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A Practical View of Gamifying Information Systems for the Future

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ABSTRACT

Gamification's role to support usability and innovation in the manufacturing industry is in its infancy. The present study displays a multi-cited ethnographical approach of a design science research project conducted between a start-up gamification firm and a manufacturing company. The case shows how different gamification design methods are used when gamifying a novel human modelling system. Furthermore, the interference from method to the design is presented and compared with conceptual views of gamification design. The findings show the need for early technical due diligence in collaborations between newer and older firms as well as the need for more comprehensive gamification frameworks to support industry design of gamification in different contexts.

KEYWORDS

Adoption, Design Science Research, Digital Transformation, Gamification, Human Modeling System, Industry 4.0, Innovation, Learning Curve, Manufacturing, Start-Up, Technology Acceptance

INTRODUCTION

Gamification is the application of game elements in a non-game context (Deterding et al., 2011) and has previously been used to increase engagement and motivation in various contexts (Dichev & Dicheva, 2017; Hamari et al., 2014; Koivisto & Hamari, 2019; Looyestyn et al., 2017). Several gamification design frameworks have been produced both from scholars, e.g., Motivational Design Lens (Deterding, 2015) GaDeP (Klemke et al., 2020) and The RECIPE for Meaningful Gamification (Nicholson, 2015) and from practitioners, e.g. Octalysis (Chou, 2016), Gamification by Design (Zichermann & Cunningham, 2011). For a comprehensive lists of gamification frameworks see Mora et al. (2017) and Morschheuser et al. (2017). Even though existing frameworks and methods provide a starting point for the gamification design process they are often theoretical and conceptual or based on practitioners' know-how or scholar disciplinary knowledge.

In the present study we explore a practical gamification design-case, applied in a collaboration between a traditional manufacturing organization and a start-up firm. When functioning well, collaboration between corporations and start-ups have the potential to offer a powerful acceleration for

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innovation. However, despite its potential, dissimilarities between traditional corporations and start-ups can inhibit effective collaborations (Kohler, 2016). This inquiry explores how a merge between practitioners' know-how and scholar disciplinary knowledge in a real gamification implementation case. The focus of the study is twofold:

1. To give insight of the potential opportunities and problems that emerge in a collaboration between a traditional organization and a startup firm implementing a gamification API into an existing information system (IS).
2. To provide an authentic industry example of a gamification studios design processes when gamifying an existing IS artefact serving as an innovation enabler for a novel technology in the traditional manufacturing industry.

The study employs a multi-sited ethnography (Marcus, 1995) standpoint, following the application of a design science research process (Peffers et al., 2007) in order to answer the following research question: *What transpires in the collaboration between a traditional manufacturing company and a novel gamification startup while implementing a gamification API in an already existing IS?*

Background

Research on gamification in IS for learning displays an optimistic stance (Koivisto & Hamari, 2019). Positive effects such as faster skill development in VR-corporate training (Palmas et al., 2019); increased user-engagement in learning management systems (LMS) (Hamari et al., 2014); increasing university students activity in course-discussions (Bonde et al., 2014); and improvements in students' retention in learning software (Barata et al., 2013) has been identified. Nonetheless, extensive grey areas on gamification research in learning technologies exists and little research has been conducted regarding the moderating effects of demographics, type of IS, and context (Dichev & Dicheva, 2017). The outcome of a gamification implementation seems to be context-dependent considering the temporal and spatial situation, type of digital technology, user-demographic and implementation goal (Majuri et al., 2018). Even with apparent knowledge gaps acknowledged by the research community, the past decade has been filled with various IS applying game elements and game design heuristics. In the early years of gamification, problematizing studies were scarce, which contributed to the fast acceptance of gamification practices in learning technology. Today the majority of gamification research relates to its effects in learning situations, yet, there is a lack of studies concerning the implementation of gamification in IS in other contexts (Koivisto & Hamari, 2019).

As the business field has preceded the research on gamification, it can be presumed that there exists a high number of unpublished gamification setbacks (Kim & Werbach, 2016). In more recent year's studies have started to reveal that gamification is not a bulletproof concept ensuring success. A longitudinal survey-study on gamification early adopter organizations in 2014 showed high interest and satisfaction in gamification processes, yet four years later the organizations implied a much more dispassionate and restrained view regarding gamification (Raftopoulos, 2020). Reasons for the lower interest and satisfaction can also be explained by the potential downsides of gamification implementations. As such, another study presented how software engineer students in higher education got expelled for their player behavior of exploiting a glitch in their gamified LMS (Palmquist & Linderot, 2020). Other downsides can be the complexities involved in the design process. Investigations on gamification design have recognized that designing fruitful gamification is a challenging endeavor requiring an excessive and multidisciplinary skillset (Koivisto & Hamari, 2019; Deterding, 2015; Morschheuser et al., 2017). Gamification is not a "plug and play" solution but has been shown to require rigorous planning, time for an iterative processes and sufficient with resources to be successful (Hassan et al., 2018). A participant observation study of meetings between a gamification studio and its clients indicated that if gamification shall remain on the market as a long term solution a more precise and clear definition of gamification is needed to modulate expectations, avoid confusions and prevent

frustrations (Palmquist, 2020). Despite recent years of a more scrutinizing and maturing research field (Nacke & Deterding, 2017), academical understanding of gamification lacks regarding practitioners design, development and focus areas (Deterding, 2012; Morschheuser et al., 2017; Nicholson, 2015). Higher problematization, including a broader and comprehensive hypothesis-generating approach in gamification research, would strengthen the theoretical and practical understanding of gamification design and development, which in the long run could stimulate the gamification field's growth for researchers and practitioners alike.

THE CASE

The case is based on the collaboration between two firms. One traditional firm providing an IS in the form of a human modelling system (the human modelling system) and one startup providing an application program interface (API) with game elements (the gamification API).

The Human Modelling System

The human modelling system (HMS) is an IS for simulating human interaction with a specific product or workstation in a virtual environment which has gained attention in the agriculture, healthcare, aviation, transportation and manufacturing sectors. It is used in relation to Computer-aided design (CAD) programs with the intention to predict and prevent injuries due to ergonomic or human factors. The HMS enables designers to optimize work environments through digital representations of individuals (manikins) to simulate and visualize their movement patterns (sequence) and interaction with the virtual spaces. The HMS also provides a virtual evaluation process for developing user-centered products by incorporating human factor principles at an early design phase, reducing the design period, and improving the future physical product quality in regard to workers' health and safety.

In early 2019 a government-funded development project of a novel HMS was launched by a longstanding international company manufacturing commercial vehicles. The HMS intended to facilitate scientific and time-efficient simulations of virtual driving test routines as well as subsequent ergonomics evaluations and comparisons of design alternatives. Previous HMS had been conducted frame by frame, resulting in low usability and reliability in previous simulations. Therefore, the new HMS was expected to offer higher usability, accuracy and speed than the previous version. Furthermore, the new HMS included disruptive features that according to the manufacturing company would be desirable to the market and end up determining the core value of forthcoming digital technologies in the manufacturing industry.

However, industrial designers actively chose the old HMS, despite its inferiority to the upgraded HMS. Early tests of the new HMS identified that the new HMS had low user engagement due to its steep learning curve. The new HMS was identified as problematic to the user since it required the user to have extensive knowledge concerning ergonomics, mathematics, and physics, and a substantial amount of time in order to produce a representative simulation output. To decrease the learning curve and increase user engagement, gamification was suggested as a solution. Therefore, the project leader approached a gamification startup that offered an API solution that could be used to implement gamification with significantly less effort than if it were to be fully created in house.

The Gamification API

The gamification API functions as a medium to channel the designers' and developers' views, attitudes, and expressions. According to the developers and designers, the gamification API (GWEN) was built due to identified patterns in clients' requests for gamification software. The development began in 2016, the first version was launched in 2018 and the platform has been continuously developed until the present year (2021). GWEN is designed with various software contexts in mind and is intended to be product-agnostic, meaning that it is not associated with any particular product, device, application or industry. The only major requirements are that the IS using GWEN must be able to uniquely identify

its users, track their activity within the IS and finally send and receive messages over the internet in near real time. The client IS interacts with GWEN through an Application Programming Interface (API), which in effect separates the gamification logic from the IS internal logic. This process allows for a relatively non-invasive introduction of gamification into an IS. Each client's IS has one or several setups within the framework of GWEN, which they connect to using an API-key (see Figure 1). This allows for the definition of standardized interfaces and design artefacts, while at the same time giving each client the ability to adapt and tweak their setup without affecting other clients' setups. The standardization that the API brings simplifies interoperability between the IS and GWEN.

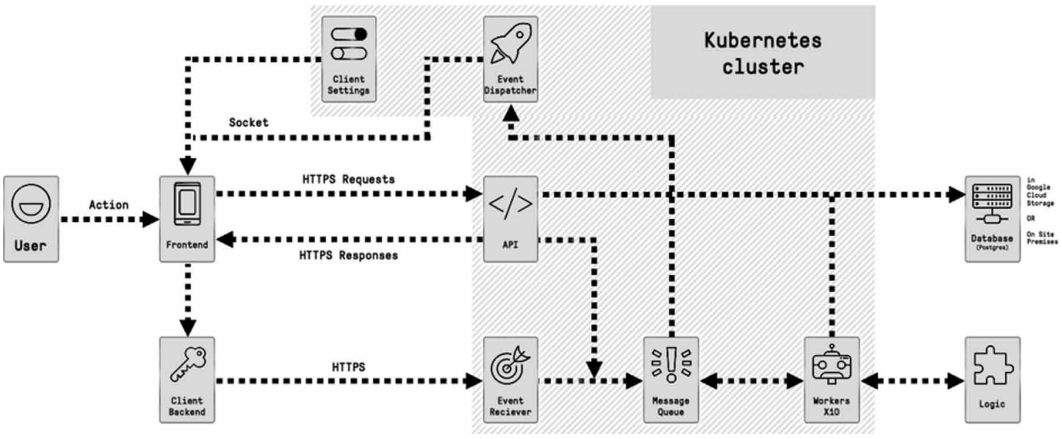
MAIN FOCUS OF THE ARTICLE

Method

The study employed a multi-sited ethnography approach (Marcus, 1995), in which the unit of analysis was followed across temporal and spatial boundaries. This method makes it possible to circumvent dichotomies such as local–global (Marcus, 1995) and virtual–real (Beneito-Montagut, 2011). There exist several reasons for multimethod approaches. One reason is triangulation used to grasp a broader understanding of phenomena investigated (Carter et al., 2014). Another reason is that the multiple sources of data ensures a higher degree of reliability and validity than a singular source (Venkatesh & Brown, 2013). Multi-sited ethnography has been criticized regarding its cross-context comparative nature (Coleman & von Hellermann, 2012). To compensate for this concern, the authors followed the project with a fixed reference point for analysis. The second and third author was part of the case to follow it precisely, whereas the first author took a more objective and unbiased view of the project. This also enabled the researchers to view the case in terms of different people, situations, events, and the processes (Maxwell, 2012). Bartlett & Vavrus (2017) state that if the full potential of the method should come in play there needs to exist rich sources of data from several of the sights important to the investigation. Therefore, the authors initially identified, collected and analyzed potential data-points. The data-points included:

1. Participant observations of three meetings: one introduction meeting, one strategy meeting, and one gamification design workshop with stakeholders from the startup firm and the manufacturing organization.
2. Communication between and with the different stakeholders in the project.

Figure 1. The gamification API platform architecture



3. Documentation in the form of summaries, gamification design suggestions and front-end implementations mock-ups.

The involvement of the second and third author provided the possibility to employ a design science research methodology (DSRM). The DSRM (Peffers et al., 2007) describes a structured procedure for research based design initiatives. DSRM applies a step-by-step instruction of development and design of IT artefacts and their evaluation in order to solve identified problems. In the present case, the author pursued the first three first sequences of the DSRM (Figure 2.).

Phase One: Identify and define problem

A gamification design workshop was a conducted by the second author together with the third author who worked with the project as a designer from the gamification studio. The workshop focused on identifying difficulties when using the HMS.

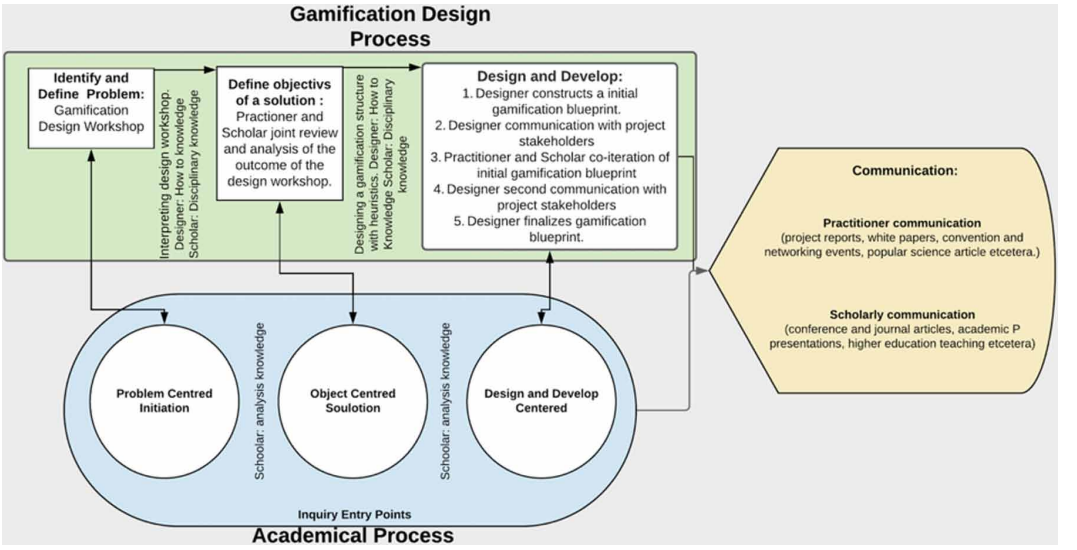
Phase Two: Define Objectives of a solution

From the gamification design workshop objectives in the form of key performance indicators (KPIs) were set.

Phase Three: Design and Develop

Author 3 (gamification designer) created the gamification design blueprint based on *Target Audience Mapping*, *Gamification Need Analysis*, *Gamification System Suggestion*, and *Gamification Mechanics Proposal*. The design blueprint, later wireframes and mockups, was iterated back and forth between the client and author 3 based on the importance of the solution objectives discussed and negotiated between the different iterations. In the demonstration of the upcoming design the designer used high-fidelity wireframes to demonstrate the interface, including visual markers and branding signifiers, colors, graphics, simple animations and font style.

Figure 2. Gamification design process



RESULTS

Phase One: Identify and Define Problem

The workshop participants were a diverse group of six different project stakeholders put together according to the gamification implementation requirements suggested by Herzig et al. (2015) (Table 1.). The first stakeholder group consisted of a trainee and senior researcher, representing the end-users who were using the HMS daily and would encounter the gamified IS. This enabled a real-world understanding of potential issues and problems. The second stakeholder group represented domain-experts with knowledge of the product application areas and its intended end-users. The domain-experts had a high understanding of several aspects of HMS with interest in improving it and could thus provide insight into the motives with the project. The third stakeholder group was business experts responsible for the overall project, budget, deadlines, interest, and project goals. The fourth stakeholder group was the HMS lead developer with expertise in the present IS who comprehended the existing IT landscape of the traditional company and was responsible for the integration of new components and tools into the existing infrastructure. The fifth stakeholder group was the gamification designer (author 3) and two assistants, with expertise in designing gamification for learning. The gamification designer had a background in automotive engineering suitable for the case. Lastly, the second author participated as a participant-observer and a member of the group being studied, being aware of the activity in order to better understand the socio-technical aspects of the HMS (Myers, 1997).

The gamification designer organized and lead the design workshop through different brainstorming sessions and exercises, e.g., Affinity Diagram and Dot-voting based on the techniques of Hanington & Martin (2012). The purpose was to gain insight into the HMS, its components, its users, and the intended outcomes of the project. The design workshop took about four hours to complete. The exercises explored the system's target groups' age, gender, how often they used the HMS, and what kind of personality they had. The target groups' attitudes and opinions towards particular subjects, e.g. gamification and their digital experience. Moreover, the gamification designer asked questions about the current obstacles with the HMS, about the goal of the gamification implementation and what key performance indicator (KPI) should be evaluated. The collected information was later refined in a gamification design document. The document contained User-Personas, a User-Journey, and Implementation Goals. This document assisted the design decisions in the gamification development process and functioned as an initial blueprint for the gamification design. The user personas were based on the following four different target groups; university students, technicians, biotechnologists and designers. The user groups were described, and main obstacles were discussed. The obstacles were related to low computer literacy and difficulty in learning the tools. The biotechnologists who were expected to have varied levels of computer literacy were expected to encounter problems with

Table 1. Participants in the design workshop

Design Workshop Role	Project Role	Affiliation
Leader	Gamification designer (author 3)	Startup firm
Observer	Gamification researcher (author 2)	University/Research Institution
Observer	Assistants	Startup firm
Contributing Participant	End users	Manufacturing company
Contributing Participant	Domain-experts	Manufacturing company
Contributing Participant	Business-experts	Manufacturing company
Contributing Participant	Lead-developer	Manufacturing company

learning the system. In the user journey similar themes emerged with the main obstacles identified being difficulties in learning, understanding and gaining flow in the system.

Phase Two: Define Objectives of a Solution

To define the objectives for a solution several measurable KPIs were discussed in the workshop and later summarized to eleven KPIs (Table 2.). The main type of measures (qualitative and quantitative) were distinguished together with the degree of importance and suggested evaluation method. The most important KPI was determined to make new users proficient faster. The other KPIs were related to increased use, i.e. make the HMS a natural part of the day to day use, increase number of reports and users; ease of use, i.e. decrease support mails; usefulness, i.e. make the HMS an educational tool; equality, i.e. increased diversity of users; and competitiveness, i.e. increased use in comparison to other tools.

Apart from measurable KPIs used for evaluation of the projects several KPIs as moderating factors were produced to guide the gamification design. This included creating a sense of competence, accomplishment and pride, providing onboarding and guidance, enhancing exploration and engagement, and reinforcing learning behaviors.

Phase Three: Design and Develop

The gamification designer (author 3), used an adapted framework based on the practitioner-orientated *Six Steps* Framework by Werbach & Hunter (2012) and *Gamify* by Burke, (2016) when constructing the intended gamification design. Author 2 contributed with research articles on gamification including several iterations with the stakeholders as recommended by Morschheuser et al. (2017), Herzig et al. (2015) and Shahri et al. (2019). The domain and business experts provided ideas and design recommendations that had participated in the workshop via email. The following email thread transpired between the participants from the manufacturing company.

Table 2. Participants in the design workshop

KPI	Degree of importance	Measurement	Suggested evaluation method
Make new users proficient faster	Most important	Qualitative	Interviews and surveys
Make the HMS a more natural part of the day to day work	Important	Qualitative	Interviews and surveys
Make the HMS an educational ergonomics tool	Important	Qualitative	Interviews and surveys
Increase number of reports produced using the HMS	Important	Quantitative	Reported by each department
Increase number of licensed users	Important	Quantitative	Reported by each department
Decrease amount of support mails	Important	Quantitative	Reported by each department
Increased diversity of users	Important	Quantitative	Surveys
Increase number of educated people	Important	Quantitative	Reported by each department
Increased number of HMS users	Less important	Quantitative	Reported by each department
Increase number of requests for reports	Less important	Quantitative	Reported by each department
Increase use of the HMS in comparison to competitive tools	Less important	Quantitative	Interviews and surveys

Email from Participant 1:

"I see several possibilities to gamify this, e.g. you could get points for each completed part in the video in proportion to how similar the SIMs [System information modeling] movement is to the instruction. If you take it one step further, the SIM in the instruction can be based on mo-cap, so we know the real movement in detail, like ground truth. This type of video assignment would, of course, only be part of the game-play. What do you think?"

Email answer from Participant 2:

"It is in line with what we have talked about. I like the suggestions that are more game-y, a best practice learning path as in adventure games or points system for using the simulation in HMS. I want to skip the more traditional instructional video. They are good but do not feel like gamification. We present the thoughts to the management new Wednesday"

Email answer from Participant 3:

"Gamification could work well as an augment and fun onboarding to make the learning curve less step and more engaging, thereby reducing the time for the users to become a full-fledge practitioner of the system, a superuser. The purpose of the gamification could be to more quickly familiarize with the HMS. Some design thought: The gamification constructs a prearranged user path (Missions) so that users can more easily learn the complex HMS. The assignments on prearranged user paths are ticked when the user has reached approved criteria in HMS simulation; otherwise the simulation has to be redone until an accepted metric is reached. We also talked about instructional videos that could serve as a guide for how the user could become a superuser. These would suggestively increase in complexity based on the user's progression (Levels). The feedback that the HMS provide could be part of the gamified content with a meta-cognitive aspect where users self-evaluate their progression (Evaluation). The user can become a better user by reflecting on, for example, risks and contemplate on the feedback that the HMS provides. We also talked about the possibilities that specific weekly, monthly, quarterly goals that the user is expected to achieve. It could be done with achievements. What do you think about this? Does it fit your expectations regarding the gamified project?"

Conclusively the gamification designer (author 3) decided upon four gamification modules as foundational blocks to the gamification design based partly on informal discussions and iterations with author two and the subject matter experts who participated in the design workshop. The gamification modules (Level, Mission, Achievement and Reward/Shop) were chosen from the Gamification APIs modifiable modules. Each module can be broken down into components from Werbach and Hunter (2012): The "Level" module was mainly constructed with the components Avatar, Points and Level, "Mission" with the Quest component, "Achievement" with Badges and Points and "Reward/Shop" with Virtual Goods. In addition to this setup, the modules are also able to interact with each other through experience points (xp) or coins. A common scenario would be that a user completes a mission and is rewarded with xp, this in turn raises the total xp to the amount needed for a new level. A level up is triggered, and the user is rewarded coins that s/he can use in the Reward/Shop module.

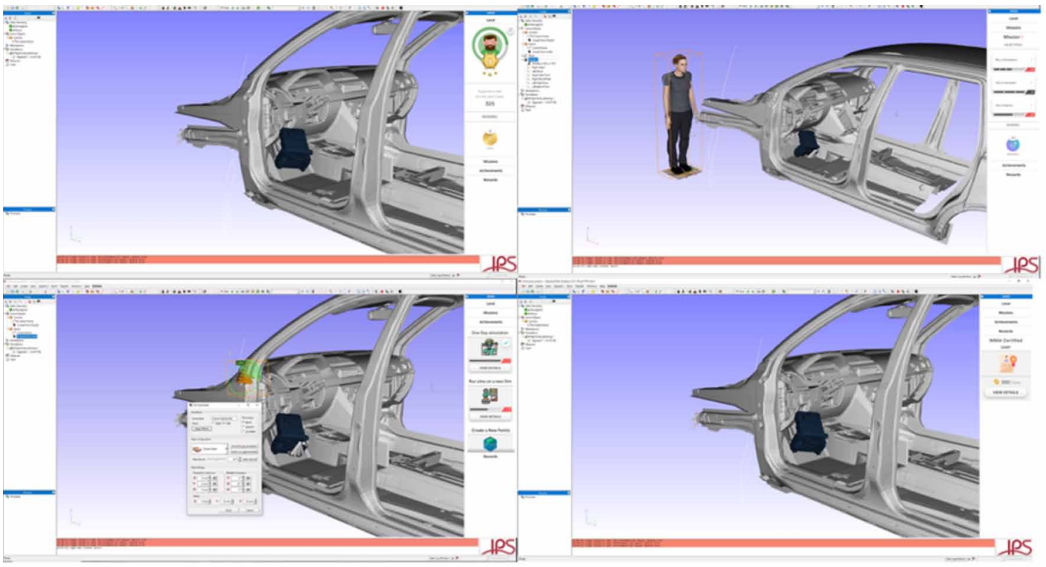
Apart from being based on the communication with the manufacturing company and the initial workshop, the gamification system was derived from the role that the different game elements were expected to serve in the system, the main goal with the elements and the connected KPIs (Figure 3). Of the modules mentioned above, the mission module became the main focus of the gamification effort, as it was regarded as the one most likely to increase the ease of use for new users, and thereby

Figure 3. Gamification System Suggestion

their adoption of the HMS. The Achievement module was regarded as secondary, since it acted as guidance towards additional functionality, with the aim of having the user explore more of the tool.

The first implementation of the gamified API was executed at the gamification startup company's staging environment. The studio added a gamification toolbar in the right corner of the screen, unifying the gamification API containing the different game modules with the HMS-tool interface (Figure 4). For the demonstration of the upcoming tools the designer used high-fidelity wireframes to demonstrate the interface, including visual markers and branding signifiers, colors, graphics, simple animations, and font style. The gamification implementation in the interface was reasoned by the

Figure 4. Integrated Gamification



gamification designer to be located at the right corner due the white space of the original interface design, not interfering or blocking any vital functions in the design. Therefore, it was reasoned that the cognitive user load would not be affected by the interface addon.

However, as the project continued, a month after the visualization of mock-ups, it was revealed that the studios cloud-based API could not be implemented in the manufacturing company intranet due to security policy at the company. Therefore, the implementation had to be made through an external proxy server HTML-based widget instead which simplified the system architecture of the implementation (Figure 5). However, this alteration in the implementation architecture caused the back-end and front-end structures, object IDs and authorization IDs, between the API and the DHM-tool to conflict. Consequently, the idea of a comprehensive implementation had to be omitted in the project, which altered the product's interface (Figure 6).

Discussion and Future Research

The present case followed a practical gamification design science research project through a multi-sited ethnography standpoint investigating what transpired between a traditional manufacturing company and a gamification startup when gamifying an HMS. Compared to previous research on

Figure 5. Temporary Architecture

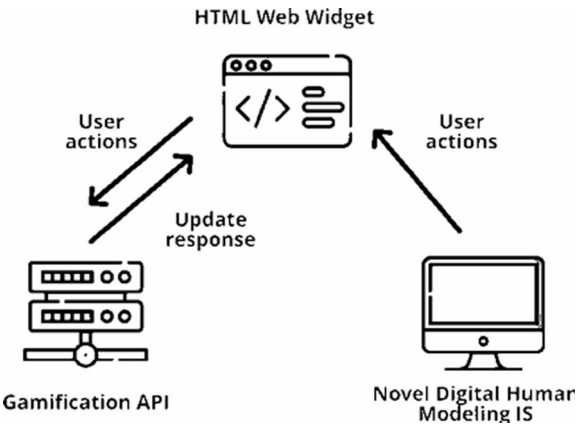
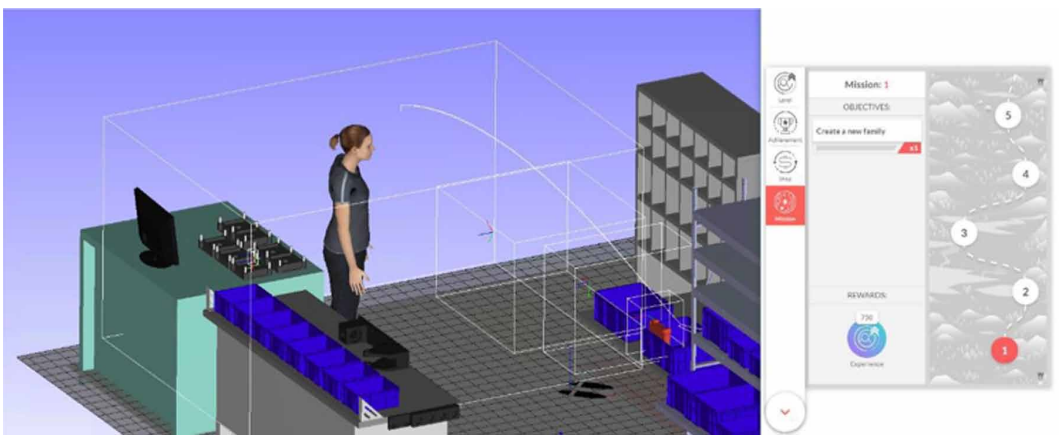


Figure 6. Interface Controlled by The Temporary Architecture



gamification, which has focused mostly on the field of education (Koivisto & Hamari, 2019), the present application of gamification involved the use of gamification for system acceptance and use. The collaboration between the start-up and the traditional manufacturing firm initially went smooth, enabling an iterative and fast design process that resulted in an initial design that was appreciated by the manufacturing firm. In the process a mix of user experience (UX) methods and gamification design frameworks were applied, and an overall design science research method was used, moving from problem identification and solution objectives to design and development. Gamification design uses different techniques. In the displayed case, the lack of a comprehensive, functional and foremost validated design framework that incorporated both practitioners' gamification know-how and scholars' knowledge of the gamification discipline called for the reliance on several methods. The use of methods was enabled through a design workshop with relevant stakeholders. Previous research has described design workshops between gamification designers and stakeholders as important in order to outline the gamification design (Herzig et al., 2015; Morschheuser et al., 2017). Herzig et al. (2015) suggest that a team of multiple roles should come together and discuss before designing, developing, and implementing. In the present case a practical example was provided of how different stakeholders can come together and provide valuable insights to the design process. Compared to a more traditional design science research approach (Peffers et al., 2007), the present case did not involve theory in the design process. This was both due to a lack of comprehensive research that covers best practices of gamification connected to aiding the acceptance and use of information systems (i.e. Jedel & Palmquist, 2021) and partly due to limited time resources in the project. Therefore, it is recommended that further research and frameworks focus on more holistic and practical frameworks of gamification design and development in several contexts. A late understanding of technical compatibility between the systems was identified in the case. Therefore, technical due diligence based on compatibility between systems should be conducted in the early collaboration phase, especially in projects between traditional firms and startup organizations. Designing and implementing gamification is not only an issue of if it should be implemented but more so and issue of how it should be implemented into varied contexts and what needs to be considered in the implementation phase. Nuance is needed related to how gamification is implemented, the involvement of different stakeholders and issues that can arise. Additional industrial research and practical cases demonstrating gamification implementations are needed.

CONCLUSION

Gamification could be a powerful accelerator for the manufacturing industry. However, more research is needed in gamifications applications beyond education. Here, a case is presented in which the development of a gamification design is followed in collaboration between a traditional manufacturing firm and a gamification start-up firm. The practical use of different methods and their interference toward the design is presented and compared with conceptual views of gamification design. The findings show the need for early technical due diligence in collaborations between newer and older firms as well as the need for more comprehensive gamification frameworks to support industry design of gamification in different contexts.

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