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AN EVALUATION OF BUSINESS SIMULATION GAMES FOR THE MANAGEMENT MODULE OF THE M(ENG) AERONAUTICAL ENGINEERING DEGREE AT LOUGHBOROUGH UNIVERSITY

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ABSTRACT

There is a drive within engineering disciplines at Loughborough University to develop the employability skills of undergraduate students. The engCETL (Engineering Centre for Excellence in Teaching & Learning) has a broad remit to enhance links with industry and to underpin developments in learning and teaching with pedagogic research and technology development. The Centre does this through research and development projects that are proposed by academics within the engineering related departments and carried out in conjunction with specialists from the engCETL team.

Prof Rob Thring, Head of the Aeronautical and Automotive Engineering Department proposed a project to the engCETL. His requirement was for some form of business simulation software for the undergraduates to use as part of the Management module on the MEng programme. Currently the students come up with an idea for a new business, create a business plan for the venture and take part in a 'Dragons' Den' style presentation at the end of the project to representatives from the department and industry. However, the department would like to take this project a step further and provide the students with the opportunity to take part in a simulated business environment where they could explore the idea of setting up or running a business as close to the real world as possible. The intention would be to enliven and enrich the student's learning experience with skills development such as; enterprise, leadership, management, teamwork, fiscal sense, business judgement and inventiveness amongst others.

An interdisciplinary project team was formed to try and resolve the pedagogic, technical and business aspects that would need to be addressed in order to implement such software within the MEng programme. The approach taken has been to form a set of criteria based on certain curriculum requirements but keep the brief broad and carry out a scoping study of existing software (commercial and open source) and take account of the academic literature in this area.

After the initial scoping study, our findings indicate two commercial business simulations that have potential for use on the course. These were; 'Marketplace Simulation' (<http://www.marketplace-simulation.co.uk>) and SimVenture (<http://www.simventure.co.uk>). An in-depth evaluation was then carried out for the two simulations. This evaluation comprised two teams made up of academics, industrial representatives and engCETL staff. The software was thoroughly examined in terms of what each application could offer to the learning experience of the students, resources to support staff and the costs involved, for example, staff time in embedding the software into the curriculum.

This paper will highlight the approach taken, findings and recommendations from the evaluation of the two business simulations. The recommendations will be presented in the context of all engineering disciplines and will cover; appropriateness of the chosen software for the programme level, plans for embedding into the curriculum, potential learning outcomes and assessment methods. It will benefit all those interested in methods for evaluating potential simulation games for suitability within the curriculum and the development of enterprise and employability skills.

INTRODUCTION

The engCETL periodically calls for teaching and learning project proposals from academics within the 7 Engineering related departments. This project was proposed in April 2007 by Professor Rob Thring, Head of Department, Aeronautical & Automotive Engineering (AAE). The deliverable, required by the department as an output from the project, is some form of business simulation software for use in a management module in the Department but that also could potentially be transferable to other departments.

The Royal Aeronautical Society and the Institution of Mechanical Engineers (IMechE) accredits the Aeronautical and Automotive Engineering degrees and it is a requirement of them to teach Management skills. There are currently two Part C management modules, in which students produce a business plan and end the assessment with a 'Dragons' Den' scenario. There is a desire within the department to establish a Part D Management module, for the students to continue their business plan through an interface with a virtual corporation. This would encourage skills development in the areas of leadership, management, teamwork, fiscal sense, business judgement and inventiveness and would therefore help to validate the Professional Bodies' accreditation.

The engCETL project did not intend to develop a bespoke software simulation in-house but instead conduct a scoping study to investigate what business simulation software is available. The study looked at the wider literature in the area including examples of where simulation or business concepts have been taught within the curriculum at HE level within engineering disciplines. The investigation analysed the content in the context of the Aeronautical & Automotive Management module requirements. The initial scoping study then make recommendations for further in-depth evaluation for 2 potential applications.

The Project team incorporates expertise from a number of disciplines and industrial viewpoints. This approach was used to jointly investigate and advise on the broad areas that needed investigation, such as pedagogy, technology, employability skills and evaluation. The project team comprised; Professor Rob Thring - Head of Department, John Grover - Lecturer, Richard Newman - Industrial Liaison Officer, John Nendick and Julian McLean - Consultants Accenture (Management, Consulting & Integrated Markets), Melanie King - Learning Technologist and Nick Rawle - Project Officer.

SCOPING STUDY

From initial meetings, the following attributes were discussed in relation to potential simulation software.

The software:

- needs to be as detailed as possible and the student must be in control of the data entered.
- needs to provide detailed and up-to-date information but perhaps the students can go in and manipulate some of this data.
- could simulate sudden changes in the market and the students could be rewarded for reacting to these.
- needs a time dimension and random real-world interventions.
- needs to simulate several years of being in business during the Semester.
- needs to have random noise in the information across groups. For example, common trading models but not a pattern, so students would find it difficult to figure it out.
- would ideally need to cope with the diversity of the businesses that the student groups have. An alternative might be to run a simulation on a generic business in an enclosed environment, which would be more game based and competitive.

After an initial meeting and exploratory look at commercial and open source software available, a shortlist was compiled for further in-depth evaluation. For addition to the shortlist, the commercial and open source software available, were initially compared in terms of; price, staff demands, fixed/variable industry, learning outcomes, trading style, number of players, playing style and target student audience.

A search for open source options from 'Sourceforge.net' using the search terms 'business + simulation' and 'business + game' came up with eight results. Four of these projects had a >70% activity ranking and had recorded some downloads.

Name	Description	Activity	Latest File	Downloads
Pizza Business	Start up and control of a pizza restaurant.	95.19%	04-05-02	15,235
Free Train	A rail and business simulation inspired by the A-Train series.	98.69%	07-02-07	4,061
WiSim	Simulates the task scope and complex processes of a hub producing company.	93.30%	26-05-03	1,392
CadaWeb	A business game to teach students how the economy works.	71.08%	16-10-04	271

From a review of the literature, specific business simulation games to support Aeronautical and Automotive students were not apparent, however, successful examples of using business simulations in Higher Education, both in the UK and in the USA, were found. In a case study, from the Higher Education Academy (HEA) Business, Management and Accountancy subject centre, Peters and Brodie (n.d.) reported on the use of 'Marketplace' in a range of taught masters in the field of business, management and marketing at the University of East Anglia, UK.

Results from the piloting of Marketplace were positive and the authors stated that, "The teaching team for the UEA MSc programme has found the introduction of Marketplace Business Simulation of great importance in helping our students to gain a real 'feel' for managerial decision-making and teamwork". Ben-Zvi and Carton (2007) discussed their experiences of using 'Intopia' within the MBA at the Wesley J. Howe School of Technology Management, Hoboken, N.J. USA.

An Internet search using Google revealed many results but in particular 'SimVenture', predominantly aimed at the schools and colleges market, had been short listed for the BETT 2008 educational technology award in the 'Post-16 Education and Training' category (which they subsequently won in January 2008).

From the scoping study two commercial options were short-listed for further detailed evaluation and these were Marketplace Venture Strategy and SimVenture. It was felt that the open source options were not appropriate because they were too specialist or related to specific industries, not recent enough or were using a technology that IT staff at Loughborough had no expertise in. Intopia was also ruled out at this stage, although having many sophisticated and similar features to Marketplace, it required a trained facilitator to run the game.

METHODOLOGY OF EVALUATION

The group split into two teams to evaluate each application, with three individuals evaluating both applications. The intention was to use the simulation as a group of students taking notes on how we found using the software initially, detailing; time spent on tasks, logistics of using the software as a group (some of whom were based in different locations) and our general initial impressions. We would then complete a more formal evaluation by carrying out separate pedagogic, technical and usability evaluation, which would allow us to gain more quantitative data for each application as well as considering the logistics of implementing each application within IT infrastructure of the University.

To address a more formal pedagogic evaluation, we focussed on the employability skills for students that the software might have a positive impact upon. We used 18 of the skills from the skills portfolio list and descriptions taken from the book *The Art of Building Windmills – Career tactics for the 21st Century* written by Peter Hawkins. Peter Hawkins is the co-founder and adviser to the Graduate Into Employment Unit at the University of Liverpool. Graduate Prospects (www.prospects.ac.uk), the UK's official graduate careers website, also use the Windmills skills portfolio list to highlight the skills that employers want. For the purposes of the questionnaire the 18 distinct skills would be used to measure perceptions of how the students would develop each of these through using the business simulation software. The skills are grouped as *people skills* (teamworking, leadership, interpersonal skills, customer orientation, oral communication and foreign language), *self-reliance skills* (self-awareness/confidence, self-promotion skills, initiative and proactivity, networking skills, willing to learn and action planning) or *generalist skills* (problem-solving, IT/computer literacy, flexibility, numeracy skills, business acumen and commitment).

Respondents were asked, "if a team of students used the business simulation software, to what extent would you anticipate that the experience would have a positive impact on their employability skills?" Each individual skill was rated on a scale of 0 to 10. A score of 0 being, "having no impact" and a score of 10, "having a high impact".

The technical evaluation addressed the issues relating to actually purchasing, using, maintaining and supporting the software within the University network. This was carried out by the Learning Technologist and was broken down into statements on; maintainability, extendibility, robustness (reliability), compatibility and accessibility.

The usability evaluation was carried by all members of the group, which involved a series of 20 statements based on the 10 Heuristic principles from Jakob Nielsen (2005). These statements covered aspects of; visibility of system status, match between system and the real world, user control and freedom, consistency and standards, error prevention, recognition rather than recall, flexibility and efficiency of use, aesthetic and minimalist design, help users recognize, diagnose and recover from errors and help and documentation. The questionnaire used a Likert scale where respondents indicated an opinion on each statement for both Marketplace and SimVenture with one of the following; strongly disagree, disagree, no opinion, agree or strongly agree.

The usability questionnaire and employability questionnaire were sent via email to the six people that used Marketplace and the five that used SimVenture. Five people completed the questionnaires regarding Marketplace; John Grover, Julian McLean, Nick Rawle, Melanie Bates and Richard Newman. Three people completed the questionnaires regarding SimVenture; John Grover, Melanie King and Richard Newman. All questionnaires were completed independently.

RESULTS OF EVALUATION

The skills questionnaire provided us with some very useful quantitative data that could easily be compared between each application. Averages were made for each skill and generally all respondents were in close agreement on the rating against each skill. Exceptions to this were the scores for customer orientation and foreign language for Marketplace where scores ranged from 2 to 7 and 0 to 7 respectively. An explanation for this might be the confusion between the simulated customers and foreign markets in the game and of physical customer facing and foreign language skills.

For Marketplace and SimVenture, business acumen was the employability skill that the respondents felt would achieve the highest positive impact on the students. This perhaps would be expected as this is the purpose of the simulation. Marketplace scored very highly on teamworking skills closely followed by interpersonal, action planning and leadership skills. Initiative, pro-activity and action planning scored highly for SimVenture. SimVenture has a very low average for foreign language and both Marketplace and SimVenture have a low average for customer orientation. Figure 1 shows results for Marketplace and Figure 2 shows results for SimVenture.

Figure 1

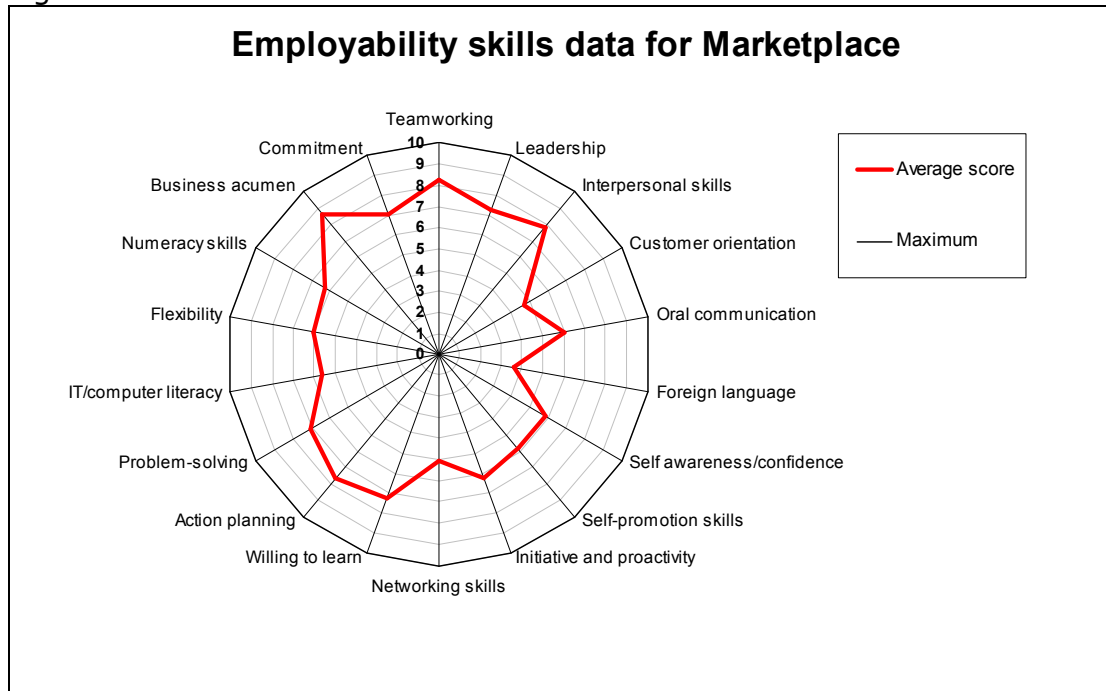
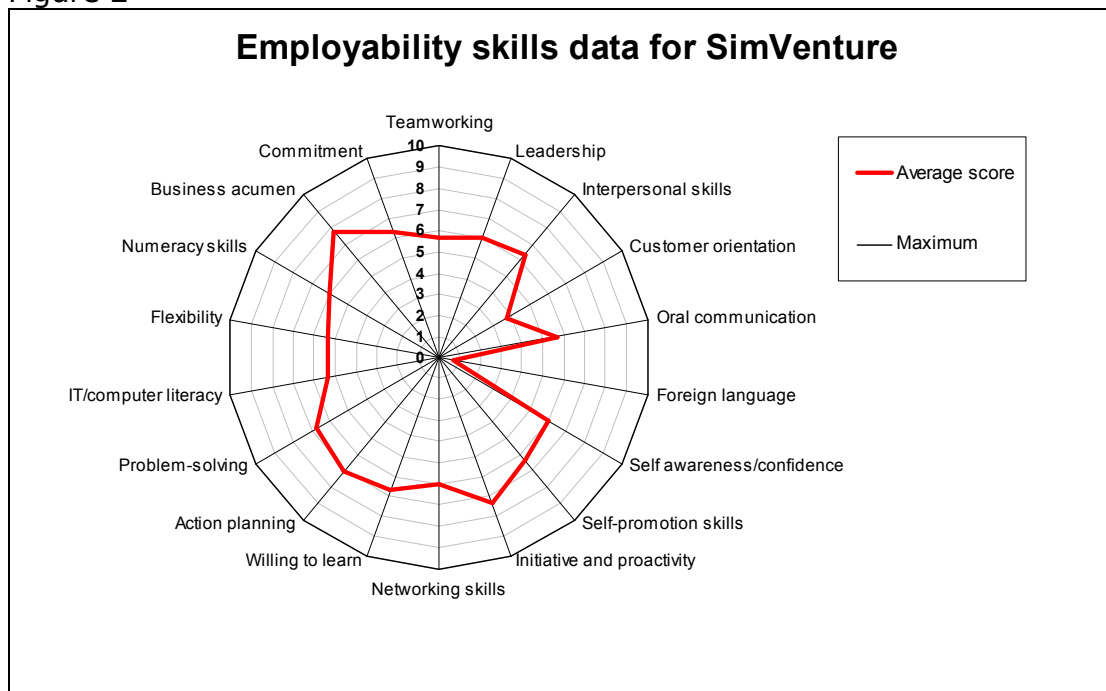


Figure 2



Adding the averages for each skill within the three categories of *people skills*, *self-reliance skills* and *generalist skills*, the two simulations can be rated as follows. Out of a maximum score in each category of 60, Marketplace scored slightly higher (40.4) for *generalist skills* compared to SimVenture (37.33). However, for *self-reliance skills*, SimVenture scored slightly higher (39.33) compared to Marketplace (37.6). The greatest difference in scoring was for *people skills* where respondents scored Marketplace (37.4) compared to SimVenture (28.01).

The higher scores for SimVenture for *self-reliance skills* might be expected because the simulation is aimed at those who would like to start-up and run a virtual company.

Overall, therefore, Marketplace scored the highest (115.4) compared to SimVenture (104.67) out of a possible maximum score (180) indicating that Marketplace would have the greatest positive impact on the employability skills of students, particularly for *generalist skills*, which includes business acumen.

The technical evaluation reported on comparisons for; maintainability (the ease at which upgrades, updates, maintenance of licenses, application of patches and associated costs), extendibility (the ease with which a software system can be modified to change or add capabilities, improve performance or correct defects), robustness or reliability (a system that does not easily break down, either recovers quickly from or holds up well under exceptional circumstances), compatibility (the way in which the system interacts with existing operating systems, software and hardware needed) and accessibility (the compliance to regulations of accessible software, for example, the Special Educational Needs and Disability Act 2001 (SENDA) requirements).

The additional resources needed to maintain SimVenture would be significantly higher because it is a desktop application that would need to be installed on individual PC's, use an internal networked license server and require that University staff update, upgrade and patch the installation. Marketplace is hosted remotely on the Internet and maintenance is the responsibility of the provider, Marketplace Simulation UK.

A costing for each simulation was obtained and compare as follows. Marketplace Venture Strategy would cost £20.50 per student playing against peer teams in the same simulation, the total cost for 80 students being £1640. This cost would be paid every academic year on a recurrent basis. SimVenture costs £120 per individual licence for a PC and up to 4 students could use the software on the PC as a team. The cost for 80 students is £2400 (20 groups with 4 students in each group). SimVenture apply a 15% discount on orders of 16 or more licences, with the discount only applying to the 16th order and above, so the total cost is £2310 (£90 discount on 5 licences). Maintenance, support and basic software upgrades for 12 months are included. After 12 months upgrades can be purchased for SimVenture. All costs exclude VAT and are for the 2007/08 academic year.

Extendibility was explored to see if any tailoring of the content of the simulation could take place. Each simulation is based on a fixed scenario and cannot be changed by the end-user. However, quotes were obtained from each company to create bespoke simulations and were prohibitively expensive for Marketplace but could perhaps be a possibility for SimVenture. Both Marketplace and SimVenture proved to be reliable and robust within our evaluation.

It was felt that Marketplace would be more compatible and accessible to a wider group of users because SimVenture requires a PC with a specific operating system, whilst Marketplace will run through most Internet browsers with JavaScript and cookies enabled.

Also, SimVenture requires a group of students to carry out the simulation on the same PC at the same time, in comparison to Marketplace where each student can log-in from different computers at different times.

The results of the usability questionnaire showed that respondents were in general agreement with one another for each statement. In general Marketplace had more positive results for statements on usability compared with SimVenture. There are 3 principles in which the two simulations significantly differed, these were; visibility of system status, user control and freedom, and error prevention.

All respondents agreed or strongly agreed that Marketplace, “..always kept me informed about what was going on and what stage I had reached in the game with status information, appropriate feedback and/or timely instructions”, whereas all respondents disagreed with this statement for SimVenture. All respondents disagreed that within Marketplace they, “..often needed to cancel or undo actions that were clicked by mistake”, whereas all of the SimVenture respondents agreed with this statement. All respondents agreed or strongly agreed that the Marketplace simulation, “..provided the opportunity to enter data and change it to ‘play’ with different outcomes before committing”, whereas those who used SimVenture disagreed or strongly disagreed with this statement.

RECOMMENDATIONS

Our recommendations are that Marketplace would be the most appropriate business simulation software that could be integrated into the Management module. We could also recommend this simulation to any other module within the University that had the same requirements, as the content is generic enough to suit most subjects. This recommendation comes from the evidence provided within the usability, employability, pedagogic and technical evaluations as well as statements from the respondents on general impressions of using the simulations.

General impressions of Marketplace, from the group as a whole, were mainly positive. It initiated a lot of good discussion and debate between us, it involved a wide range of important business subjects and it is structured and methodical in its delivery. The software would not allow you to wrap up any decision round without taking all the actions that are necessary in that quarter, or move on without saving your actions, which was very helpful considering how many decisions there were to make and, potentially, to forget to save. Pop-up wisdom screens explain the effect of some types of decision and action, putting the various possible actions and business considerations in context, which may prove particularly illuminating for the newcomer to business thinking. Once over our initial scepticism, we found the process of going through the business decisions to be fun, engaging and challenging to our preconceived ideas. We warmed very quickly to the software and what we at first considered weaknesses, in terms of plain forms and dense text, soon became real benefits as we searched for reasons why we should or should not take certain decisions. In fact, after only one decision round we found ourselves caring about the virtual business we started just over an hour and a half earlier.

Results from the usability study and technical investigation favoured Marketplace and it also scored the highest within the employability skills evaluation.

Marketplace would be more appropriate for incorporating into the curriculum with regards to flexibility of use for individual students and teams. A real benefit also, is the detailed log that is kept of each student's interaction with the simulation in relation to time spent, decisions made for example which will provide the tutor with a better overview of the progression through the simulation. Marketplace is also more appropriate for the programme level and required learning outcomes for the Management module as opposed to SimVenture, which we felt might be more suited to ad hoc individual use. It would be a useful trial however, for a small number of SimVenture licenses to be made available on PC's or laptops for interested students to practice setting up and running a virtual business.

The initial cost of Marketplace is significantly less than SimVenture and even though Marketplace will have the same yearly costs whilst SimVenture will not, we felt that this might be outweighed by the institutional cost of the installing, maintaining and upgrading SimVenture on a yearly basis.

General recommendations, for embedding Marketplace into the curriculum, were made by the group. Firstly, before the students use the business simulation, the lecturer would need to provide the students with information about the benefits of the simulation in terms of knowledge gained and the positive impact on employability skills. Assessment could be in the form of marking the initial business plan (as a group task), an individual reflective diary per student, based on their experience of using the business simulation and their overall performance as a team compared to their peers.

Overall, we recommend the methods we have used to be effective and efficient at capturing usability and employability skills data for each simulation and they enabled us to easily compare products. An inter-disciplinary group also provided a rich source of experiences and different perspectives with regards to teaching, technology and employability. We also recommend a further study to carry out the evaluation with the students to confirm our findings.

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