Opportunities for Gamified Learning in Purchasing and Supply Management Education

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Abstract

Gamification has been used in a wide variety of subject-specific education contexts. Examples of such usage in the Supply Chain Management (SCM) context include the oft-played beer distribution game, developed by MIT Sloan School of Management (Forrester, 1961), which simulates the coordination of typical problems in supply chain processes, promoting information sharing and collaboration throughout a supply chain (Sterman, 1984). Purchasing and Supply Management (PSM), a subset of this wider SCM area, focuses on the direct relationships between organisational buyers and suppliers, covering aspects such as establishing trust, identifying and selecting suitable suppliers, managing supplier performance and the overall relationship. A systematic review of the PSM gamified learning literature establishes that there has been limited research to date and that which there is tends to focus on quantitative representations of managing overall supply and demand, using wider SCM elements. This suggests that there are opportunities to gamify PSM learning, in particular focusing on the human element in PSM and developing soft skills, as strong buyer-supplier relationships can generate significant benefits to both parties. To provide a more focused PSM contribution, a second systematic literature review distils the relevant principles, techniques and processes to inform the development of two gamified PSM learning activities. Negotiation and supplier relationship management rely heavily on personal interactions and are both seen as key activities at different stages of the PSM process. The development of the two gamified learning activities is strengthened by being underpinned by a synthesis of the literature review’s key findings, ensuring they are domain-meaningful abstractions of reality, contain rewards and rankings based on clear objectives and have appealing gameplay. It is hoped that this paper provides a platform for future domain specific PSM research and will be of use to educators in this field in developing their own gamified learning.

Keywords: Purchasing and Supply Management, game elements, education, decision tree.

1. Introduction

The scope and use of gamification in a variety of contexts has increased as technology and educator and student user acceptance grows. This paper first explores how gamification has been deployed in the education of participants in a specific organisational functional setting, Purchasing and Supply Management (PSM), which focuses on the direct relationships between organisational buyers and suppliers, covering aspects such as establishing trust, identifying and selecting suitable suppliers, managing supplier performance and the relationship. Examples of such usage in the wider Supply Chain Management (SCM) context include the oft-played beer distribution game, developed by MIT Sloan School of Management (Forrester, 1961), which simulates the coordination of typical problems in supply chain (SC) processes, promoting information sharing and collaboration throughout a SC (Sterman, 1984). A systematic literature review of the PSM gamification education literature shows that the coverage is limited and relatively narrow in scope. Second, recognising the limitations of current PSM gamified education research, the paper uses the results of the literature review in its distillation of the key characteristics, principles and techniques, and the processes and stages of implementation, to develop two PSM relevant gamified learning scenarios. The following research questions are addressed:

RQ1 – How has gamification been used in PSM education?
RQ2 – What are the underlying characteristics, principles and techniques and the processes and stages of implementation of gamified education?

RQ3 – How can these findings inform the development of gamified learning in PSM education?

The paper first describes the conceptual background to the work, covering PSM and more general aspects of gamification. It then discusses the method used in the systematic literature and identifies the key principles, techniques and implementation processes that are used to inform the two PSM focused gamification learning elements that are described in the discussion section. Finally, the conclusions summarise the work, set out some opportunities for future research and some practical implications.

2. Conceptual Background

2.1 Purchasing and Supply Management

PSM is the management of an organisation’s external resources (i.e. from suppliers), in the form of their goods, services, capabilities and knowledge, in an effective and efficient manner to ensure the achievement of overall organisational aims and objectives (Van Weele, 2009). A number of different process models exist to illustrate the different stages and activities involved in PSM, but a widely used one is shown below.

![Figure 1: Purchasing Process (derived from Van Weele, 2009).](image)

The heightened need for organisations to focus on their PSM activities has seen the role of PSM professionals evolving from a more clerical/operational one towards being more tactical and strategic (Giunipero, Handfield, & Eltantawy, 2006). This evolution has led to a growing attention being paid to PSM knowledge, however the tendency has been somewhat descriptive (i.e. identifying the ideal skills required) and so developing these skills is still an emerging area (Feisel, Hartmann, & Schober, 2008). New education techniques, such as gamification, will play a key role in developing the required skills and competencies for current and future PSM practitioners.

2.2 Gamification

Gamification is the use of game elements (Peixoto & Silva, 2017) and game-design techniques (Mora, Riera, González, & Arnedo-Moreno, 2017) in non-game contexts (Werbach & Hunter, 2012) and the process of making activities more game-like (Werbach, 2014) to promote desired behaviours (Morford, Witts, Killingsworth, & Alavosius, 2014). Gamification is an emerging area of focus in a variety of literature areas, across different industrial settings and within various subject-specific education contexts (Costa, Aparicio, Aparicio, & Aparicio, 2017); computer science (see Gari, Walia, & Radermacher, 2018); accountancy (see da Silva, Rodrigues, & Leal, 2019); industrial engineering (Despeisse, 2018); enterprise resource planning (Horng-Jyh, 2016) and quality management (Brauner, Philipsen, & Ziefle, 2016). Gamified learning can strengthen both student knowledge and also their ability to communicate and cooperate with fellow students in furthering their understanding of learning content (Hamari, Koivisto, & Sarsa, 2014). In addition, using gamified learning should make the experience motivating and pleasant, rather than dull (Wu, 2011).

Examples of education usage of gamification in the wider SCM context began with the widely used Beer Distribution Game (Forrester, 1961), which simulates the coordination of typical problems in a SC process and promotes the need for information sharing and collaboration throughout a SC (Sterman, 1984). Development of the game has gone from a paper-based board game to online software versions and is still widely used today.
There are several other SCM-related gamified education examples, e.g., SC optimization (van den Berg, Voordijk, Adriaanse, & Hartmann, 2017), sustainable SCM (Hidayatno, Hasibuan, Nimpuno, & Destyanto, 2019), and humanitarian logistics (William, Boo, & de Souza, 2018).

3. Method - systematic literature review

A search was done to identify any relevant sources of literature that analyse the use of gamification techniques and tools in a PSM specific setting. The SCOPUS database was used, as this has been demonstrated to pick up the highest number of papers across the relevant academic disciplines when compared to the Web of Science and without the quality criticisms levelled at Google Scholar (Harzing & Alakangas, 2016) and this database was available to all of the researchers involved. The search itself was limited to outputs from the last 5 years, to take into account more recent technological and pedagogical developments, covering journal and conference papers, as well as book chapters, using the search terms below:

TITLE-ABS-KEY (“PSM” OR "supply chain" OR "purchasing" OR "procurement" OR "outsourcing" OR "supply* network") AND TITLE-ABS-KEY (“training” OR "education" OR "learning" OR "teaching") AND TITLE-ABS-KEY ("serious game" OR "augmented reality" OR "applied game design" OR "employee training software" OR "gamification" OR "badge" OR "leaderboard" OR "game mechanics" OR "gameful" OR "avatar" OR "quest")

This search yielded a total of 67 results and a detailed review of these papers was conducted and the following rejection criteria utilised: (1) operational (rather than education) usage, (2) did not focus on industrial PSM or SCM (e.g. consumer usage), (3) focused on the technical aspect of a gamified concept (e.g. augmented reality) but did not extend to an education or PSM context, (4) summary of a full conference proceedings, (5) full-text was inaccessible by members of the project team or not in English or a language spoken by one of the team members, (6) used a simulation with students to test non-education phenomena. This detailed analysis resulted in the identification of 14 relevant papers (Table 1). It should be noted that many of them cover wider SC activities (e.g. logistics and distribution), rather than the more narrow focus of PSM, but these were included for review due to their potential functional relevance.

Table 1: Gamification in PSM and SCM education papers

<table>
<thead>
<tr>
<th>Authors &amp; Year</th>
<th>Title</th>
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<tbody>
<tr>
<td>Destyanto et al. (2019)</td>
<td>Serious simulation game design to support extensive understanding of closed-loop supply chain concept in e-waste management context</td>
</tr>
<tr>
<td>Hidayatno et al. (2019)</td>
<td>Designing a serious simulation game as a learning media of sustainable supply chain management for biofuel production</td>
</tr>
<tr>
<td>Reggelin &amp; Weigert (2019)</td>
<td>A logistics management game for actors of a geographically distributed supply chain</td>
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<tr>
<td>Egilmez &amp; Gedik (2018)</td>
<td>A gamification approach for experiential education of inventory control</td>
</tr>
<tr>
<td>Milosz &amp; Milosz (2018)</td>
<td>Computer decision simulation games for logistic training of engineers</td>
</tr>
<tr>
<td>Van Den Berg et al. (2017)</td>
<td>Experiencing Supply Chain Optimizations: A Serious Gaming Approach</td>
</tr>
<tr>
<td>Lindawati et al. (2017)</td>
<td>ThinkLog: Interactive learning for supply chain management</td>
</tr>
<tr>
<td>Horng-Jyh (2016)</td>
<td>Learning enterprise resource planning (ERP) through business simulation game</td>
</tr>
<tr>
<td>Oates (2016)</td>
<td>Learning and designing with serious games: Crowdsourcing for procurement</td>
</tr>
<tr>
<td>Brauner et al. (2016)</td>
<td>Projecting efficacy and use of business simulation games in the production domain using technology acceptance models</td>
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Due to the limited results in the first search, a wider search was done to identify any systematic literature reviews dealing with general education and also more specific industrial settings. The search terms “gamification” AND
“literature review”, limited to the last five years were used in the SCOPUS database, with a focus on the titles of the papers, to ensure that only systematic literature reviews were identified, rather than the literature sections of individual papers. This resulted in the identification of 26 papers, which were then reviewed in detail and 11 papers were rejected as they did not have a clear educational focus or their full-text was inaccessible by members of the project team and the 15 remaining papers are shown in Table 2.

Table 2: Gamification in education literature reviews

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<tr>
<th>Author &amp; Year</th>
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<tr>
<td>Antonaci et al. (2019)</td>
<td>The effects of gamification in online learning environments: A systematic literature review</td>
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<tr>
<td>Limantara et al. (2019)</td>
<td>The elements of gamification learning in higher education: A systematic literature review</td>
</tr>
<tr>
<td>van der Poll et al. (2019)</td>
<td>A Systematic Literature Review of Qualitative Gamification Studies in Higher Education</td>
</tr>
<tr>
<td>Júnior et al. (2019)</td>
<td>Systematic literature review of Gamification and Game-based Learning in the context of Problem and Project Based Learning approaches</td>
</tr>
<tr>
<td>da Silva et al. (2019)</td>
<td>Gamification in management education: A systematic literature review</td>
</tr>
<tr>
<td>Hallifax et al. (2019)</td>
<td>Adaptive Gamification in Education: A Literature Review of Current Trends and Developments</td>
</tr>
<tr>
<td>Muangsrinun &amp; Boonbrahm P. (2019)</td>
<td>Game elements from literature review of gamification in healthcare context</td>
</tr>
<tr>
<td>Gari &amp; Radermacher (2018)</td>
<td>Gamification in computer science education: A systematic literature review</td>
</tr>
<tr>
<td>Fabriccio (2018)</td>
<td>Using gamification in education: A systematic literature review</td>
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<tr>
<td>Ortega et al. (2017)</td>
<td>How gamification is being implemented in MOOCs? A systematic literature review</td>
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<tr>
<td>Könnölä et al. (2016)</td>
<td>Food-related gamification: Literature review</td>
</tr>
<tr>
<td>Mora et al. (2015)</td>
<td>A Literature Review of Gamification Design Frameworks</td>
</tr>
<tr>
<td>Azmi et al. (2015)</td>
<td>Gamification in online collaborative learning for programming courses: A literature review</td>
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4. Findings
A detailed analysis of the papers identified in both searches was done to identify the specific characteristics of gamification; type of gamification (e.g. simulation), platforms used, learning being delivered, how effective it was and also any proposed improvements. Our key findings on the characteristics show that there is a mix of both physical and technology supported games and therefore there are a range of opportunities to deliver gamified learning. Some papers demonstrate a positive impact on learning and achievement and so care should be exercised in developing a range of relevant performance metrics that ensure that teaching objectives can be met and that the full process of learning is considered. Some papers noted that a potential improvement would be the development of more comprehensive learning outcome measurements. Key improvements include the development of a robust user interface, which reflects the need for gamified learning to be engaging for students. Most of the games deal with quantifiable scenarios, e.g. how much to order and to pay, within the wider SCM context, and so these would lend themselves more readily to simulation type games. However, there is an increasing focus on soft skills within PSM (e.g. Bals, Schulze, Kelly, & Stek, 2019), so a wider range of game types should be considered that can develop and evaluate more qualitative requirements. Second, a series of gamification principles and techniques underlying the development of effective gamification (summary shown in table 3) were distilled from the reviewed papers, as follows:
Table 3: Summary of gamification principles and techniques with relevant sources

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<tr>
<td>Meaningful to specific stakeholders with specific domain-specific knowledge [Van Den Berg et al. (2019)]</td>
<td>Right level of rules and complexity [Cuesta Aguiar &amp; Nakano (2018), William et al. (2019)]</td>
</tr>
<tr>
<td>Performance and outcome measures for retention, satisfaction, attendance, engagement, motivation, improvements in learning, socialisation [Mora et al., 2015], Júnior et al. (2018), Fabricio (2018)]</td>
<td>Stealth learning (focused on playing, but not necessarily on learning) [Cuesta Aguiar &amp; Nakano (2018)]</td>
</tr>
<tr>
<td>Opportunities for feedback [Brauner et al. (2016), Gari &amp; Radermacher (2018)]</td>
<td>Appealing aesthetics via user interface and gameplay [Cuesta Aguiar &amp; Nakano (2018), Brauner et al. (2016), Hosseini &amp; Haddara (2020)]</td>
</tr>
</tbody>
</table>

A detailed analysis of these papers showed that a robust process should also be used that incorporates the principles of gamification contained in the preceding section. A number of these papers identified further papers - Hidayatno et al. (2019), Mora et al. (2017), Ibrahim and Jaafar (2009), Marache-Francisco and Brangier (2013) and Werbach and Hunter (2012) that are focused on the processes and stages that have been used to implement gamified activities and these have been synthesised as follows:

1. Clear definition of learning and game objectives, with a focus on the curriculum (outcomes, assessment and feedback).
2. Gather data on the user types.
3. The use of a prototype/testing stage/phase incorporating best practices from game/software development and the use of cases.
4. Establish robust and relevant performance metrics and effective feedback measures.
5. Continual redesign based on feedback from learners and educators.

The findings show that, although there are a number of examples of SC gamified learning (e.g. dealing with stock management, pricing and supply and demand), there is little that looks at specific PSM activities. In addition, much of the existing gamified learning uses simulations (either physical or technological) that relies on quantitative decision making and therefore more qualitative factors could be introduced in a gamified context. There is therefore an opportunity to develop PSM focused gamified learning that is underpinned by relevant gamification principles and techniques and is deployed using pertinent gamification processes/stages. This will ensure that this learning is robust and offers students a different learning environment, which will be more relevant to developing the key skills, competencies and knowledge required for working in and adapting to the challenges faced by organisations.

5. Discussion - development of two PSM relevant games

5.1 Buyer-supplier relationship management

Within a current project under development the presented literature findings on gamification principles and techniques will be used to develop two game design ideas. Here, the above mentioned five step game development process will be used as guideline. Further, the current project attempts to consider the eleven
gamification principles and techniques described in table 1. Hence, the following two sections present two game
design ideas within the field of PSM education.

The first game focuses on managing buyer-supplier relationships, addressing one of the most crucial topics in
PSM, due to its significant influence on organisational performance (Nair, Jayaram, & Das, 2015). Previously,
PSM professionals focused on fulfilling the operational tasks of managing orders from the suppliers to ensure
the supply of components. However, current PSM professionals fulfil a more strategic role by utilizing the
organisation’s supply base to increase competitive advantage, as those with high levels of PSM maturity and
highly skilled PSM professionals will outperform competitors (Hartmann, Kerkfeld, & Henke, 2012). This shift in
focus is due to recent technological developments reducing the workload of PSM professionals to manage orders
by the introduction of advanced software systems, freeing up capacity (Glas & Kleemann, 2016; Torn & Schiele,
2020) and an increased involvement in using the supply base to harness innovation (Schiele, 2010). In addition,
value-adding operations and capabilities shift from the manufacturing firms towards a limited number of
available suppliers (Nair et al., 2015) and increase the supply risk for the firm. To develop learners to deal with
these challenges, new PSM gamification elements should ensure the learning of core principles to gain deep
insights into the topic and this can be achieved by following the five-game design steps described above and
including the relevant principles and techniques.

In the first step of game development, a clear definition of learning objectives is needed, allowing the developers
to define clear goals for the game. These learning objectives are retrieved from recent research publications in
the PSM field and include recent technological developments in PSM; supply risk management, innovation
sourcing, and enhancing supplier satisfaction and the focus of this game is effective supplier relationship
management. Here, the learner should be involved in various decisions in the area of managing the supply base
of a firm. The second step ensures that the game is meaningful to specific stakeholders with domain-specific
knowledge and two user types are identified. The first is higher education students, attending PSM classes on
organizing and managing an organisation’s supply base. The second user type is PSM professionals, engaged in
practitioner training, learning how new technologies and trends influence their approach to supplier
management or how to increase PSM maturity within their organisation. Designing game elements that suit
both user types ensures higher levels of usefulness of the game in different educational environments.

The third steps address the game design and focuses on gamification elements that ensure an enjoyable
experience and use of knowledge in a learning scenario. The supplier relationship management game is designed
as a scenario-based decision tree (see Figure 2), which starts with a PSM relevant case. The decision tree sets
the framework for the game, allowing for the right level of rules, to achieve an effective balance between
complexity and real-life experience. Within the game, the learner works through decisions that influence their
individual game scenario, allowing for high learner diversity. The choices the player makes will affect the
availability of later decisions, therefore reflecting an abstraction of concepts and reality. Learner game
performance is tracked depending on how well decisions are aligned with the achievement of overall
organisational aims and objectives. The level of alignment determines the number of points received by the
player and this should facilitate in game stealth learning. For example, learners start with decisions relating to
the selection of the overall purchasing strategy, which should relate to the firm strategy described in the
introductory case. Possible options for this PSM functional strategy include the focus of purchasing activities on
low price products/services, innovative suppliers, or high-quality products/services. After defining this strategy,
the user will be able to take various operational decisions, such as deciding to source products/services from a
limited number of suppliers, focusing on a closely-coupled SC or sourcing from larger multiple supplier supply
bases, establishing a loosely coupled supply market. Further operational decisions include the choice to source
from a local or global supply base. Learners who can see the link between the overall organisational strategy,
the functional strategy and the operational decisions taken will receive more points, reflecting the closer
alignment. For example, a single-source strategy from local suppliers within a closely coupled SC favours
collaborative innovation activities. Conversely, a price-focused strategy would most likely benefit from a closely
coupled supply market with multiple suppliers within a global supply base, due to the possibility of benchmarking
prices and bidding competition. From a supplier relationship perspective, as a customer of the supplier, the
learner will have to consider various antecedents, e.g., growth opportunity of the customer, profitability of the
account, customer’s relational behaviour and customer’s operative excellence, to ensure supplier satisfaction and improve firm performance.

Step four of the design process aims to incorporate robust and relevant performance metrics and effective feedback measures. Within the described game design, a PSM dashboard and game performance ranking informs the learner about the achievement of specific functional (e.g. cost savings) and overall organisational objectives (e.g. market share) in a cross user online leaderboard. The game environment should use appealing aesthetics via a user interface and gameplay, which are hosted in an online game environment. The decision tree game design allows for further feedback via small case descriptions as text or videos, which are shown after a decision is taken. These interim interventions are excellent opportunities for feedback and can be made user specific on an individual level, depending on the detail of the game design. A performance and outcome measurement can be achieved by comparing the final game scores to previously obtained scores or group performance comparison. A post-game assessment allows for a more objective measure of learning outcome. Within the last step of the game design process, the design of a scenario decision tree allows for the continual redesign of the game and its content, through changing the introductory case study, adding new decision tree branches, to ensure a high actuality of the game content. Further, a module design of the tree allows customizing the game content according to the needs of the user.

Figure 2: Example of a scenario decision tree game design

5.2. Game 2 - Negotiation
The second game design within the educational project under development addresses the negotiation competence of PSM professionals. Negotiation is the: “...process of communication back and forth for the purpose of reaching a joint decision” (Fisher, Ury, & Patton, 1991, p. 20). This can done in a distributive and an integrative manner with, using a pie analogy, distributive negotiation focusing on dividing the pie between the participants and integrative negotiation on enlarging the pie for both. There is evidence that “buyers and sellers perceive their business-to-business (B2B) negotiations as distributive exchanges rather than opportunities for integrative bargaining and value creation” (Sigurðardóttir, Hotait, & Eichstädt, 2019) and Sigurðardóttir et al. (2019) found that negotiations tactics are in most cases (too) assertive and competitive, probably due to a lack of negotiation training. This means that the distributive approach tends to prevail over the integrative one, which promotes collaborative negotiation for use in strategic business environments (Sigurðardóttir et al., 2019). Therefore, there are opportunities for developing training in the integrative negotiation approach, with the need
to incorporate social exchange aspects, to form the basis of the learning objectives. The parties in the game need to question each other in real life, via video conferencing or at least via a chat function (e.g. WhatsApp), whereas the tendency currently is to use offline situations, meaning that the outcomes of the negotiations are noted on paper and have to be examined by the educator during the class. Hence, the use of a computerized application would be a useful and efficient teaching method.

This negotiation game prepare PSM students (the focal group) to understand the advantages of an integrative negotiation. Learner will be taught the basic principles of negotiation via more traditional teaching methods and then they are teamed up in buyers or suppliers groups (in the online tool), the case is issued and all groups will be provided online with the general background and then specific buyer or supplier information. The game starts with a number of multiple choice questions on the negotiation process that have to be answered by both groups. After this point the game will proceed offline. Both groups need a certain amount of time to negotiate in a real life situation. After the negotiation, both groups answer a number of multiple choice questions on the negotiation process and both groups fill out their final bid in units of money and other requirements criteria, such as delivery date, quality requirements and length of contract. The online tool provides scores for each group and presents the ranking of groups and then the educator discusses the outcomes; why groups are ranked high or low and evaluates with the students the do's and don'ts in integrative negotiations. The potential outcomes consist of the outcomes of the answers given by the counter party and the created integrative value via the negotiation. The advantage of using an online tool in class for the lecturer as a teaching method is that the administrative work, i.e. comparing the negotiation outcomes and the ranking is done instantly, which leaves more time for evaluating the negotiation process and for emphasising the integrative negotiation style.

6. Conclusion and future research
Our literature review revealed that there is little academic reporting of gamification education in the PSM field, beyond those broader quantitative supply and demand based on the Beer Distribution game. This paper has developed two PSM focused games, underpinned by the key principles and implementation techniques identified in the broader gamification literature, at different stages of the PSM process that can be used by those involved in the education of PSM. It should also serve as a platform for further development of a fully gamified underpinned system across all stages of the PSM process. Future academic research could explore the impact on outcomes of these games on the achieving of a wide range of objectives, such as meeting learning outcomes, enhancing student satisfaction and retention and also how they could be deployed in a work-place setting. There is an opportunity to research into the workplace context and analyse the impact of learning in this manner on the achievement of organisational and functional objectives, such as achieving cost savings, increasing quality of supply and buyer-supplier satisfaction.

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