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A framework for implementing gamification in Purchasing and Supply Management education

Summary

This paper uses the findings from a literature review and series of expert interviews to develop a richer and Purchasing and Supply Management (PSM) context-specific perspective of the different key techniques, tools and principles that can be used to develop gamified learning to enhance the skills required by PSM professionals in dealing with current and future challenges, such as the transformation to Industry 4.0. It also provides further details of the different stages of implementing gamified learning, which can enhance the success of any such provision.

Keywords: Gamification, gamified learning, skills, Industry 4.0.

Submission category: Academic working paper.

Introduction

The transformation towards Industry 4.0 is changing the skills required by PSM professionals, which will necessitate new educational methods to develop these skills. Based on a literature review and expert interviews, this paper analyses how gamified learning can contribute to a more effective and innovative experience in PSM education. To support this overall aim, three key research questions have been distilled:

1. What techniques, tools and principles can be used to deliver effective gamified learning?
2. What process steps should be followed in implementing gamified learning?
3. What examples of gamified learning products have been identified?

Literature review

Gamification can be defined as the use of game elements and game-design techniques in non-game contexts (Werbach & Hunter, 2012) and the process of making activities more game-like (Werbach, 2014). Gamification is an emerging area of focus in a variety of literature areas, across different industrial settings and within various educational contexts. To provide a basis for answering the three research questions of this paper, a literature review was conducted. In a first search string, three groups of keywords (synonyms) were combined: 1) PSM; supply chain; purchasing; procurement; outsourcing; suppl* network; 2) training; education; learning; teaching; 3) serious game; augmented reality; applied game design; employee training software; gamification; badge; leaderboard; game mechanics; gameful; avatar; quest. In a second search string the phrases "gamification" and "literature review" were combined. The SCOPUS database search was limited to outputs from the last five years, as our focus is on the potential of delivering gamified learning in an Industry 4.0 context. A total of 93 results have been identified and analysed (the detailed analysis showing the rejection criteria is available in (PERSIST 2020)). This review showed that, although there are several examples of supply chain 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 technologically supported) that rely 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 (e.g. enjoyment, rewards and rankings, etc.) 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 PSM in an Industry 4.0 environment. Although there has been some empirical work in the

field of gamified learning and some in the wider field of Supply Chain Management (SCM), there is very little that specifically focuses on the PSM context.

Method

The limited amount of literature in this area establishes that there is a requirement for exploratory research, which is best done by the collection and analysis of qualitative data obtained from semi-structured interviews. Doing this ensured that a full and deep understanding of the phenomenon could be obtained (Yin, 2018). To ensure a range of individuals who have the required expertise and interdisciplinary backgrounds, initial approaches were made by the project team and then a snowball sampling strategy (Goodman, 1961; Heckathorn, 1997) was deployed to reach further contacts as appropriate. This resulted in eight interviews being completed, across a range of sectors (4 from academia, 3 from industry and 1 from practice-focused training) and from a range of disciplines (4 from management, 3 from technology and 1 from entrepreneurship). As the interviews were conducted by various members of the research team, a robust semi-structured interview protocol was developed and the individual questions were informed by the key findings from the literature review and the details of the interview protocol can be obtained from the lead author. Due to the travel restrictions brought on by the Covid-19 pandemic, all interviews were conducted through video conference and were recorded and transcribed. Before each interview, all interviewees were sent a participant information and consent sheet to sign, to cover any ethical issues, as well as a short presentation document outlining the background to the project and brief definitions of some core concepts. This ensured that all interviewees shared a common understanding of the project’s scope and the areas that the interviews would cover. Although the interview questions provided some structure, most of the data was inductively coded (Bazeley & Jackson, 2013), i.e. using the data to develop codes, apart from two aspects in which pre-defined coding from the extant literature was used (Eisenhardt, 1989), as shown in Table 1.

Table 1: Pre-defined codes based on literature review

Aspect	
Stages of implementation	<ol style="list-style-type: none"> 1. Clear definition of both learning and game objectives 2. Gather data on the user types 3. Prototype and testing 4. Establish performance metrics and effective feedback measures 5. Continual redesign based on learners’ and educators’ feedback
Underlying principles	<ul style="list-style-type: none"> Enjoyment Rewards and rankings Meaningful to specific stakeholders with domain-specific knowledge Performance and outcome measures Opportunities for feedback Recognising learner diversity Clear objectives and goals Abstractions of concepts and reality Right level of rules and complexity Stealth learning Appealing aesthetics Effective combinations

However, in the coding process a richer, more context-focused understanding emerged from each of these pre-defined codes. Some additional codes were identified and these will be discussed in more detail in the findings section. To ensure that all relevant findings would be generated from the data, the analysis was done by two researchers, who coded all interviews using the NVivo 12 qualitative data analysis software. In addition, to establish inter-coder reliability (i.e. how similar the coding between coders was), a coder comparison report was generated from NVivo and this showed high levels of agreement between the two researchers. To ensure that research quality was maintained throughout the process, the work of Lincoln and

Guba (1985) and Yin (2018) informed the overall research process. For example, credibility was achieved by a rigorous review of the interview guide by multiple project members and peer discussion of the evaluation results; transferability by the common approach adopted by all of the interviewers; reliability by coding and node creation in NVivo via a defined process of organising, coding, searching, and modelling (Strauss & Corbin, 1994; Yin, 2018); and confirmability by the interview questions audited by individuals not involved in interviews.

Findings and analysis

This section has been structured in line with the research questions.

RQ1 - What techniques, tools and principles can be used to deliver effective gamified learning?

Examples of each of the pre-defined categories developed from the literature were given by the interview participants. Table 3 shows some pertinent quotations from the interviewees (# denotes the interviewee number) against each of the a priori codes developed from the extant literature. For brevity, a single example source quotation has been shown, but a full coding matrix can be obtained from the lead author.

Table 21: Techniques, tools and principles of gamified learning with associated sources and key findings (using categories from the extant literature)

Category of technique, tool and principle	Source and context-specific quotation	Key findings
Abstractions of concepts and reality	“You can transfer the skills that you're learning in that gamified environment into the actual industry that you're expected to work in” (#4)	Make use of organisationally generated (big) data as an input into gamified learning to recreate as close to a real-world scenario as possible
Appealing aesthetics	“User interface that's intuitive to them” (#4)	Relevant and immersive aesthetics are needed
Clear objectives and goals	“Matching the learning goals with what you're trying to do in the game or a gamified environment is probably one of the defining elements of success” (#1)	Develop the game based on the learning objectives and ensure these are staged throughout the learning journey
Enjoyment	“But ultimately if they're not enjoying the time that they're having or if it's not intuitive to them, however, they might perceive that, it will make learning those skills more difficult” (#4)	Needs to be an effective balance between enjoyment and the learning journey, but this needs to relate to the individual learners
Meaningful to specific stakeholders with domain-specific knowledge	“There's some story, there's some meaning that's important to you to dive into” (#7)	Maintain a close focus on the specifics of the job role etc.
Opportunities for feedback	“Have a breakdown per system that they interacted with so they can see areas where they might have knowledge lacking or lack of expertise or understanding” (#4)	Have regular (real-time if possible) feedback that clearly shows performance levels and any gaps for learners and the ability to adjust the learning as it progresses
Performance and outcome measures	“The metadata. The stickiness of the game” (#5)	Multiple levels of performance can be monitored (i.e. at the learning objective level and also the “stickiness” of the game), which may offer different insights
Recognising learner diversity	“As we are working now it's one size fits all. And our biggest challenge is that we are going to optimise that. People with personality will get game one first etc. And one of the elements of that challenge is that we want to know whether the validity of the games within the certain cultural ethnic groups, the outcomes are the same” (#5)	Important to assess the types of learners in a nuanced way (e.g. beyond simplistic demographics)

Rewards and rankings	“Badges, achievement tracking progression tracking that sort of thing, as well as kind of milestone rewards is sort of in my experience anyway, mainly targets to try and keep people engaged” (#8)	Ensure that leader boards and rankings are used judiciously and appropriately and not merely because they are available
Right levels of rules and complexity	“We need to think of how we present information to the players so that it's not overwhelming, it's easy to understand, it's easy to follow” (#1)	Rules need to be clear and gamified learning needs to be stretching and challenging
Stealth learning	“Focused on playing, but not lesson learning” (#2)	Consider the use of mini games as part of the overall narrative of the learning journey

A key benefit of qualitative research is that it can generate hitherto unidentified aspects of the research area. Therefore, in addition to the data analysis using a priori codes from the extant literature, we also identified some additional categories in Table 4. According to a report by the U.S. Department of Education (2010), the personalisation of gamified learning includes individual pacing (individualisation), tailoring to individual learning preferences (individualisation), and tailoring to the specific interests of different learners. To do this more effectively, specific combinations of the different techniques, tools and principles were identified, ensuring that there is “a blend of education and entertainment” (#4) as a balance between “when the fun factor of a game is high the validation and the trustworthiness is low. So, the more boring the game, the less multi-interpretable a game is, the more valid a game is in terms of: Does it do what you want it to do? Or it did measure what you don't want to measure?” (#5). Also, there needs to be appealing aesthetics, but not over and above the content and the objectives.

Table 3: Techniques, tools and principles of gamified learning with associated sources and key findings (newly identified categories)

Category of technique, tool and principle	Source and context-specific quotation	Key findings
Individualisation (pace of learning based on the needs of different learners)	“You can't manage to make progress or the feeling, the subjective feeling of progress when you dictate to do something. When you give checklists or when there is only one right way to do something” (#7)	Although linear games have advantages, giving individuals more autonomy and control over the pace of learning is useful
Differentiation (tailored to the learning preferences of different learners in terms of both pace and learning preference)	“So, we can both play the same game, but we each have the individual feeling of performance because I know you will have progressed differently than I have” (#7) “But then having done more research around the avatar setting, personalisation became an important part” (#3)	Considering and giving individuals more autonomy and control over the approach of instruction is useful

RQ2 - What process steps should be followed in implementing gamified learning?

The core process stages identified in the extant literature were found in the interview data, however, additional depth and insights were generated and these are shown in the table below.

Table 42: Key implementation process stages, with associated sources and key findings (using categories from the extant literature)

Process stage	Source and context-specific quotation	Key findings
Clear definition of both learning and game objectives	“Layout exactly all the components of the project itself and then go in a linear order that made sense to a person if they are approaching it from step zero” (#4)	Although this is related to the corresponding section on having learning and game objectives, it is important to have this as a specific part of the learning development process
Gather data on the user types	“Identify which sort of gamers would interact with certain things and achievements is one of those sorts of collector kind of traits and some people just don't fall into it. So, some people just don't necessarily interact with things in that way” (#8)	Consider going beyond traditional student differentiation measures and look at gamer types etc.

Prototype and testing	“And then do some testing phases as well, normally with a small number of participants before you do your big experiment so that you can get some initial feedback, adapt accordingly, then move on” (#3)	Testing could be done within the project team and could make use of agile/sprint techniques in this stage of the process
Establish performance metrics and effective feedback measures	“More traditional approach of survey, so construct parameters to measure how their understanding of their location changed before and after the game. Have they more trust and confidence in the government's recommendations after they've played the game and the general how engaged they are with the game. It all depends on the context” (#1)	Could consider a wide range of techniques to measure performance (e.g. interviews and surveys), but it needs to relate to the early planning stages
Continual redesign based on learners' and educators' feedback	“However much consultation you do in the beginning until you start creating it and it comes to life there's always things that you may have missed in the consultation phase, which is why it's important to keep getting that feedback and coming up with that correct balance, that correct experience versus the goals that we're trying to achieve” (#3)	An important stage in the process which needs to ensure that the changes relate and are adaptive to specific learners

A key aspect of this research is to identify some specific challenges (from the data) and possible mitigation strategies (from our understandings) and these are shown in Table 5.

Table 53: Challenges of implementing gamified with associated sources and mitigation strategies

Challenge	Source and context-specific quotation	Possible mitigation strategy
Match between learning goals and the game	“We didn't do match very well the learning goals with the game itself” (#1)	Ensure that gamified learning is flexible enough to adapt during the process
Capabilities of both educator and learner	“In digital, probably expertise would be a challenge” (#2)	Gamified curriculum development should involve subject educators, pedagogy and didactic experts, and technologists Gamified content benefits from built-in tutorials, guidance, hint systems, etc.
Resource availability	“Stops us from that, is funding, is finance is money” (#5)	Establish a sufficient budget for development, maintenance, and delivery of gamified content
Learner engagement	“Needs to be some enjoyment or motivator to it and finding one that fits everybody, I think is going to be the big difficulty” (#8)	Regular meta-data monitoring to check engagement and build in opportunities to change delivery etc. based on feedback

RQ3 - What examples of gamified learning types or products have been identified?

The participants were asked for specific examples of games that they had used and a summary of these is useful to those who are interested in making use of specific types and platforms in implementing gamified learning in a PSM context. Unsurprisingly, a wide variety was identified, such as strategy games, quizzes, roleplays, simulation, gamified assessments, storytelling with a gamified approach, card games, and board games. In addition to the types of games, a list of the proprietary Massive Open Online Courses (MOOCs), Virtual Learning Environments (VLEs), and other digital platforms was identified in the analysis process, as follows: Mentimeter, Blackboard, Coursera, Moodle, WordPress, FutureLearn, LinkedIn Learning, Classcraft, the learning platform on Epic Games, Unity Developer Associate courseware, Totem Learning, and SharePoint.

Conclusions

This research provides an empirically based addition to the understanding of how gamified learning works in practice, identifying some tangible examples and guidance for others undertaking similar activities in both a specific PSM context, but also in other settings. The research has developed a richer and context-specific perspective of the different key techniques, tools and principles used in gamified learning, as well as some additional categories not focused on in the previous literature. It also provides further details of the different stages of

implementing gamified learning, which can enhance the success of any such provision. These key findings can be summarised as follows:

- Any gamified learning must be based on the learning objectives and ensure these are staged throughout the learning journey. Also, gamified learning should not be used for the sake of it, but only when it serves a purpose and when it will increase the potential impact of the learning.
- There needs to be an effective balance between enjoyment and the learning journey and there needs to be a focus on learner personalisation (in terms of pace, outcomes and methods/approaches of learning).
- It is important to robustly assess the types of learners in a nuanced way. This means going beyond simplistic/traditional demographics, such as gender or age, but could also consider using gamer typologies (i.e. how different groups play and engage with games) as a way of developing this aspect further. This will also help to personalise the individual learner experience, as learners will have increased expectations of how much control and autonomy they can have over their interaction with gamified learning.
- Traditional gamification techniques (e.g. leader boards) should be used judiciously and appropriately and not merely because they are available. As these have been widely used in many gamified contexts, users may now see these as over-simplified and not engage with them as fully as they should. Similarly, there should be a clear focus on the types of skills, knowledge etc. that are being developed and these requirements should be captured in the assessment of specific learner requirements and related to the learning objectives.
- Feedback and data collection opportunities, both metadata, i.e. overall gameplay, and outcome data, i.e. meeting learning outcomes, should be factored into the development of the gamified learning activities. The design should be flexible enough to change as appropriate based on this feedback and performance data analysis.

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