to the subject, or more interactive and multi-engaging (Sloan, et al., 2010).

This point is supported by Lowry and Bush (2009), who conducted a study to measure response of student and faculty to course material enhanced by computer mediated communication tools. Factors measured were usefulness, ease of use and behavioural intention. The subjects who were measured were distinguished according to age, gender, enrolment status and delivery method i.e. traditional, hybrid or online. The results of the study showed that although a large majority of the participants agreed that technology greatly improved learning, they were still better inclined to traditional methods of teaching (Lowry & Bush, 2009). Though this conclusion might appear contradictory, a similar study by Lewis and Price (2007) also gave similar outcomes.

The participants in the Lewis and Price study did express how beneficial technology use in distance learning had enhanced their experience. However, about half of them confessed to being daunted and feeling overwhelmed by the participatory requirements of the course. Particularly, was the requirement that each student had to interact, via discussions, and contribute to online postings (Lewis & Price, 2007).

This underscores the need for the audience to be comfortable with any platform which is selected in order that the learning itself is not compromised while the participant is getting accustomed to the technology.

An experiment in using e-learning to teach operations management was conducted by Sloane et al. Tools such as e-mail, discussion forums, instant messaging and online collaborative learning tools were all employed to achieve the objective (Sloan, et al., 2010).

Grashaf makes some interesting points about teaching styles and how these can be integrated with learning styles to improve the whole experience (Grashaf, 2002). According to Grashaf, teaching styles depend on the approach the instructor takes and can be modeled according to the expert, formal authority, personal model, facilitator or delegator perspectives. When the objective is dissemination then the styles that are most applicable are the facilitator and delegator style. The facilitator style relies on guiding, rather than telling, in order to transfer the knowledge. Facilitation in e-learning can be achieved by the use of user manuals, instructions, etc. where the subject would be required to actually carry out the process themselves.

Successful facilitation would then organically lead to the delegator style where the student is required to function in an autonomous environment (Grasha, 2002). At this point either facilitator or student, having absorbed the learning, is confident enough to work with little or no supervision in executing any given tasks.

3.0 Methodology

The focus of this research was two-fold; first to disseminate research findings through educational material thereby embedding the knowledge and secondly using novel platforms to ensure global reach.

In order to achieve the initial objective generic learning theories were reviewed and different dissemination media were selected and classified. These technology genres were in turn analyzed against traditional learning paradigms as one means of determining the success of dissemination as well as demonstrate that the learning, which is central to the research, can be transferred via these technologies. Focus groups were used to determine the groupings for the different technology types that were used to create the learning styles/ dissemination technology matrix.

The next step was the use of a case study, which is the lean new product introduction (NPI) game that currently runs as part of a module in WMG at the University of Warwick, and is itself the result of industry based research. Collaboration, video conferencing, website and dissemination technologies were explored to determine the ways that facilitators and players could participate in the game virtually.

3.1 Description of Case Study – Lean New Product Introduction (NPI) Game

Through the UK LAI programme, a highly successful business lean-simulation game was developed. It is currently a desk based game supported by electronic presentation material and a set of notes, the output of research.

The game has been designed to play over a day of presentation and consists of a lecture, lasting about 1.5 hours and three sub-games that last for 40 minutes each. After each game has been played, time is taken to reflect on what went well and where improvements can be made. The subsequent games use this learning to hopefully improve performance, simulating a 'continuous improvement' business culture. The game has evolved into a robust, scalable, multinational game.

4.0 Findings
4.1 Embedding the Knowledge
The reviewed learning paradigms (Learning Theories Knowledgebase, 2011) were analyzed and juxtaposed against carefully selected collaboration and dissemination media (Hadjikosta, et al., 2012). These classifications were chosen because they were consistent with pedagogical styles (Coffield, et al., 2004) and therefore acceptable in the academic arena and applicable to this study. However, it has been taken into consideration that design and classification of learning models is not an exact science (Coffield, et al., 2004).

The technologies were selected because they could enable collaboration, online presence, dissemination and video conferencing. These were the elements that were seen as relevant to playing the game and at the same time creating wider access.

These technology genres were ranked against the learning styles, in terms of relevance, and the result was tabulated (Hadjikosta, et al., 2012). It should be noted that the learning style favoured by the lean NPI game was the problem based learning style. By using technology and analysing the results from the evaluation, it was clear that certain tools served to enhance, deepen and embed other learning, beyond the problem based approach.

The table demonstrates how the learning developed by the research could be presented and embedded with the use of technology. A more rigorous validation of this table would be done by a group of experts in the near future. Table 4.1, Technology Evaluation table shows the results of the technology ranking.

4.2 Dissemination using Technology
The primary objectives for disseminating the game, and the tools chosen, were to provide usability as well as accessibility.

The aim was to transform a desk based simulation game and present it in a format that would enable both participants and facilitators the opportunity to comprehend, as well as, replicate the game. Also providing relevant supporting documents and user notes that would allow a potential facilitator the confidence needed to lead the simulation.

Accessibility and availability were achieved by putting the media on internet platforms and ensuring the content was free.

Map of the Game
A map of the game was drawn and the key learning points were identified (Hadjikosta, et al., 2012). This was to serve as a means of distilling the important learning points which the game was attempting to get across.

Furthermore this would form the basis of the dissemination material, ensuring that the media selected would be consistent in conveying these learning points. Video content and cartoon depiction were chosen as the main tools to be used for capturing and disseminating the knowledge embedded in the case study. Figure 4.1, Map of the Lean NPI game, is an illustration of the sequence and learning contained in the game.

Video Content and Online Access
Video content was central to the dissemination of this game. A video of students playing the game in WMG, at the University of Warwick was captured, and then edited to ensure key elements of lean NPI were depicted.

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The objective was to demonstrate the game environment, enable understanding and provide an overview to both novices and experts. The video content follows the map sequence and shows how the game is assimilated by different players, all the while demonstrating the actual learning progression of both participant and facilitator.

The video opens with the tutor talking to a class of students through lean NPI techniques and following different groups of teams as they figure out how to execute their tasks. Finally footage of the tutor showing the various teams' performance by calculating cost, delivery time, profit and excess material is shown. Thereafter the teams report on their experiences and challenges.

The video would be posted on the University's iTunesU and the Warwick Youtube channels to ensure wider access.

In order to encourage participation, the potential of developing a lean community and sustaining interest; Warwick Knowledge centre would host a forum.. The video content and forum delivered through these platforms would help to foster an online presence for the game.

Cartoon Depiction

A visual illustration technique was used to provide a fun, but informative depiction, of the game map, in the form of a cartoon.

The concept of the cartoon was to show one student's learning journey brought about by being introduced to the game, participating in the game, researching the module assignment then finally using the lessons learned about lean NPI at some crucial point in life, such as at job interviews, thesis presentation etc. In addition to the map, experiences gained from both facilitating and playing the game were used in developing the cartoon. In contrast to the video, the cartoon only shows one individuals' perspective in a more in-depth and extensive way.

5.0 Conclusion

After carefully reviewing various learning styles and measuring dissemination technologies against them, it was discovered that these tools and platforms would serve as a means to broaden the learning that the game currently transfers. Furthermore, this would ensure that the key objective of reaching a more global audience, without comprising the knowledge, can be achieved.

Outputs of the Game

The game aims to teach the knowledge of lean product development processes following the simple structure of conceptual, procedural and metacognitive transfer (Steiner, 2001).In other words, a pattern of construction, reproduction and then consolidation is desired, in terms of the embedded knowledge.

Successful lean New Product Introduction (NPI) require that individuals in multi-disciplinary integrated project management teams are able to manage data, knowledge, risks, costs, customer requirements and supplier variations within a fixed time period (Martin, 2011).

The game takes places over three stages, as a result the knowledge is first gathered, then applied and finally, re-applied over the different stages and possibly within the module.

Table 4.1 Technologies Evaluation Table

Learning Theories	Constructivist and Social					Motivational and Humanist			Cognitivist					Design	Behavioural				Descriptive and Meta	Identity	Miscellaneous	
	DL	SL	CoP	PBL	SDT	ET	MHoN	ARCS	AT	DC	CLM	CTM	STC	ADDIE	ET	CC	GOMS	SLT	ACT		AHT	MIT
Technology Genres																						
Online Presence 1. Prezi 2. Warwick Knowledge Centre	5	4	5	5	5	5	3	5	4	4	5	5	1	5	5	4	4	5	5	1	2	4
Dissemination 1. iTunesU 2. Cartoon 3. YouTube Channel	3	5	2	3	2	5	3	5	5	4	4	5	1	4	5	1	1	5	5	1	2	4
Social Media 1. Facebook 2. Twitter 3. LinkedIn	4	5	5	4	5	3	3	2	4	1	1	1	1	2	1	1	2	4	5	1	2	4
Document Sharing 1. SharePoint 2. GoogleDocs	5	5	5	5	5	5	3	5	1	5	1	1	1	4	1	1	4	2	5	1	2	4
Video Conferencing 1. WebEx 2. Skype	5	3	5	5	5	5	3	5	1	5	4	1	1	4	1	1	4	2	5	1	4	4
Collaboration	5	5	5	5	5	5	3	5	1	5	4	5	1	4	4	4	4	4	5	1	4	4
1. Online Ordering 2. Website 3. Mindjet-Mind Manager																						

Table 5-1 Technologies Evaluation Table

1 = not at all relevant 2 = slightly relevant 3= neutral (relevance not easily determined) 4 = relevant 5 = extremely relevant (perfectly suited)

Abbreviations

DL – Discovery learning
SL – Situated learning
CoP – Communities of practice
PBL – Problem-based learning
SDT - Social development learning
MIT – Multiple intelligence theory
MHoN – Maslow's hierarchy of needs
ARCS – ARCS Model (Attention, Relevance, Confidence and Satisfaction)

CML – Cognitive theory multimedia learning
CLM – Cognitive load of multimedia learning
STC – Stage theory of cognitive development
ADDIE – ADDIE theory (Analysis, Design, Development, Implementation and Evaluation)
ET – Elaboration theory
CC – Classic conditioning
GOMS – GOMS model (Goals, Operators, Methods and Selection rules)

AffT – Affordance theory
DC – Distributed cognition
ET – Experiential learning
AT – Attribution theory
SLT – Social learning theory

Sourced from Hadjikosta et al
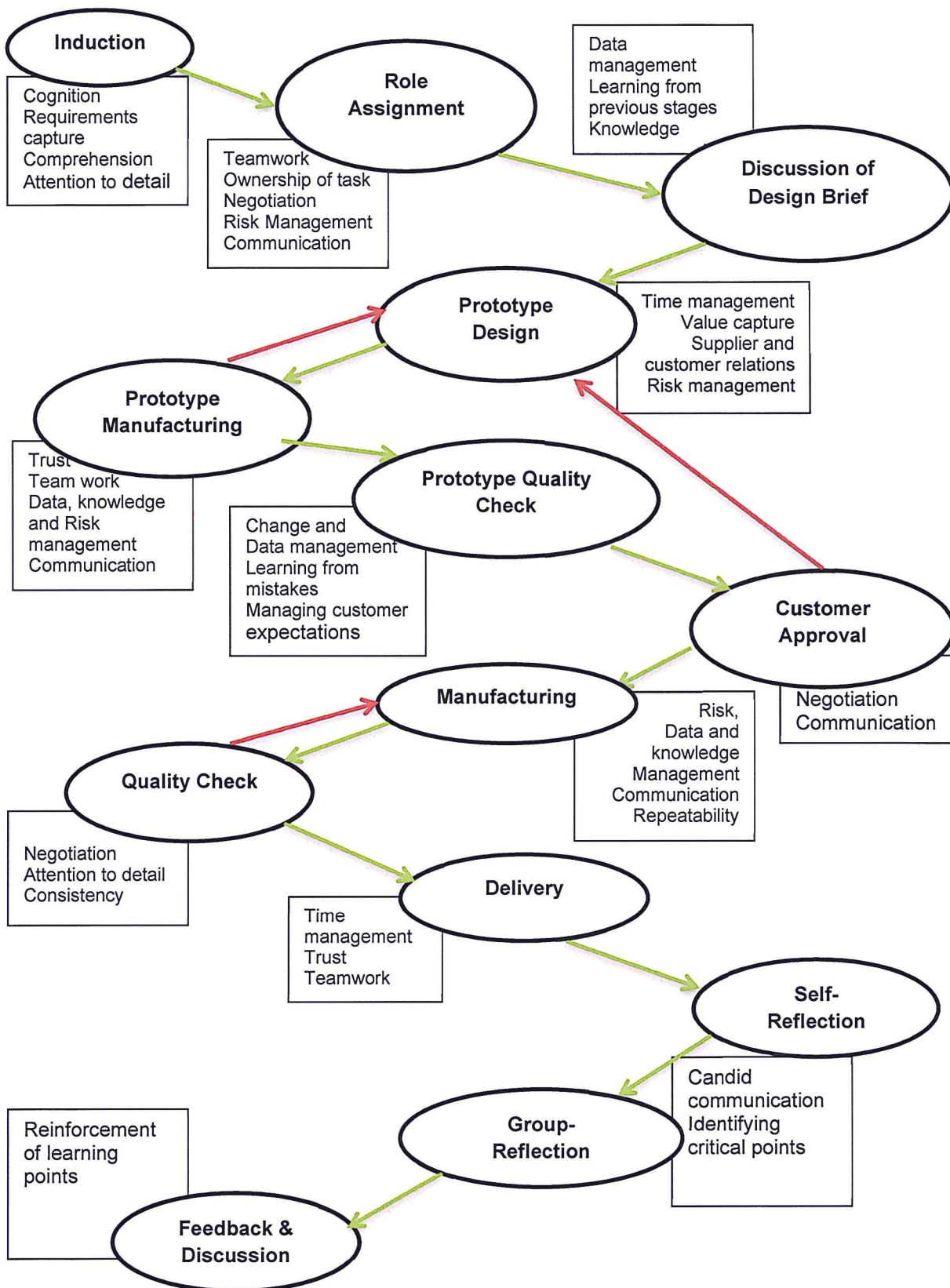
Figure 4.1 Map of Lean NPI game with learning points illustrated. Courtesy Hadjicosta et al

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TRANSFERING INDUSTRINAL KNOWLEDGE TO EDUCATIONAL LEARNING: THE JOURNEY SO FAR

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ABSTRACT

As part of an Aerospace focussed research programme, an industrial game teaching important aspects of product development was developed. With the parallel teaching of an MSc programme it became apparent that there was an opportunity to transfer the learning experience from the game to postgraduate students, which is uncommon to industry-led research. Currently the programme reaches over 400 students per year worldwide and there is potential to exceed this via a number of innovative e-learning and online teaching methods. The game runs on a global scale, is fully scalable and can be delivered to many different levels of experience.

The intention of this research was to enable knowledge sharing that occurs during the product development process in industry and transfer these as key learning points via a lean product development game.

By working as part of multi-disciplinary teams, consisting of individuals with different skill sets, key elements of a typical business operations environment can be experienced by players of the game. Additionally it illustrates the importance of the lean principles and good project management and how the two need to work together for achieving an effective system.

Participants function in project team roles as they exist in real life in order to understand the critical concepts that go into successful product development; such as team work, customer/supplier development, knowledge management and accurate communication.

The use of established pedagogical theories has been employed to guide the development of the project in order to achieve key objectives. Although the game was first developed based on the aerospace sector, the learning points regarding teamwork, communication and collaboration are skills that can be applied across sectors. Based on previous simulations of the game, it is observed that both professionals and students share the same learning points.

By playing this game repeatedly, both participants and instructors have the benefit of improving performance by refining technique, learning from past mistakes and collaborating with others. This learning through failure approach is conducive to Problem Based Learning. Additionally, its simplicity allows for participants to become future facilitators after undergoing a single simulation.

Questionnaires have been used to evaluate the perception of the participants about the critical factors that are involved in a successful new product introduction (NPI) process, before and after participating in the game. The findings indicate a marked transformation in their perception about some learning points, and highlight which learning points require further emphasis. In addition, the results show a significant increase in knowledge transfer and management over subsequent phases of the game. Lastly, the use of questionnaires reviled the great potentials of the game, as it was observed that the game capable to communicate additional learning points, not only those intended.

Similar results are illustrated in video footage, in which participants are captured acting differently as the game progresses.

The game's simplicity allows for executing the game anywhere easily and the learning experience it offers lies across sectors, thus making it global and multi-discipline.

1 INTRODUCTION

The UK Lean Aerospace Initiative (UK LAI) was a UK research programme [1] comprising a leading consortium of Universities of Bath, Cranfield, Nottingham and Warwick, and working in close collaboration with the US Lean Aerospace Initiative at MIT. It was funded by the EPSRC and by forty-five SBAC member companies. The project was divided into four main themes: Lean Product Development, Lean Accounting, Lean Manufacture and Lean Supply Chain. The University of Warwick

led the theme Lean Product Development. As part of the output, an educational game to teach the research findings of an investigation into the application of lean principles to the design process was developed [2].

The game runs on a global scale, and has been delivered to class sizes ranging from ten to over one hundred and has been presented to many different levels of experience. Currently the programme reaches over 400 students per year worldwide but there is potential to exceed this via a number of innovative e-learning and online teaching methods.

Necessarily the game is underpinned by andragogy and can be understood as being in line with the constructivist, problem-based learning approach although it does meet some criteria of other learning styles.

2 OBJECTIVES

The purpose of this paper is to evaluate the effectiveness of that desk based simulation game to deliver learning outcomes that are in line with findings from long term research carried out in the aerospace industry. More specifically the main the objectives of this paper are:

- To determine how effective the game is to deliver the learning outcomes.
- To determine the effects of previous industrial experience, previous educational experience and/or size of the group on the learning outcomes.

3 METHODOLOGY

In order to evaluate the game as it is, identify its effectiveness of delivering the learning outcomes and investigate its potentials and weaknesses, a questionnaire was established (see Appendix A).

The questionnaire in that form can only provide qualitative data regarding the perception of participants about the five most critical factors that are involved in a successful new product introduction (NPI) process. Additionally, it helps in identify a correlation, negative or positive, between the participants' perceptions and their background degree and working experience.

However, by carrying out the survey before and after the game enabled us to determine its effectiveness. This was achieved by comparing the difference in the participants' perceptions before and after the game.

The first survey was completed in November 2011 by 85 full-time students attending courses offered by the Warwick Manufacturing Group (WMG). The group consisted of students with different backgrounds and work experience, and therefore, it was an effective sample for determining the effectiveness of the game.

The findings, the analysis and the discussion that follow refer to the results of the initial study of the questionnaires. As a first step, the game was tested on whether it can demonstrate to the participants how critical the factors for a successful new product introduction (NPI) process, as identified by the UK LAI research programme [3] [4], are. Based on that research the most critical factors to manage are:

1. Risk Management
2. Knowledge Management
3. Project Management
4. Core Competence
5. Value Capture(Customer)
6. Multifunctional Teams

The findings of the first analysis follow. The questionnaires will undergo deeper analysis in an attempt to investigate its actual effectiveness and potentials, as the first observations have shown that the game is also capable of demonstrating the importance of additional aspects of the new product introduction (NPI) process(e.g. supply chain management).

4   FINDINGS

As a first step, the 85 questionnaires completed before the game were analysed. In the questionnaires, the participants were asked to mention the top five areas that should be managed to ensure a successful introduction of a new product. Therefore, in order to convert the qualitative input into quantitative, the number of questionnaires in which those factors were mentioned, directly or indirectly, was calculated.
Based on that analysis, Risk Management was mentioned in 1 questionnaire; Knowledge Management in 2 questionnaires; Project Management in 58 questionnaires; Core Competence in 0 questionnaires; Value Capture in 31 questionnaires; Multifunctional Teams in 4 questionnaires; and Supply Chain Management in 5 questionnaires.
The 85 questionnaires completed right after the completion of the game undergo similar analysis. Based on that investigation, Risk Management was mentioned in 6 questionnaires; Knowledge Management in 1 questionnaire; Project Management in 68 questionnaires; Core Competence in 0 questionnaires; Value Capture in 64 questionnaires; Multifunctional Teams in 11 questionnaires; and Supply Chain Management in 17 questionnaires.
A summary of these results is conducted and illustrated in Table 5.1. These observations are also graphically illustrated in Appendix B.

Table 4.1: A summary of the results of the initial analysis

Important Areas to Manage for a successful NPI	Perceptions before the game	Perceptions after the game
Risk Management	1	6
Knowledge Management	2	1
Project Management	58	68
Core Competence	0	0
Value Capture(Customer)	31	64
Multifunctional Teams	4	11
Supply Chain Management	5	17

5   ANALYSIS AND DISCUSSION

By observing the summary of the results of the initial analysis (see Table 4.1), it can be concluded that there is a significant transformation in the participants' perceptions regarding some of the critical factors that are involved in a successful new product introduction (NPI) process, while there also exists room for improvement of the game.

5.1   Transformation in the participants' perceptions

The results regarding the importance of capturing the customers' value indicate a critical transformation in the participants' perception. An increase from 31 to 64 out of 85 participants shows that the game was very effective in delivering that specific learning outcome.
The minor increase of the questionnaires mentioning Risk Management, Project Management and Multifunctional Teams as critical factors of the new product introduction (NPI) process, also indicates that the game is in position to communicate their importance, but it is somehow limited to the number of the participants it influences. The limitation can be hidden behind the roles of the teams, as team

members are influenced by different stimuli based on their roles. These detections also indicate that the game has the capacity to deliver those learning outcomes to some participants, the number of which can increase after some modifications.

5.2 Indication of room for improvement

In addition to the minor increase of the questionnaires mentioning Risk Management, Project Management and Multifunctional Teams as critical factors, stronger indications about room for improvement of the game are the numbers of questionnaires mentioning Knowledge Management and Core Competence before and after the game. The numbers go from 2 to 1 for Knowledge Management and remain 0 for Core Competence. These results show that the game was not effective in demonstrating the importance of Knowledge Management and Core Competence in a successful new product introduction (NPI) process.
Therefore, modifications are required to enable the game to deliver these learning outcomes, and improvement to ensure that the learning outcomes, that are already being delivered, will influence more participants.

5.3 Increase in Knowledge Transfer and Management

A significant increase in knowledge transfer and management can also be detected, when realising the increase of the questionnaires mentioning specific critical factors. It is worth mentioning that groups have the option to change their roles only in three instances, before the games start. For that reason it is impossible for all the participants to experience each role. However, the increase of questionnaires mentioning the importance of capturing the customers' value from 31 to 64 indicates significant knowledge transfer between the team members.

5.4 Indication of great potentials

As mentioned the objective of the initial analysis was to determine the effectiveness of the game in delivering the six learning outcomes. During the analysis, it was detected that the importance of the supply chain management was delivered. More specifically the number of questionnaires mentioning that specific area increased from 5 to 17. This detection indicates that the game has the capacity to deliver additional critical factors involved in a successful new product introduction (NPI) process. Therefore, it is critical to deeply analyse the outcomes of the survey and identify further ways to investigate its potentials.
Such analysis will enable the creation of a game capable to deliver a wider range of learning points by properly incorporating the additional learning points as part of the game.
Possible findings could include limitations of scalability, most effective and least effective methods of dissemination.
The context to be simulated is a real world, complex problem and the research findings, designed to emerge from the simulation, reflect the multidisciplinary nature of the design environment.

6 CONCLUSION

The purpose of this paper was to evaluate the effectiveness of a desk based simulation game to deliver learning outcomes that are in line with findings from long term research carried out in the aerospace industry.
A questionnaire was conducted and surveys were carried out before and after the game in an attempt to identify the difference between the participants' perception about the critical factors that are involved in a successful new product introduction (NPI) process.
The outcomes of the first questionnaire analysis have shown that the game is capable to significantly demonstrate the importance of the customers' Value Capture, while it can communicate the importance of Risk Management, Project Management and Multifunctional Teams in a smaller degree. Additionally, a significant increase in knowledge transfer and management was detected.

Furthermore, it was identified that there is room for improvement, as the game fails to communicate the importance of Knowledge Management and Core Competence, and demonstrate the importance of Risk Management, Project Management and Multifunctional Teams very effectively.

Lastly, indications that the game is capable of delivering additional learning outcomes were detected during the first analysis. This highlights the need of investigating its potentials and properly incorporating the additional learning points as part of the game.

In addition it was noted that certain learning styles could be enhanced by the use of supporting technologies.

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APPENDIX A

New Product Development Questionnaire

The information that you contribute will be anonymous and you will not be identified.

I am a	Full-Time Student	Part-Time Student	Executive Programme Student
	☐	☐	☐

I study	EBM	PPM	CSM	e-BM	IAE	INT	MBE	MSE	PBM	SCLM
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

How many years of work experience do you have?

What is/are your background degree(s)?

List the top 5 areas that should be managed to ensure a successful introduction of a new product.

1.

2.

3.

4.

5.

APPENDIX B

Bar chart titled "Times mentioned in the questionnaires" comparing Before the Game (blue) and After the Game (red).

Category	Before the Game	After the Game
Rist Management	1	6
Knowledge Management	2	1
Project Management	58	68
Core Competence	0	0
Value Capture	31	64
Multifunctional Teams	4	11
Supply Chain Management	5	17
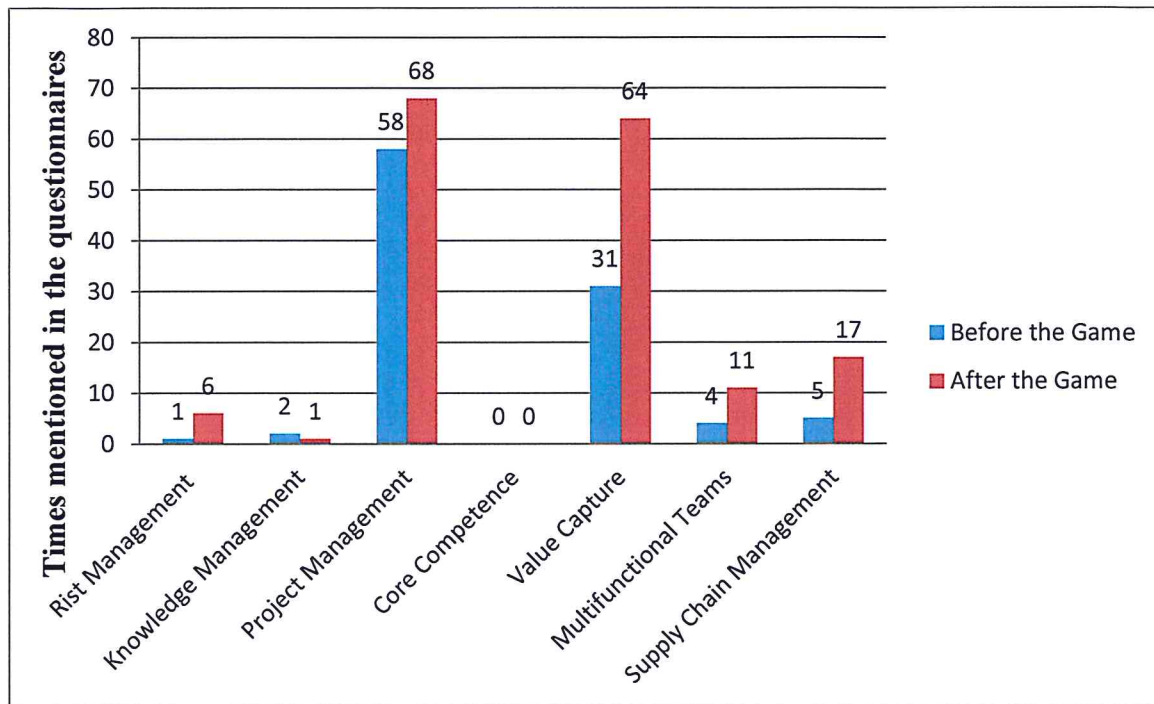
ENHANCING THE STUDENT LEARNING JOURNEY THROUGH THE USE OF TECHNOLOGY

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Abstract

The lean NPI game was developed as an educational game that enables learning through design simulation. The game runs on a global scale, is fully scalable and can be taught in many different levels of experience. Currently the programme reaches over 400 students per year worldwide but there is potential to exceed this via a number of innovative e-learning and online teaching methods.

Working as part of multi-disciplinary teams, participants with differing skill sets can experience key elements of a business operations environment. By playing the game repeatedly, both participants and instructors have the benefit of improving performance by refining techniques, learning from past mistakes and collaborating with others. A critical element of review is incorporated as part of a feedback loop in order to allow for reflection and improvement.

Whilst the game has been running successfully for many years there is now an opportunity to take the learning journey one step further, by developing creative opportunities using current technology to increase both the range and the depth of the learning experiences for the participants and the facilitators.

Technology plays a critical role in business operations; its incorporation into the game can become a vital enabler of the learning journey.

The use of current technology provides the capability of creating realistic scenarios regarding interactions between participants and facilitators. Such initiatives will increase both the range and the depth of participants and facilitators, who will be in a position to recognise the challenges of developing new products in either physical or virtual teams.

The use of established pedagogical theories has been employed to guide the development of the project in order to achieve key objectives.

Possibilities of using software technologies will be explored, in an attempt to simulate a real world experience for participants and facilitators. The Problem Based Learning basis of the game can continue through the use of these technologies.

Collaborative software tools, such as video conferencing, web-based technologies and document sharing tools; will be tested to find different ways team members can interact, both locally and remotely, with the supplier, customer and each other.

The 'social network' of the workplace is considered an important area for efficient collaborative working, and the ability to demonstrate this through the use of collaborative software will add to the learning experience.

Visual tools will be examined to discover how they can be utilised by teams to enable a more structured project management process.

Finally, the potential of using social media to enrich student learning journey will be investigated for their effectiveness as an enhancement to learning.

Keywords: student learning journey, NPI, e-learning, technology, problem based learning.

1 INTRODUCTION

The Lean NPI game, which consists of a set of three simulations per game, provides an opportunity to acquire skills and knowledge that are relevant to similar processes in industry. The game is classroom based and is played by up to eight teams of between six to ten participants who assume different roles, specific to the game requirements.

Now there is an opportunity to adapt and modify the game in its current form taking advantage of established technologies. Technology is being used to improve both access and content of learning; the extents to which it can be exploited for this game will be further explored in the literature and findings. The virtual/distance learning environment underpins the idea that a student is encouraged to learn when allowed to fail and learn from their mistakes. By creating this environment and using appropriate tools, the student could be encouraged to be experimental, inventive and in the process gain more knowledge.

The focus would be on investigating how the specific lessons of NPI resident within the games' processes, can be transmitted and possibly enhanced by the use of technology, both inside and outside the classroom.

2   OBJECTIVES

The purpose of this paper is to demonstrate the benefits that technology can give when used to enhance students learning experience. In particular it will explore the outcomes of presenting a desk-based, lean NPI game, on various media and online platforms with the aim to achieve the following:

- Increase potential access to the game via media technology
- Enhance the way the game can be delivered and played with a bid to better simulate industry practices.
- To determine how much the student learning experience can be broadened in addition to the problem-based learning style that the game now employs.
- .

3   Literature Review

This section begins by summarising and then reviewing popular learning styles that are used by educators to improve the learning gained by students and individuals. Finally examples of how technology is used to enhance education in schools are presented.

3.1   Discovery Learning:

Discovery learning is a method of teaching that involves investigation based teaching which is widely viewed as a modernist method of education (1). Discovery learning occurs when student or individual is not given the tools directly and must attain it autonomously through investigation and by interaction with the tools available. Through discovery learning individuals gain learning with the least direction and they learn by undertaking seminars and simulations. The extent of the learning comes through the level of participation of the individual (2). However there is a lot of criticism regarding the use of unassisted discovery learning also called pure discovery learning. It has been said that pure discovery learning will not help the learning gain the most of the learning. If the individual is a part of a large group discussion even with various practical activities it does not ensure that the student will learn everything that has to be learned. This negative criticism arises from the fact that there is no concrete proof to show that learners can gain from a pure discovery learning method (2). Discovery learning is only considered a strong teaching method when it is combined with a small amount of direct guidance (2) (3).

3.2 Situated Learning:

Situated learning basically comprises of individuals learning when the learning takes place in the same situation as it is to be applied in. This concept of situated learning was first introduced by Jean Lave and Etienne Wenger as a model of communities of learning. They argued that learning is not simply one individual passing on information to another. Learning only occurs when the individual and the teacher co-generate the knowledge and the individual learns from the knowledge and the context in which the knowledge is being applied in (4). The best way to implement situated learning is through role playing activities and with teaching that occurs in unconventional places such as workshops and seminars (4) (5).

3.3 Problem Based Learning:

Problem Based Learning originated from the North American medical sector in an attempt to teach students more effectively. The tutorial process used was found so efficient that it was implemented outside the medical sector. Problem based learning aims to provide students

with problem solving skills, self-learning abilities, increased teamwork capabilities and self-motivation to succeed. The key attribute to problem based learning is working in groups or teams. When students work in groups, they tend to gain from the shared knowledge of the group whilst identifying the solutions for a given problem while collaborating with the others in the group (6). Another core trait of problem based learning is the support given to students by the tutor. The tutor or the facilitator helps the students by guiding them on their journey through encouragement and support. There have, however, been made negative criticisms made about this approach to teaching (5) (6). The biggest issue faced by this method is concerning cognitive load. Cognitive load describes the amount of load placed on the minds of students because of the intensive problem based learning approach that might hamper their abilities to learn. The best way to counter this problem in the method has been to gradually increase the complexity of the problems that have to be solved (3).

3.4 Social Development Theory:

Social development theory is a learning style which lays strong emphasis on the social interaction between individuals. Social development theory has three main aspects to it. The first being social interaction. Social interaction helps individuals learn from interacting with others and learn from shared experiences. The second aspect to social development theory is the More Knowledgeable Other or MKO. MKO refers to another individual in the group who has knowledge about a certain topic. The rest of the group can then learn from this individual's knowledge and experience. The last aspect is the Zone of Proximal development. This is defined as the zone within which most of the learning occurs (5) (7).

3.5 Experiential Theory:

Experiential learning essentially comes from the individual's direct experience. Experience can either be self-made or can be generated for the students. However to partake in the learning the individuals must have a certain mind-set. They must be willing to participate in the experience and should have the ability to reflect on their experiences. In addition to this individuals must have analytical skills to solve problems and truly gain knowledge from their experiences. Experiential learning has three basic stages on implementation. The first stage is observing where individuals learn by observing or even simply watching. The next stage is reviewing wherein individuals will get a chance to review the information that was presented to them. The last stage is implementation where individuals actually get to implement what they have learnt in the previous sessions (5) (8).

3.6 Attribution Theory:

Attribution theory is a structure which has become very popular in social psychology. Attribution theory states that individuals try and understand what action taken causes a specific event or behaviour. The main characteristic of attribution theory is accomplishment. Attribution theory can be easily explained using one example. Whenever an individual succeeds at an activity, they attribute this success to internal factors i.e. it was their ability to accomplish the task. Whenever an individual fails at an activity, they blame external contributors rather than blaming themselves. Whenever a competitor fails at an activity, they tend to assume it was the rival's internal attributes that caused the failure. In most cases, an accomplishment is generally recognized to occur due to four underlying reasons, effort, skill, level of task complexity and luck (5) (9).

3.7 Activity Theory:

Activity theory is a framework which is embedded in cultural psychology. Activity theory essentially provides individuals with the means to understanding certain phenomenon and then gives them the tools to analyse these phenomenon. One of the most widely studied concepts in activity theory is the Activity system. In essence it is a triangle with six elements, subject, object, tools, rules, community and division of labour. In order to reach a goal it is essential to produce certain *objects* such as experiences and information. Individual activity is interceded by artefacts such as documents and recipes. Activity is also refereed by an institution or a community. Also, the community may force rules that influence activity. The subject has to work as a part of society to achieve his goal. An activity normally also features a division of labour (5) (10).

The use of technology in education is not a new concept (11). There are many institutions nowadays that have realised the benefits of technology and incorporate it into their education. Children currently get introduced to complex technology such as smart phones and computers at a very young age. The use of the internet to impart knowledge has been documented on various occasions. Wikipedia is one such online community which purely exists for knowledge sharing and education (11).

a. Pure education says that everyone learns the same thing at the same time. However the great aspect in the use of online technology is that different people can learn at different times better suited to them.

b. In schools, teachers are considered to be the experts in their field and all the knowledge gained by students is a facet of the teacher's existing knowledge. However, the internet provides students with various different sources and the student's learning is a combination of all the sources.

c. In schools students are assessed on a standard format which includes multiple choice questions and subjective answers. By this method all students end up learning the exact thing in the end, whereas technology allows students to arrive at their learning in their own manner.

d. In schools, it is widely accepted that learning only occurs if a student can answer a question without the use of any external help. However this never occurs in adult or work life, where technology is always used to help combat any given situation.

e. In schools most of the learning that occurs is conceptual and theoretical as opposed to adult life where people and individuals only learn by actual participating in an activity (11).

With the explosion of technology it is imperative to change the way most schools and colleges operate. There has to be a balance found between the use of technology in education. It is already being implemented in various educational institutions in the developed world. Educators are realising that the use of the internet is very important and use the web to design interactive sessions which will keep the mind of a student occupied for longer. Educational games are already available which impart the same learning through a more fun and interactive method (12).

4   METHODOLOGY

Investigations were made into the different methods the game could be both enhanced and disseminated. Critical review of the literature was carried out to evaluate how accepted learning paradigms could benefit from current technology and the results were analysed and presented in a table. Furthermore, the game was used a case study to validate the findings of the technology/learning analysis and determine how much benefit could be derived, by both student an instructor, from further dissemination and alternative platforms of participation.

5   FINDINGS

5.1   Technology Evaluation

The game is based on the problem based learning theory which transmits learning through a combination of action and instruction. Problem-based learning is a theory that belongs to the constructivism pedagogy where learning is achieved mostly by doing. However the introduction of technology to enhance the game itself would mean that the method of learning could be enhanced and deepened.

In the technology evaluation element of the methodology, an attempt was made to juxtapose traditional learning styles with modern technology and investigate the outcomes.

The technologies were ranked against the learning styles according to how relevant they were and how well they fit, 5 being most relevant and 1 being least relevant. It was anticipated that, through the incorporation of these technologies, the learning experience of the game will be enriched. Table 5.1 Technology Evaluation table shows the results.

The specific technologies selected for testing, from the categories, was on the basis of what was readily available at the University and that these tools are currently used both in industry and academia for similar purposes (13).

5.1.1 Analysis of Technology Evaluation

Taking into consideration the learning theories which were discussed in the literature and contrasting them with the technology genres selected the following analysis was drawn.

Table 5.1 technology evaluation table illustrates the outcomes and shows the impact these technologies have on the student learning journey.

It is evident that some tools deepen certain learning styles while some others styles did not seem to be either supported or affected by any of the technologies chosen.

Team based learning, which is based on constructivist theories, works very well with collaborative, document sharing, video conferencing and online tools.

The tools that provide instruction, application and reinforcement are consistent with learning according to the motivational and humanist paradigms. These include all that are relevant to the constructivist theories as well as dissemination technologies. The exception to this is Maslow's theory which does not appear to have any relevance.

The tools which are designed to deliver instruction and facilitate communication such as the online technologies and multimedia content in the video are very useful in enhancing cognition. Distributed cognition even expands to include all the genres except social media. Only attribution theory, which sees learning as occurring through observation, is relevant to social media; in this group.

Design based theories, particularly the ADDIE model, explain techniques used to transfer research outputs to practical/teachable application. In this context all the tools chosen, and their genres, are very consistent in encouraging this learning style. Social media however might not be as relevant when compared to the others; hence it was given a rank of 2. The elaboration theory is a bit more specific in how learning is transferred as can be seen in the table.

Behaviourist theories require stimulation and reinforcement to accomplish learning. Therefore collaborative tools and online ordering which encourage repetitive action apply to classic conditioning. The GOMS model is relevant to all except dissemination because this does not require the user to take much action.

All tools selected are relevant to the Activity Theory method of learning because the emphasis is that human activity is enabled by various tools which help to express implicit knowledge. Collaboration and social learning is a very relevant to externalising internal knowledge which in turn helps to improve the knowledge.

Affordance theory is similar to classic conditioning and the technologies that prompt actions, especially at a subconscious level, such as collaborative, document sharing and video conferencing tools would apply.

Multiple intelligences theory shows seven ways people understand the world and therefore acquire skills. Different tools enable different skills. Logical-Mathematical which requires inductive and deductive thinking could be stimulated by collaborative and dissemination tools. Musical-Rhythmic which determines social and communication skills could work with document sharing, video conferencing, and social media. Verbal-Linguistic and Visual-Spatial intelligences are relevant to video conferencing and dissemination tools respectively.

Identity theories which focus on self-identity were not found to benefit from any of these enhancement methods.

The evaluation of the technologies against learning styles indicated that they could enhance not only the way the game can be played, or disseminated, but also the breadth and depth of learning points/knowledge transferred.

5.2 Transferring Lean NPI Techniques via new technology

Successful lean New Product Introduction (NPI) lies in mastering techniques that enable effective integrated project team management, data management, knowledge management, risk management and requirements capture (14). Every stage of the game attempts to teach the players/students one or more of these techniques by requiring them to carry out a set of tasks, as a team, in a bid to achieve an objective (14). Continuous improvement, which is a critical aspect of lean NPI, is enabled by playing the game in three stages so that reflection, mistakes identified and feedback from a previous stage are put into improving the next stage.

5.2.1 Process Map of Lean NPI game

The game layout mimics a generic lean NPI process which can be found in industry (14). The games structure was mapped in order to identify the learning points and areas that could benefit from

enhancement via technology use. The game process is structured in such a way as to ensure that specific learning points, knowledge and skill are transferred over its duration. The map and learning points are illustrated in Figure 5.2 process map of lean NPI game

5.3   Video for dissemination

About 450 minutes worth of video, showing students playing the game, was filmed. This video was edited to about 10minutes of content; the sequence closely followed the map of the game shown in figure 5.2 process map of lean NPI game.   The edit was used to make video to form the basis of material which will be made available for dissemination on Youtube, iTunesU and the University of Warwick Knowledge centre in combination with the website tools such as wikis, glossary and a feedback forum.

Table 5.1 Technologies Evaluation Table

Learning Theories	Constructivist and Social					Motivational and Humanist			Cognitivist					Design	Behavioural				Descriptive and Meta	Identity	Miscellaneous	
	DL	SL	CoP	PBL	SDT	ET	MHoN	ARCS	AT	DC	CLM	CTM	STC	ADDIE	ET	CC	GOMS	SLT	ACT		AHT	MIT
Technology Genres																						
Online Presence 1. Prezi 2. Warwick Knowledge Centre	5	4	5	5	5	5	3	5	4	4	5	5	1	5	5	4	4	5	5	1	2	4
Dissemination 1. iTunesU 2. Cartoon 3. YouTube Channel	3	5	2	3	2	5	3	5	5	4	4	5	1	4	5	1	1	5	5	1	2	4
Social Media 1. Facebook 2. Twitter 3. LinkedIn	4	5	5	4	5	3	3	2	4	1	1	1	1	2	1	1	2	4	5	1	2	4
Document Sharing 1. SharePoint 2. GoogleDocs	5	5	5	5	5	5	3	5	1	5	1	1	1	4	1	1	4	2	5	1	2	4
Video Conferencing 1. WebEx 2. Skype	5	3	5	5	5	5	3	5	1	5	4	1	1	4	1	1	4	2	5	1	4	4
Collaboration 1. Online Ordering 2. Website 3. Mindjet-Mind Manager	5	5	5	5	5	5	3	5	1	5	4	5	1	4	4	4	4	4	5	1	4	4

Table 5-1 Technologies Evaluation Table

1 = not at all relevant 2 = slightly relevant 3= neutral (relevance not easily determined) 4 = relevant 5 = extremely relevant (perfectly suited)

Abbreviations

DL – Discovery learning
SL – Situated learning
CoP – Communities of practice
PBL – Problem-based learning
SDT - Social development learning
MIT – Multiple intelligence theory
MHoN – Maslow's hierarchy of needs
ARCS – ARCS Model (Attention, Relevance, Confidence and Satisfaction)

CML – Cognitive theory multimedia learning
CLM – Cognitive load of multimedia learning
STC – Stage theory of cognitive development
ADDIE – ADDIE theory (Analysis, Design, Development, Implementation and Evaluation)
ET – Elaboration theory
CC – Classic conditioning
GOMS – GOMS model (Goals, Operators, Methods and Selection rules)

AffT – Affordance theory
DC – Distributed cognition
ET – Experiential learning
AT – Attribution theory
SLT – Social learning theory

Induction

Cognition
Requirements
capture
Comprehension
Attention to detail

Role Assignment

Teamwork
Ownership of task
Negotiation
Risk Management
Communication

Data
management
Learning from
previous stages
Knowledge

Discussion of Design Brief

Prototype Design

Time management
Value capture
Supplier and
customer relations
Risk management

Prototype Manufacturing

Trust
Team work
Data, knowledge
and Risk
management
Communication

Prototype Quality Check

Change and
Data management
Learning from
mistakes
Managing customer
expectations

Customer Approval

Negotiation
Communication

Manufacturing

Risk,
Data and
knowledge
Management
Communication
Repeatability

Quality Check

Negotiation
Attention to detail
Consistency

Delivery

Time
management
Trust
Teamwork

Self-Reflection

Candid
communication
Identifying
critical points

Group-Reflection

Reinforcement
of learning
points

Feedback & Discussion

Figure 5.2 Process Map of Lean NPI game

6   Conclusion

The aim of this project was to determine how to both enhance a desk-based game by widening its dissemination while possibly deepening the learning journey currently experienced. This was to be done using various creative opportunities and by exploring how current technology could support different learning outcomes.

Various social media, collaborative, dissemination, document sharing, online, video conference and website technologies were tested and evaluated against a myriad of learning styles. Subsequently, the game process was mapped out and the key learning points identified. The knowledge transferred while playing the game in its original form was consistent with constructivist learning theories.

Established learning pedagogies have been satisfied in the design and execution of this game and by introducing technology to enhance how to game is accessed, played and disseminated; more learning paradigms were seen to become relevant.

By putting the game on different media and online platforms the learning styles possible were broadened to include those which are based on such paradigms as cognitivism humanism and behaviourism. Other learning theories that have been made relevant by the use of these technologies are those based on the motivational, design and descriptive META styles.

This research demonstrated that using these technologies to enable alternative methods of playing the game achieved the following objectives:

- Increased access to the game and the way it is currently being played
- Enhanced and deepened the learning that could be gained from playing the game in its conventional format.
- Introduced the potential of using these tools to disseminate and enable similar educational games and material.

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Appendix B

October 2011

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
					01	02
03	04	05	06	07	08	09
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

PDDM game facilitation, 5 days

Identification of the learning j

Questionnnaires development, 2 days

Process Map, 1 day

PDDM game facilitation, 5 days

November 2011

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
	01	02	03	04	05	06
PDDM game facilitation, 5 days						
07	08	09	10	11	12	13
Paper edit for video footage, 2	Abstract development , 3 days					
14	15	16	17	18	19	20
Paper edit review with Celine		Meeting with Robert, 1 day				
Abstract development , 2 days		Student journey mapping, 2 days				
			Weekly progress report submi			
21	22	23	24	25	26	27
Abstract development, 4 days						
Video editing, 2 days						
		Preperation of interim report, 2 days				
			Weekly progress report submi			
			Abstract submission, 1 day			
28	29	30				
Interim report submission, 1 c						
Video editing, 4 days						
Cartoon development, 4 days						

December 2011

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
			01	02	03	04

Video editing, 4 days
Cartoon development, 4 days
Weekly progress report submi

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
05	06	07	08	09	10	11

Video editing, 4 days
cartoon development, 4 days
SPSS training session, 1 day | Weekly progress report submi

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
12	13	14	15	16	17	18

Technolgy testing, 4 days
Documentation, 4 days
Weekly progress report submi

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
19	20	21	22	23	24	25

Technolgy testing, 4 days | Break for christmas!!!, 7 days
Documentation, 4 days
Weekly progress report submi

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
26	27	28	29	30	31	

Break for christmas!!!, 7 days

January 2012

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
01						01

Break for christmas!!!, 7 days

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
02	03	04	05	06	07	08

Conference paper development, 4 days

Testing and documentation, 4 days

Weekly progress report submi

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
09	10	11	12	13	14	15

Conference paper development, 4 days

Testing and documentation, 4 days

PDDM game facilitation in Cyprus, 2 days | Weekly progress report submi

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
16	17	18	19	20	21	22

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
23	24	25	26	27	28	29

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
30	31					

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ID	Task Name
1	PDDM game facilitation
2	Identification of the learning journey
3	Questionnaires development
4	Process Map
5	PDDM game facilitation
6	Paper edit for video footage
7	Abstract development
8	Paper edit review with Celine & Alan
9	Abstract development
10	Meeting with Robert
11	Student journey mapping
12	Weekly progress report submission
13	Abstract development
14	Video editing
15	Preperation of interim report
16	Weekly progress report submission
17	Abstract submission
18	Interim report submission
19	Video editing
20	Cartoon development

Project: Project top level plan
Date: Thu 24/11/11

Task		External Milestone	◇	Manual Summary Rollup
Split		Inactive Task		Manual Summary
Milestone	◆	Inactive Milestone	◇	Start-only
Summary		Inactive Summary		Finish-only
Project Summary		Manual Task		Deadline ◆
External Tasks		Duration-only		Progress

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Page 2

ID	Task Name
21	Weekly progress report submission
22	Video editing
23	cartoon development
24	SPSS training session
25	Weekly progress report submission
26	Technolgy testing
27	Documentation
28	Weekly progress report submission
29	Technolgy testing
30	Documentation
31	Weekly progress report submission
32	Break for christmas!!!
33	Conference paper development
34	Testing and documentation
35	Weekly progress report submission
36	Conference paper development

Project: Project top level plan
Date: Thu 24/11/11

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Page 3

ID	Task Name
37	Testing and documentation
38	PDDM game facilitation in Cyprus
39	Weekly progress report submission

Project: Project top level plan
Date: Thu 24/11/11

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Project: Project top level plan
Date: Thu 24/11/11

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Project: Project top level plan
Date: Thu 24/11/11

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Project: Project top level plan
Date: Thu 24/11/11

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Project: Project top level plan
Date: Thu 24/11/11

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Project: Project top level plan
Date: Thu 24/11/11

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Project: Project top level plan
Date: Thu 24/11/11

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Appendix C

LEAN PRODUCT DEVELOPMENT GAME

To: Mairi	**Date:**23 February 2012
From: Ant, Kyriaki and Nkoyo	
Subject: Weekly Progress Report – Week 15	

Introduction

This report shows the status of our activities and our targets for next week.

Enhancing the learning experience

Photos for the cartoon development have been taken and further work will has gone into the table to incorporate more teaching styles.

Paper

Completed 10 Final draft slides for presentation of paper – Ant 23 Feb

Action Complete cartooning of the pictures and adding dialogue

Dissemination

The opening and losing voice over text for the DVD have been prepared and should be added to the video on Monday.

Completed produce text for 1 minute voice over MM 20th Feb

Completed Cartoon development (photos and scenes) built into software as reviewed – Nkoyo 24 Feb

Ongoing Review blog http://teachenglishthroughtechnology.blogspot.com/ - Team

Website

Ongoing Create structure for website and familiarise with site-builder – Kyriaki 24 Feb

Video

Write 'flow' scenes written

1 minute words of intro for team to record words MM for Monday 20 Feb team to record with Al 27th Feb

Ongoing Stills for introduction Ant and team

Action Shots of hands on bricks in main body – Al

Completed Chapter title Slides – Ant 24th feb

Action Ppt in corner of main body – team 29th feb

Completed Write/record 30 seconds at end of video 24th Feb - Team

Converting research outputs to educational material

LEAN PRODUCT DEVELOPMENT GAME

Paul Taylor and Mike Roberts requested that we create report on our management approach and methodology for the internship in a way that could be made useful to other departments. We are also preparing to develop our final report.

Paper

Completed Add ADDIE/ISP to position work Kyriaki Feb 16
Completed Final draft 10 slides for paper presentation – Kyriaki (24 Feb)

Admin

Resources

Action Request for more of Al's time – MM

Completed Request for voice recording 24th Feb – MM

Final Report

Action Compile next draft of final Report Nkoyo Mar 3

Ongoing finalise report on the way of approaching the management of the internship (to create a record for the future) this can ultimately belong inside the final report but write as a stand lone document – Kyriaki (23 Feb)

Travel
Action Make arrangements for travel for conference – MM Kyriaki (22 Feb)

Budget

Action Ant to report budget Feb 24th

Comments (for Mairi only):

WMG/IATL Research project

Appendix D

Learning Theories	Constructivist and Social					Motivational and Humanist			Cognitivist					Design		Behavioural			Descriptive and Meta	Identity	Miscellaneous	
	DL	SL	CoP	PBL	SDT	ET	MHoN	ARCS	AT	DC	CLM	CTM	STC	ADDIE	ET	CC	GOMS	SLT	ACT		AHT	MIT
Technology Genres																						
Online Presence 1. Prezi 2. Warwick Knowledge Centre	5	4	5	5	5	5	3	5	4	4	5	5	1	5	5	4	4	5	5	1	2	4
Dissemination 1. iTunesU 2. Cartoon 3. YouTube Channel	3	5	2	3	2	5	3	5	5	4	4	5	1	4	5	1	1	5	5	1	2	4
Social Media 1. Facebook 2. Twitter 3. LinkedIn	4	5	5	4	5	3	3	2	4	1	1	1	1	2	1	1	2	4	5	1	2	4
Document Sharing 1. SharePoint 2. GoogleDocs	5	5	5	5	5	5	3	5	1	5	1	1	1	4	1	1	4	2	5	1	2	4
Video Conferencing 1. WebEx 2. Skype	5	3	5	5	5	5	3	5	1	5	4	1	1	4	1	1	4	2	5	1	4	4
Collaboration	5	5	5	5	5	5	3	5	1	5	4	5	1	4	4	4	4	4	5	1	4	4
1. Online Ordering 2. Website 3. Mindjet-Mind Manager																						

Table 5-1 Technologies Evaluation Table

1 = not at all relevant 2 = slightly relevant 3= neutral (relevance not easily determined) 4 = relevant 5 = extremely relevant (perfectly suited)

Abbreviations

DL – Discovery learning
SL – Situated learning
CoP – Communities of practice
PBL – Problem-based learning
SDT - Social development learning
MIT – Multiple intelligence theory
MHoN – Maslow's hierarchy of needs
ARCS – ARCS Model (Attention, Relevance, Confidence and Satisfaction)

CML – Cognitive theory multimedia learning
CLM – Cognitive load of multimedia learning
STC – Stage theory of cognitive development
ADDIE – ADDIE theory (Analysis, Design, Development, Implementation and Evaluation)
ET – Elaboration theory
CC – Classic conditioning
GOMS – GOMS model (Goals, Operators, Methods and Selection rules)

AffT – Affordance theory
DC – Distributed cognition
ET – Experiential learning
AT – Attribution theory
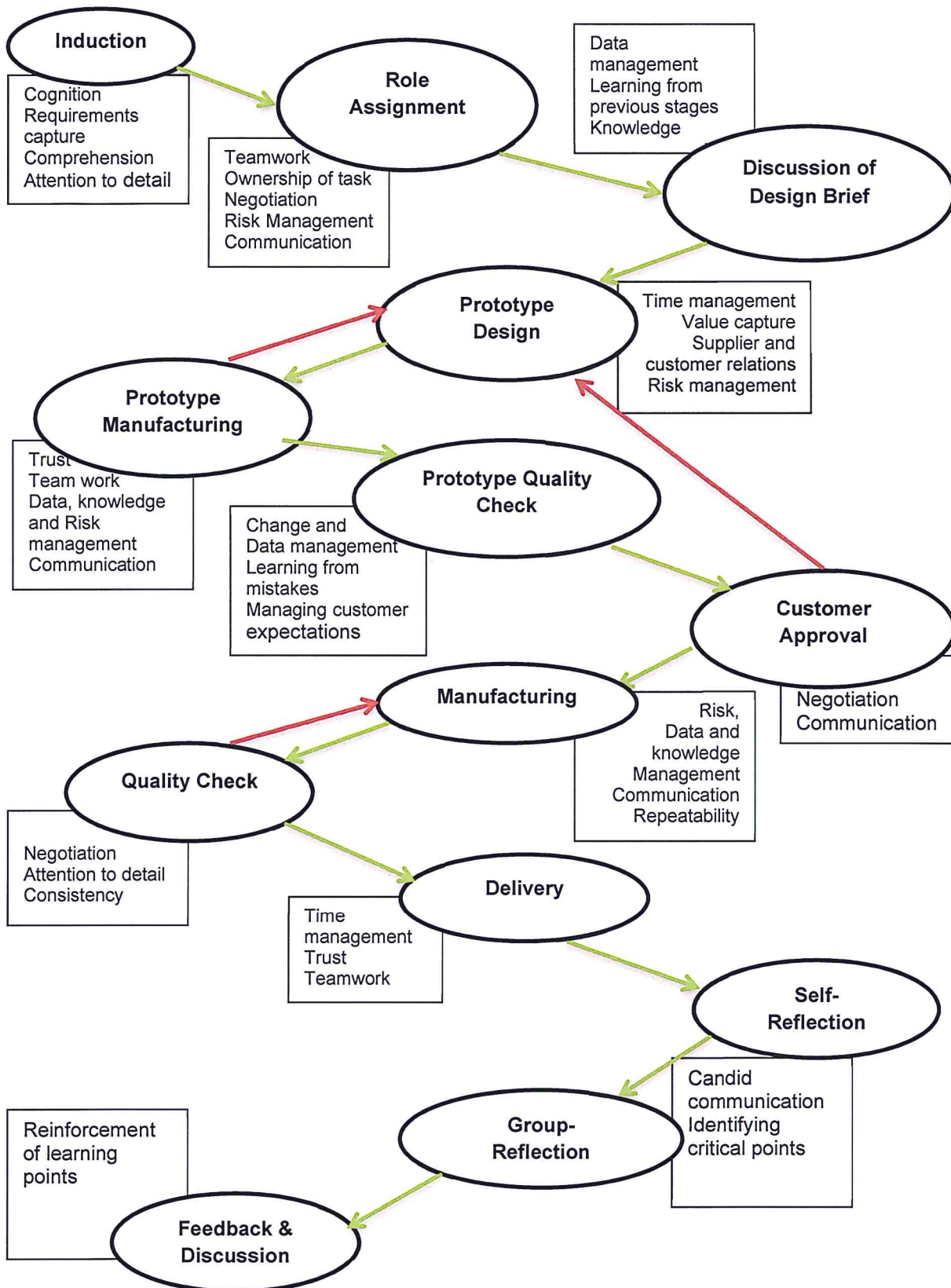SLT – Social learning theory

Appendix E

Appendix E

Figure 4.1 Map of Lean NPI game with learning points illustrated. Courtesy Hadjicosta et al

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Appendix F

Appendix G

APPENDIX A

New Product Development Questionnaire

The information that you contribute will be anonymous and you will not be identified.

I am a	Full-Time Student	Part-Time Student	Executive Programme Student
	☐	☐	☐

I study	EBM	PPM	CSM	e-BM	IAE	INT	MBE	MSE	PBM	SCLM
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

How many years of work experience do you have?

What is/are your background degree(s)?

List the top 5 areas that should be managed to ensure a successful introduction of a new product.

1.

2.

3.

4.

5.