A Suite of System Dynamics T&L Simulations and Games Based Upon the Australian Qualifications Framework (AQF)

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ABSTRACT

The paper details the specification of a model that will underpin the development of system dynamics based teaching and learning simulations across five of the nine levels of the Australian Qualifications Framework (AQF). The model functions as a scaffold, building on previous levels of knowledge and simulation experience to guide students as they progress to higher levels of learning. It is anticipated this will enable students who reach AQF Level 9 to have developed a strong understanding of system dynamics and interactivity between model variables, as well as complex cause-and-effect decision-making and unintended consequences, culminating in their ability to define and specify their own variables so as to enhance models.

Keywords: Australian Qualifications Framework (AQF), Teaching and Learning (T&L) simulations and games, system dynamics (SD)

Introduction

Management games have a long history and an established place in business education (Douglas, 2008), particularly with the development of advanced simulation software packages and technology (Powersim, 2016) and with the almost-universal access of modern students to powerful, personal computer technology.

This paper details the results of early planning and research work aimed at extending the design, development, implementation and validation of an automated teaching and learning

(T&L) simulation game for use in an introductory Tourism and Hospitality (T&H) program at William Angliss Institute in Melbourne, Australia. The original game was designed to reinforce the T&L of sustainable tourism principles and its design and preliminary evaluation have been detailed by McGrath et al. (2015 and 2017). Results of early trials with the game have been encouraging and have motivated efforts to extend the use of such games and simulations beyond the sustainable tourism domain to other areas of T&H learning. We have employed the Australian Qualifications Framework (AQF) (AQF, 2013) to provide guidance for the ongoing design of future games and simulations. In this paper, we present a simulation and games design template prepared for this purpose. A feature of this template is that it is specified using the 'entity-relationship' conceptual modelling technique (Chen, 1976), commonly employed in Information Systems development work. A result of this is that our template can be readily implemented as a computer database.

In the following section, the background and motivation for our work are presented and this is followed by details of our research approach. Our AQF-based games design template is then specified and validation and results are then discussed. Concluding remarks are then presented.

Background and Motivation

Simulations in Business Education

Simulations, as a form of role-play, are designed to provide students with opportunities to participate in real-world decision-making without the associated risks[1] (Douglas et al. 2008). Simulations involve and engage students in ways that supplement lectures, resulting in active learning that is beneficial for building students' work-related capabilities (Toomey et al., 1998; Ampountolas, Shaw & James, 2108; Singh, Mangalaraj & Taneja 2010). Simulation games (SGs) have long been used as learning aids in business education; see, for example, Gosen and

[1] An obvious example is the crew and passenger safety risks in flight simulator pilot training. While we are dealing with nothing quite as safety-critical with our simulation games; poor decision-making could, for example, result in significant economic losses.

Washbush (2004). This learning tool has enjoyed a surge in popularity in recent years as it allows students to enhance employability through the application of critical thinking and decision-making skills (Benckendorff et al. 2015). In addition, these tools also offer a fun element, rather than the often used, and arguably abused, nature of other forms of assessment, including reports, presentations, quizzes, exams etc.

For T&H practitioners, this then, raises the issues of: i) previous SG development work and the availability of suitable software; ii) which approaches to model development and software platforms might be most suitable for specific T&H purposes; iii) strengths and weaknesses of particular approaches; and iv) costs, expertise and other software implementation and maintenance issues.

There is a surprisingly limited selection of off-the-shelf[2] business education simulation software available. The more popular games, such as *Markstrat* (Larréché, Gatignon, and Triolet 2010) and *The Business Policy Game* (Cotter and Fritzsche 2010), are designed predominately for experienced managers and final-year postgraduate business degree students. Such simulations are complex and often rely on an advanced level of knowledge and experience that makes them unsuitable for use in subjects designed for undergraduate students and vocational students at certificate and diploma levels.

While there is an array of simulations available for business education, many of them focus either on organization-based business management or specific business functions, such as marketing or event management (OLT 2017b). Within T&H, the aforementioned focus on management and specific business functions has translated into a number of simulations being developed for hospitality education, particularly concentrating on hotel, airline and restaurant management. Such simulators include 'Simr' (restaurant simulator), 'HOTS' and 'RevSim'

[2] An important issue instructors must take into account with off-the-shelf SGs is that users have little control over game context. With a custom-developed solution, the simulation may be based on one or more actual case studies, allowing a combined simulation/case analysis T&L approach (see e.g. Ferreira, 1992).

(hotel management simulators), and ‘AIRLINE Online’ (airline management simulator), and typically focus on revenue, pricing and inventory management. Similarly, the predominance of simulations for specific business functions manifests itself in T&H as function-specific simulations, such as the use of marketing or corporate social responsibility simulations as supplements to lectures (OLT 2017a). The lack of T&H-focused simulations at undergraduate and lower levels, particularly those that use system dynamics (SD), is a gap that our current research and development simulation work seeks to address.

Naturally, as with any Information Technology project, organisations and educators wishing to deploy SGs in their course offerings will (and should) attempt to minimise costs[3], other resource usage and implementation timeframes by utilising mature, commercially-available packaged software products. As argued in the foregoing however, there appears to be a dearth of readily-available T&H SGs and this applies particularly to those designed for introductory-level T&H students. Moreover, our objectives with this project go well beyond simply gaining the benefits of using simulations in a particular course setting to developing students’ systems thinking capabilities. All of these factors demand a customised development approach and, moreover, one that is based firmly upon a SD model specification, development and implementation paradigm.

Systems Thinking and System Dynamics (SD)

The use of systems thinking in organization science, made popular by Senge (1990), Brown & Duguid (1991), Argyris (1976) and others, allowed the development of the debated concept of the learning organisation (Easterby-Smith, Crossan & Nicolini, 2000). Briefly, though typically reported without much research evidence to justify the approach, systems thinking is used in

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[3] Zendejas et al. (2013) have argued that the cost of deploying simulations for educational purposes is very much an under-researched issue and, moreover, in the few studies that do address this aspect, many important cost elements (e.g. staff training, the preparation of tutorial and instructional material and ongoing maintenance) are ignored. While their study is focused on simulations in medical training (where IT equipment costs can be very large), the same is probably true for business education SGs and this would appear to be a fruitful and important area for further research.

organizational development to understand, model, shape and influence how individuals, groups and organisations, along with their embedded systems as a whole, interact and learn, evolve and change. An aligned approach with the same goal of understanding the interacting parts of a complex system and incorporating systems dynamics has been applied in teaching and learning (Arndt, 2006) especially in public health programs (Brown, Reeders, Cogle et al, 2018) and education in the biological sciences (Verhoeff, Knipples, Gilissen et al, 2018). Learning is not conceived as linear in this approach; rather it is dynamic, complex, discursive, protean and interactive.

Brown et al. (2018) used systems thinking to conceptualise and understand a peer-led education program for HIV treatment within the Australian community and policy environment in which it operated. The researchers' aim was to surface the role of peer leadership to influence the adoption, dissemination, resistance and disruption of the program implementation. Similarly, in a biological education example at Utrecht University, Verhoeff and colleagues (2018) used systems thinking as a rationale to develop a coherent understanding of the complexities of biological phenomena from the molecular level up to ecosystems. While noting the fuzziness of systems thinking, the authors argued that developing the students' ability to think at abstract levels and make connections among dynamic parts was a key learning strategy to help them explain and predict natural phenomena in biology education.

Drawing on the forgoing, we contend that there are significant learning and personal development benefits to be gained by students of tourism and hospitality through the acquisition of systems thinking knowledge and skills. The T&H sector requires students to understand the complex interactions among actors and organizational functions and processes so they can develop the capacity to manage fluid and competing demands, make decisions and lead innovation in this dynamic context. These capabilities transcend the objectives of any particular subject or course to the much broader domain of critical thinking beyond the formal education curriculum (Maani & Cavana, 2000). We believe that the earlier students are exposed to these concepts, the better. However, such changes in thinking orientation demands that students are ideally exposed to SD concepts[4] progressively, in an integrated manner, and at increasing levels of complexity as they move through successive levels of T&H education. Moreover, such activities need to be constructively aligned, linking explicitly to course learning outcomes, teaching and learning activities, assessments and rubrics (Biggs &Tang, 2007). To facilitate this objective, we employ the AQF as a broad guide.

The Australian Qualifications Framework (AQF)

The AQF was first introduced in 1995 to underpin the national system of qualifications in Australia, encompassing higher education, vocational education and training (VET), and schools (AQF, 2013). It has multiple objectives, some of which include: supporting nationally consistent qualification outcomes in order to engender confidence in those qualifications; establishing pathways that enable access between the different education sectors and between those sectors and the labour market; supporting lifelong learning and recognition of prior learning; and enabling mobility through alignment with international qualifications (AQF 2015:8). The AQF is broadly consistent with similar international frameworks (Deij, Pevec Grm & Singh, 2013).

The AQF is structured around taxonomic descriptions of learning outcomes for each level and its aligned qualifications. Spanning Level 1 (Certificate I – knowledge and skills for initial work, community involvement and/or further learning) to Level 10 (Doctoral Degree), each level outlines the relative complexity and depth of achievement that graduates are expected to know, understand and apply to undertake tasks, and the degree of autonomy with which they are expected to demonstrate their knowledge by way of these tasks. This is articulated in the three dimensions of knowledge, skills and application of knowledge and skills.

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[4] Systems thinking may be thought of as a problem analysis approach for developing an holistic view and understanding of a complex problem domain and may involve the use of a number of modelling tools: e.g. soft systems methodologies, scenario planning and causal loop diagrams (Maani & Cavana, op. cit.). Systems dynamics is one such modelling and analysis approach, with its modern roots generally considered to date back to Forrester (1961) and operationalised through the use of visual modelling and simulation tools such as *Powersim* (2016).

The level one to ten criteria are expressed in broad terms to allow for a range of disciplinary qualifications at the same level, while the qualification descriptors are more specific to protect the consistency and integrity of the qualification level and type regardless of discipline (AQF, 2013:11).

At the time of writing, the AQF is undergoing its second review since its inception in 2005, 2013 being the most recent. A number of factors have prompted the current review, including changes in the nature of work brought about by influences such as technology, demographic changes and globalisation, which have affected the skills that graduates will need. It is proposed that this will require the AQF to incorporate greater flexibility to meet individual learning needs (Department of Education and Training, 2018a). It is likely that the taxonomies and levels may change because the contextual research for the review found that the level descriptors lack clarity and differentiation. The inclusion of both level criteria and qualification descriptors is seen as particularly problematic in that they sometimes repeat or contradict one another (Department of Education and Training, 2018b). Any changes will need to be incorporated into future iterations of the simulation games.

Nonetheless, as the AQF currently stands, according to Whitelaw et al. (2015: 6), levels relate to each other as follows:

- The body of *knowledge* increases from elementary to advanced, contemporary and integrated;
- *Task* difficulty increases from straightforward to routine and complex;
- *Context* increases from unambiguous to ambiguous; and
- The degree of *autonomy* increases from close to minimal supervision.

Later in the paper, simulation games aimed at Diploma to Bachelor Degree levels (AQF 5-7) are outlined, with the AQF Levels 5,7 and 9 descriptors of graduate knowledge, skills and application of knowledge and skills included. The relationship between the levels and the development of systems thinking is also explored.

Research Approach

Underpinning the simulation is the design science (DS) research methodology (Hevner, March, Park & Ram, 2004). With a DS research study, the major objective is not the building or confirmation/denial of theory per se, but the design, construction, implementation and evaluation of a research artefact (Goes, 2014). Such artefacts are comprised of constructs, methods, models and instantiations (March & Smith, 1995) and, as argued by Gregor and Hevner (2013: 345), a DS research project's contribution should be assessed in terms of problem maturity and solution maturity, with improvement involving the development of " ---- new solutions for known problems".

Hevner (2007) extends his and his colleagues' earlier work in explicating that the DS research process consists of the following three iterative, interlinked phases: the *relevance*, *design* and *rigor* cycles, as illustrated in Figure 1. A key step in this process is *evaluation* and, as noted by Benckendorff et al. (2015), it is common with business T&L simulations to undertake this through monitoring key variables, including attitudes, self-efficacy and cognition, individual engagement, team dynamics/interaction, behavioural learning, subjective outcomes and objective outcomes (see also: Lohmann et al., 2019). Thus, both subjective and objective measures must be captured and we employ a problem-based scenario as one significant objective measure of the extent to which students have developed a better understanding of key concepts and processes. Results of our evaluation work to-date are summarised in the penultimate section of this paper.

Insert Figure 1 about here.

Details of our actual research design are presented in Table 1, with the second column displaying the actual research steps followed and the third column showing the links to the design science-based research cycles of Hevner (op. cit.). Thus, the design and development of our sustainable tourism SG was informed by the initial relevance cycle and is a product of the first design cycle. Classroom trials[5] and feedback sessions then followed and these led to further cycle iterations, involving: i) enhancements to the initial sustainable tourism version; and ii) development of hospitality and events versions[6]. As is typically the case with DS research projects, no specific project end-date has been specified: rather, further iterations of the relevance, design and rigor cycles will continue indefinitely, in much the same way as Deming's (1986) 'plan-do-check-act' quality management framework cycles. The AQF was established on these principles and we now detail our specific instantiation of this framework, which we have employed to guide ongoing design, development and evaluation of our SGs.

Insert Table 1 about here.

An AQF Framework for SD Simulations

While our intention is to encompass most of the 10 levels of the AQF, our initial work focuses on Levels 5-7, which typically represents the three years of an undergraduate degree. Thus, for Level 5 subjects and courses, we have designed a simple SD model, involving three variables only *(meal cost, demand* and *takings).* This model has been implemented as a game for use in diploma-level hospitality courses and subjects at AQF Level 5. The control panel for this game is presented in Figure 2.

Insert Figure 2 about here.

At face value, the student's task is very simple, involving only the manipulation of restaurant customer prices to maximise revenue. However, market response delays are built into the system, so that novice players are tempted to respond far too rapidly (and often too extremely) to short-term fluctuations in minor upturns or downturns in weekly takings. The result is potentially wild fluctuations in system behaviour. Thus, our seemingly-simple game provides a sound and very relevant example of the 'bullwhip effect' often observed in more-advanced

[5] Numbers of students involved in each of these, together with details of our feedback and validation instruments are detailed along with our results in the penultimate section.
[6] Development of these is continuing, with initial trials planned for late-2019.

supply chain management (SCM) games; notably the 'beer game[7]' (D'Atri et al., 2009).

At Level 7, systems become somewhat more complex. Again, focusing on the hospitality stream, we have designed and implemented a restaurant-based SCM game. However, this time students have to focus on supply as well as customer demand. The *Powersim* stock-flow model[8] for our game is presented in Figure 3.

Insert Figure 3 about here.

Students play the role of a restaurant owner-chef. Each week, an average of 100 customers order a specialty dish, which is popular with regulars. The central ingredient is dry-aged mutton (sheep meat over two years old), which must be dried six weeks in advance, ensuring players must pre-plan the amount to order (i.e., players cannot accept orders at the last minute and there is only a 2-week window to use the meat). The restaurant sources its supplies direct from the grower with a once-per-week delivery. Top-ups during the week are not possible and because the mutton spoils within two weeks, any supplies left at the end of the weekly delivery cycle must be written off (given to staff to take home or thrown out). Order amounts each week are based solely on the historical average, with no account taken of seasonal factors or other extraneous factors (e.g., holiday periods, poor weather conditions, significant events in the media etc.).

Major learning objectives here are to reinforce earlier lessons on the significance of delays in SCM, to introduce students to the important concept of unintended consequences in complex systems and to have them experience some of the realities of balancing supply,

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[7] In this classic SD game, players assume the role of parties at different points of a beer supply chain (manufacturer, wholesaler, distributor and retailer), with a tutor generally playing the part of the end-consumers. Players aim to minimise holdings while ensuring they have enough stock-on-hand to satisfy demand. Sometime into the game (e.g. around 10 weeks), consumers double their orders and chaos generally ensues as players respond to short-term fluctuations.

[8] Generally in SD work, models are specified initially in simple CLD form but need to be converted to stock-flow form to obtain a working simulation. The basic constructs of these models are stocks, which have a level associated with them (e.g. *Total Servings),* and flows, which replenish or diminish stock levels (e.g. *Weekly Servings).*

demand and overall revenue management in a realistic setting. Thus, compared to our Level 5 game, students here must come to grips with a wider range of variables and look beyond the more obvious consequences of their management decision-making. Extending our model further, at AQF 9, we expect masters level students to design and develop their own simulation that incorporates SD elements which clearly demonstrate advanced knowledge and emergent creativity and innovation in system design.

Table 2 displays our interpretation of key differences (with major variations highlighted) in learning outcomes between AQF Levels 5, 7 and 9 (AQF, 2013: 13).

Insert Table 2 about here.

In general, higher AQF levels subsume the learning objectives of lower levels and introduce additional requirements. Thus knowledge to be acquired at Level 7 needs to be broader than with Level 5 but also has to be to at least the same level of depth and, while associated skills at both these levels demand the ability to cope with some complexity, Level 7 students must be able to deal with unpredictability and also to evaluate information quality (rather than just accept what is provided). Also, in terms of the application of knowledge and skills, while the ability to undertake learning tasks without close supervision is necessary at both levels, Level 7 students are expected to be capable of self-directed work and learning.

Vennix (1996) defines ‘messy’ problems as being characterized by complexity, uncertainty, inter-connected sub-problems, recursive dependencies and multiple interpretations of the nature of the problem (and objectives). While there are no hard and fast rules for classifying problems at one AQF level or another, ‘complexity’ and ‘uncertainty’ both increase at the higher AQF levels. For example, our price-demand SG includes very few variables and has been designed for AQF level 5 (Diploma level – first year UG), while the SG model illustrated in Figure 4 includes additional (inventory management) variables and has been designed for AQF Level 7 (Bachelors degree level). Thus, at Level 7, our students are expected to be able to cope to some extent with the ‘inter-connected sub-problems’ facet of messy problems.

In addition, messy problems involve ‘recursive dependencies’ and these are intrinsic to the systems thinking/SD decision-making model we employ as the foundation of our suite of SGs. However, messy problems also often feature in situations where key stakeholders can have ‘multiple interpretations of the nature of the problem and objectives’ and this type of problem solving becomes important at AQF Level 9 (Masters by coursework level), where tasks become somewhat ambiguous and students are required to critically reflect upon (all of) the task objectives, the solution tools (established theories) and the quality of available information and data.

Eventually, the project team plans to develop and implement a comprehensive array of SD simulation games, covering all courses, levels and disciplines offered by William Angliss Institute. To allow students to move between different course offerings reasonably seamlessly, it would, consequently, seem essential that these simulations are developed in a structured and integrated manner. As such, the need for a template employed to guide design and development of our SD products was deemed crucial. As a first step, a model of the course domain, within the AQF, was designed using the Entity-Relationship (E-R) approach (Chen, 1976), a methodology commonly used in Information Systems conceptual and database modelling and an approach we have previously found useful in this particular research project (McGrath et al., 2018). Our E-R model is illustrated in Figure 4.

Insert Figure 4 about here.

In our E-R modelling, we employ the REA (resources-events-agents) abstracted approach first proposed by McCarthy (1982). A *simulation* is developed for one or more *offerings,* each of which may be related to a number of other offerings (e.g., *subjects* are part of *courses* and courses, in turn, are part of *discipline* majors – such as *hospitality, tourism* and *events).* Each simulation is developed for one specific *setting* and features a number of key *variables* which, almost invariably, may feature in a number of other disciplinary and subsequent settings. Offerings have a number of *goals* (e.g., subject learning objectives) and a particular goal may be part of many offerings. Goals themselves may be related to each other (often in subtype hierarchies) and each goal has a specific *goal type;* including *simulation goals* and *AQF Level goals,* and these relate back to simulations and AQF Levels through *simulation-offering-goal involvements (sogis)* and *AQF Level-goal involvements (AQFLgis). Parties* (e.g., *students, lecturers* and *developers)* are related to offerings through *party-offering involvements (pois)* and these, in turn, may be related to *simulation-offering involvements (sois)* through (simulation) *trials* (i.e., typically, a simulation is trialled once per semester but this may be more if appropriate to the simulation setting and subject learning goals or if desired by the subject lecturer and students). Finally, *pois* are related to (student) *capabilities* through (simulation trial) *completions* and capabilities relate back to AQF Level goals in m:n relationships.

This may sound reasonably complicated but this E-R model actually represents a simple database schema[9] that may be conveniently implemented in *MS Access*^{TM}, for example, and then easily manipulated (using a standard databases query language), in order to derive whatever database 'views' are required. An example is presented in Table 3, which presents learning outcomes (goals) of the two exemplar simulations discussed earlier in this section[10]. To conclude this section, we should note that the simulation adapted for use at Level 9 will encourage students to explore the impacts of variables on each other and discover variables that may contribute to the body of knowledge.

Insert Table 3 about here.

While still at an early stage, our database is a tool intended to be employed to provide some structure and rigor in the development and enhancement of our suite of T&L SGs. We have

[9] In fact, the model as shown here needs refinement before it can be directly converted to a 'third normal form' (3NF) database schema (Martin, 1982); specifically, each m:n connection must be translated to two 1:n relationships, utilizing 'intersecting entities', such as the *pois* of Figure 4.

[10] This view excludes much of the detail included in the current database implementation of our template: specifically, it only deals with the AQF learning outcomes section of the model presented in Figure 5 and the usual relational manipulation operators (projection, join, subset, selection etc.) (McFayden, 2014) were employed to construct an illustrative database snapshot relevant to this discussion.

only begun to explore the possibilities of its use but it could be used, for example, to identify areas of an institution's course and subject offerings lacking adequate SG support. Additionally, we have begun to populate the database with details of the rapidly expanding suite of T&L SGs developed elsewhere. This, we believe may prove to be a useful resource for other T&H educators in Australia, New Zealand and elsewhere.

Results and Validation

Sustainable Tourism SG Trials

Consistent with the research approach outlined in Section 2, assessment and validation of our individual simulations and our framework is ongoing and iterative. Essential to this are post-trial evaluations of student learning and participant feedback on game experiences and suggestions for refinements and enhancements to simulations. Some preliminary results were detailed by McGrath et al. (2017) and, since then, further classroom trials of our original sustainable tourism simulation (aimed at AQF Level 5 students) have taken place and additional assessment material obtained and analysed. In the following three sub-sections we present and compare results of three separate trials of this SG, conducted in 2017, 2018 and 2019. We also present additional feedback results for these game editions.

Game Performance

The sustainable tourism destination version of the simulation was first played in August 2016 with first year students at the beginning stages of their Bachelor Degree enrolled in an AQF Level 5 subject that introduced foundation destination development concepts. Teams of approximately four-to-five students imagined they were managers of a Destination Management Organisation (DMO) for Ballarat, a real regional tourism destination in Victoria, Australia. Students were asked to make decisions regarding three variables: (1) green economy (GE) investment, (2) tourism development (TD) investment, and (3) rezoning of rural lands. They were given four five-year segments (for a total timeline of 20 years) and deliberated upon their investment decisions with team members over intervals between segments (usually around ten minutes) and then input their decisions (e.g. to increase DMO expenditure on GE and TD while not releasing any land from agricultural use to tourism development).

In the 2016 trial a total of 52 students participated, divided into 12 DMO teams, across four tutorials as a classroom activity. In 2017 a curriculum restructuring occurred, resulting in the original ‘Destination and Attractions’ unit being replaced with a ‘Destination Concepts’ unit. This, along with other course changes, resulted in a drop in student numbers participating in trials. Thus, when trials recommenced in 2018, only five students participated, broken up into three DMO groups. In 2019, 10 students took part, again broken up into three DMO groups.

Insert Figure 5 about here.

Game performance can be measured in a number of ways (Ferreira, 1997; Douglas et al., 2008), including trends in annual visitor numbers (AVN), annual visitor revenue (AVR), tourism development (TD), tourism development quality (TDQ) and destination attractiveness (DA). Because of inbuilt game delays and stochastic factors, trends in each of these variables do not correspond exactly but they are closely correlated. Consequently, we employ AVR as the principal measure of performance and, in Figure 5, the performance of the 12 DMO groups from the 2016 trial is compared with that of the six 2018 and 2019 groups.

The numbers of participating groups are too small to make any definitive statistical assertions but 10 of the 12 2016 groups improved their revenue performance by game’s end, at an average increase of 48.2M. In contrast, only two of the six 2018 and 2019 groups managed an improvement and the average loss with these two cohorts was -9.6M.

There is no reason to believe that any of the cohorts participating in our trials were any less clever, less experienced or less well-trained than others and they did all undertake the SG classroom exercise at around the same stage of their degree courses. Moreover, the course restructure that took place in 2017 (discussed earlier) meant that the 2018 and 2019 groups were undertaking a unit with a greater focus on destination sustainability than the 2016 teams. The only intervention that can be identified is that students in 2016 were given a one-hour lecture from an external guest, during which they were introduced to systems thinking/dynamics concepts and, in particular, application of SD in T&H. This extra background may have afforded them some SG advantage compared to their 2018 and 2019 classmates.

Post-Test

Students were asked three questions. First, they were required to draw a causal-loop-diagram[11] (CLD) for a simple sustainable tourism scenario involving four variables (increased *destination development* leads to more *environmental damage* etc.). They were then required to extend this diagram to include additional variables related to social factors (e.g. an increase in *destination development* leads to more *T&H employment).* Finally, they were asked what would be likely to happen in the game were you to invest all available funds in destination development and none on GE spending. All questions were assessed using a 5-point scale, ranging from completely correct to absolutely wrong (including no attempt), corresponding to awarded marks of 10, 7, 5, 3 and 0 respectively. Results, comparing 2016 tutorial clusters with those from 2018 and 2019 are presented in Table 4.

Insert Table 4 about here.

Q1 was answered reasonably well, indicating that most students had developed a reasonable understanding of CLDs and their specification. Q2 (the more demanding CLD) was answered less well, but the 2016 groups performed better than those of 2018 and 2019. Overall though, the results suggest that learning might be enhanced by some out-of-class exercises and assignments. This is consistent with the experience of Michaelsen, Knight & Bauman (2004), who have argued particularly for learning reinforcement ~~through learning reinforcement~~ in small teams. It would also be interesting to see how game performance itself might improve

[11] CLDs are a basic SD modelling tool and a knowledge of these is essential to the development of systems thinking skills (Senge, 1990).

through an intervention of this sort.

Finally, caution must be exercised in inferring too much from these sets of post-test results. In particular, students were not assessed directly on either their game performance or post-test performance, with one result of this being that, among the 67 students, no attempt at an answer was made in 21.7% of possible question answer attempts. This suggests perhaps, that a more direct assessment strategy might lead to greater engagement. However, caution needs to be exercised here, as Mislevy, Steinberg & Almond, (2003) are among many to have argued that this may be problematic sometimes. One strategy being actively considered for future coursework trials of the game is to have students produce a report based upon their SG learning and allocate a portion of unit marks to this assignment (Edelheim & Ueda, 2007).

Game Experience Feedback

At the conclusion of their class, students completed a short survey to reflect on their game-play experience. The results of this survey suggested that most students not only noted an improvement of understanding, but also outlined the ways in which their understanding was improved (e.g., recognition of cause-and-effect, reinforcement of key concepts taught in the subject, appreciation of the complexity of the tourism system and the variety of factors involved in decision-making). In addition to other suggestions for improvement, the results from this trial found that some students, particularly those who did not feel confident with the course content and key concepts in tourism systems, would have benefitted from further explanation regarding the simulation outputs (i.e. graphs and numbers) to help with the interpretation of the consequences of their decision making. This might suggest that this particular version of the simulation game, which involved three separate variables and hence several layers of numerical output, was overly complex and perhaps overwhelming for some of these students. Additional findings include:

- With the objective being to maximize tourism destination revenue, the objective performance of most students has been satisfactory to good with, overall, more than 50% of teams improving their revenue performance by game’s end;

- Most students also displayed an awareness of the need to secure long-term destination viability through adequate ‘Green Economy’ (GE) investment;
- Initial trials revealed the need for some fine-tuning of the simulation, with some players appearing to have been penalised unnecessarily heavily for adopting investment strategies not all that different from successful players[12]; and
- Players made a number of very useful enhancement suggestions. Perhaps the most significant of these was that game investment decisions need to be made more realistic and, ideally, based upon actual tourism destination experiences.[13]

Thus, results to-date (with our initial AQF Level 5 simulation trials at least) have been encouraging. A particularly pleasing result is that the game (together with the associated tutorial experience) appeared to indicate that students had developed quite a reasonable understanding of some fundamental systems thinking skills. One can see no reason why these skills cannot be applied in other learning contexts and this would appear to go some way towards addressing a recognised problem with simulation games; namely that games-based learning may not always be very generalisable (Lainema, Najmul Islam & Lainema, 2018). It is our intention to test the extent to which this applies in our ongoing evaluation work.

Conclusion

In this paper we have argued that capabilities in systems thinking are beneficial for students planning to enter the T&H sector to equip them both to make sense of, and to make sound business decisions within, complex and dynamic environments. This paper details the progressive development of a T&L simulation that is designed to scaffold the advancement of these capabilities, mapped according to the incremental approach of the AQF levels. This initial mapping highlights the settings, variables and learning outcomes that will enable this

[12] At the same time, the simulation is stochastic and, as such, as in real life, outcomes may not always appear to be ‘fair’. Thus, instructors have the opportunity to emphasize that, with destination management, nothing is ever certain (Richie and Crouch, 2003). See also comments on direct assessment strategies in the previous sub-section.

[13] This enhancement is currently being implemented and is scheduled to be trialed initially in April 2019.

simulation to be used as a T&L tool from AQF Levels 1 to 9 at WAI, with a specific focus in this paper on AQF Levels 5 to 7. Our initial work appears to validate our belief that the development of such a versatile simulation for T&L will enhance students' ability to understand and apply SD thinking to their decisions relating to T&H studies and beyond.

The preliminary findings from the trials conducted in 2016 and 2018 point to a number of ways forward. Firstly, refinements to the existing games may be required to ensure realistic contexts for decision making and appropriately balanced consequential outcomes. Secondly, textual explanations may need to be developed to assist students to make sense of the numerical data. Thirdly, additional simulations need to be developed for other decision contexts of relevance to T&H, as well as for other AQF levels. Finally, the application of the systems thinking skills that students have developed through the simulation are yet to be tested in other contexts.

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Figures and Tables

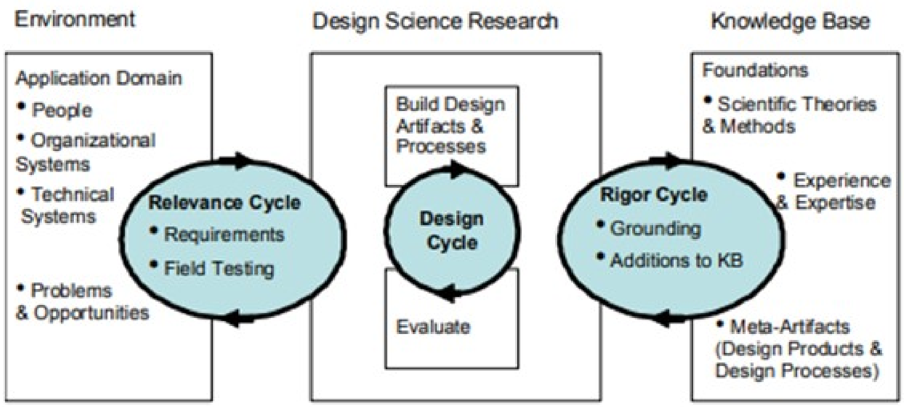

Figure 1. Design Science research cycles (reproduced from Hevner 2007: 16).

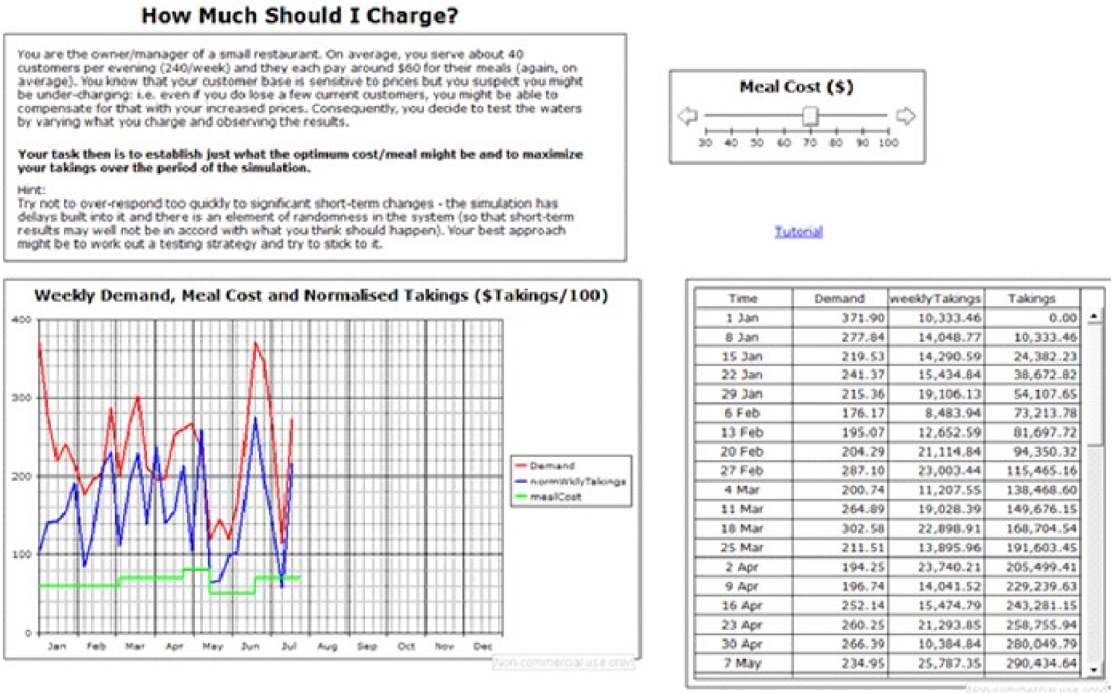

Figure 2. Level 5 simulation game – control panel.

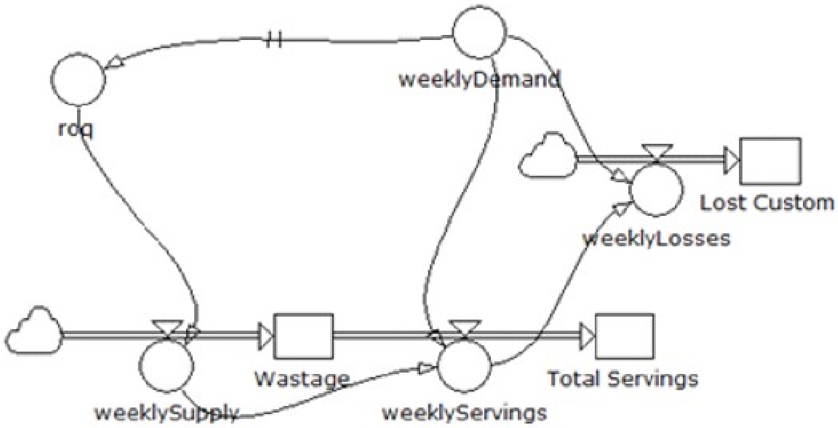

Figure 3. AQF level 7 stock-flow model (core model only).

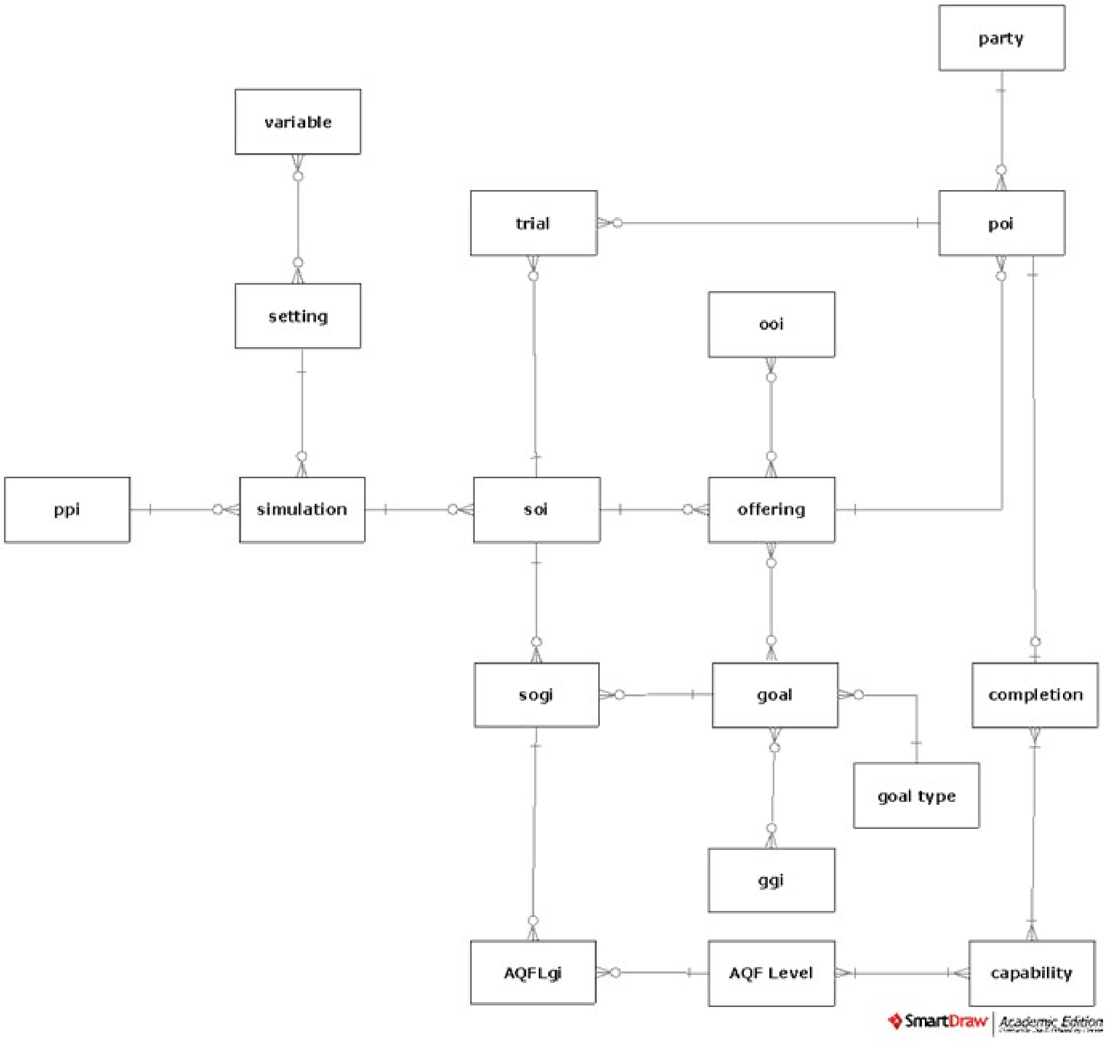

Figure 4. Simulation design E-R model (database schema).

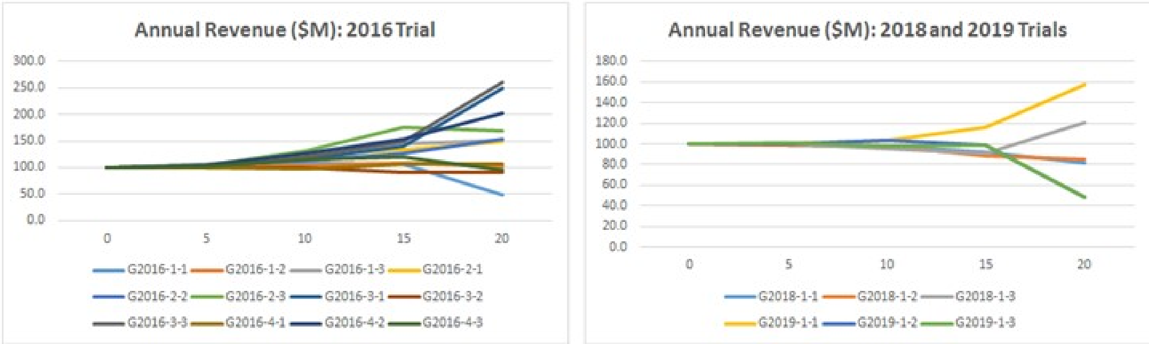

Figure 5. SG trials Annual Revenue performance – 2016 versus 2018 and 2019.

Table 1. Research phases and links to DS research cycles.

Phase	Activity	DS Research Cycle(s)	Dates
1	Design and development of initial (sustainable tourism) SG version (1)	Relevance, design	2015-16
2	Trials, feedback and evaluation	Rigor, relevance	2016-19
3	Enhancements of Version 1 (to Version 1a)	Design	2016-19
4	Further trials, feedback and evaluation	Rigor, relevance	2018-19
5	Design and development of hospitality and events versions (2, 3 and 4) and design of the AQF SG planning framework	Relevance, design	2018-
6	Further trials and feedback sessions	Rigor, relevance	2019-
7	Further iterations	Relevance, design, rigor	Ongoing

Table 2. AQF learning outcomes – Levels 5, 7 and 9.

	Level 5	Level 7	Level 9
Knowledge	Knowledge in a specific area or a broad field of work or learning	***Broad and coherent*** knowledge in one or more disciplines or fields of practice	Advanced, integrated and complex knowledge.
Skills	Analyse information to complete a range of activities Provide and transmit solutions to sometimes complex problems Transmit information and skills to others	Analyse and ***evaluate*** information to complete a range of activities Analyse, ***generate*** and transmit solutions to ***unpredictable*** and sometimes complex problems Transmit ***knowledge,*** skills and ***ideas*** to others	Analyse critically, reflect and synthesise complex information ***Research*** and apply established theories ***Interpret*** and transmit skills and ideas to both specialists and non-specialists
Application of knowledge and skills	Apply knowledge and skills in known or changing contexts Within broad but ***established*** parameters	Apply knowledge and skills in contexts that require ***self-directed*** work and learning Within broad parameters	Apply knowledge and skills to demonstrate autonomy, expert judgement, adaptability and responsibility
System Dynamic Modelling Activity	Simple price and demand variables to model consumer price sensitivity	Simple price and demand variables to model consumer price sensitivity complicated by supply side decisions.	Design and build a system dynamic model to represent the key variables to be managed in a restaurant.

Table 3. Partial implemented template view.

JHTE2019 : Database (Access 2000 file format)

SGId	Discipline	AQF Level	AQF Goal Description
SG4	Hospitality	L5	Moderate complexity
SG4	Hospitality	L5	Known context
SG4	Hospitality	L5	Information analysis
SG4	Hospitality	L5	Established parameters
SG4	Hospitality	L5	Autonomy
SG5	Hospitality	L7	Moderate-high complexity
SG5	Hospitality	L7	Unpredictable context
SG5	Hospitality	L7	Evaluate information quality
SG5	Hospitality	L7	Low-moderate ambiguity
SG5	Hospitality	L7	Self-directed work

Table 4. Post-test results – 2016, 2018 and 2019.

Group	Q1	Q2	Q3
T2016-1	7.5	2.3	4.6
T2016-2	6.0	6.0	4.3
T2016-3	7.3	5.0	2.7
T2016-4	8.2	5.1	5.1
Avge - 2016	7.3	4.6	4.2
T2018	6.1	2.7	3.3
T2019	6.5	5.3	2.1
Avge - 2018/19	6.3	4.0	2.7