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The Challenges of Designing Learning Games: Interviewing Professional Learning game Designers

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Abstract: The professional practice of designing digital learning games has existed for more than four decades. Even though considerable work has been done on research and development projects that include learning games (e.g., through Design-Based Research projects), there is relatively limited research on how professional learning game designers work, and what design challenges they face when trying to develop learning games for K-12 educational contexts. In this explorative interview study, we take a closer look at the design challenges that experienced learning game designers face during the design process, and what complexities and dilemmas they need to balance in doing so. The interview study is based on extended semi-structured interviews with five experienced learning game designers from five different learning game companies from Europe and the US. Having transcribed and coded the interview data, we conducted a thematic analysis to address the following research question: How do learning game designers experience and manage the different knowledge forms and design challenges that emerge when developing games for K-12 educational contexts? To answer this question, we draw on insights from design theory and domain theory, which allows us to map and analyse how the learning game designers try to establish links between different forms of knowledge across three domains: the pedagogical domain, the disciplinary domain, and the game design domain. Based on the thematic analysis, we identify three design principles across these domains, which are central to the learning game design process: 1) creating a shared language and repertoire for the involved actors (e.g., game designers, subject matter experts, and educational practitioners) across the three domains, 2) establishing meaningful links between educational aims and game elements, and 3) considering the educational context of the learning game. Addressing these design principles are all crucial, when engaging in the highly complex task of designing games for educational purposes.

Keywords: learning game design, domain theory, design theory, design challenges, K-12

1. Introduction

The professional development of digital learning games has been going on for more than four decades (Egenfeldt-Nielsen, 2005). In the beginning, learning games were based on simple designs, often based on simple skill and drill exercises or multiple-choice questions wrapped in primitive graphics and loose narratives. However, much has happened since the early days. Nowadays, digital learning game designers have a broad range of technological tools to choose from when creating new designs. Despite these technological developments, learning games have repeatedly been criticised for a lack of solid integration between game mechanics and learning goals, which may lead to poor learning outcomes. Several researchers have addressed this challenge when designing their own learning games. One example of this is Habgood and Ainsworth's (2011) study, which demonstrated the importance of ensuring meaningful integration of game mechanics with curricular knowledge to support the students' mathematical learning outcomes.

Despite the large body of research on games and learning, there exist relatively few studies on how professional learning game designers actually work and what challenges they face as a part of their professional practice. Designing learning games is a relatively complex process, which involves integration and use of expertise by actors from many different domains such as game developers, subject matter experts, and practitioners that are experienced in teaching the target domain of the game. In this way, the aim of the current study is to explore how professional learning game designers address the complexities of learning game design processes. Our research question is: *How do learning game designers experience and manage the interplay of different knowledge forms across domains that emerge when developing games for K-12 educational contexts?* To limit the scope of the study, we have focused only on design cases that relate to primary and secondary education (K-12). However, we will argue that our findings may also be relevant in relation to other target domains when design learning games.

2. State of the art

There exist several studies, which describe the development of digital learning games (de Freitas & Oliver, 2005; Kiili, 2005; Yusoff et al., 2009; de Freitas & Jarvis, 2009; Marne et al., 2012). The studies all show that the development of learning games is complex, and that many different types of knowledge are involved in the development process. This is also emphasised by Arnab and Clarke (2017), who presents a transdisciplinary methodology for developing learning games (or "serious games" as they call it). The model describes different phases of learning game development (pre-production stage, production stage, post-production stage), which each involves different steps such as mapping the learning goals of a game, the choice of methods for the design process, what experiences the game should create, how the game should be linked to the learning games etc. However, the model does not describe how the interdisciplinary collaboration can or should take place, or what challenges that such collaborations may create, which is the focus of the current paper. An interesting paper worth mentioning in this regard is Linderoth and Sjöblom's (2019) two case studies of learning game development at a national defence college and at a university course. The authors argue that learning game development benefits the most from the involvement of stakeholders, who both have pedagogical content knowledge and experience in game development.

3. Methodological approach

The study is a qualitative case study that involved interviews with learning game development companies who develop digital learning games or serious games. This involved extended semi-structured interviews with five experienced learning game designers from five different learning game companies spread out across Europe and the US.

The learning game designers were selected according to several criteria. First, we were mainly interested in interviewing experienced learning game designers. In this way, we only selected professional designers, who had or have had more than 10 years of experience as a leading role in a company that develops digital learning games or serious games. Moreover, we were interested in talking to designers, who had broad experience with learning game development. In this way, the learning game designers' areas of responsibilities should cover both organisational and practical development of learning games. We also ensured that the selected designers were willing to share experiences from their professional practice that included whatever challenges they had faced in the design process. Lastly, we decided that the designers should have a comparable academic background within the fields of game studies, education, or digital learning. This should ensure that the game designers would use the same shared language.

One of the authors interviewed the designers using a qualitative semi-structured interview guide (Brinkmann, 2013). All interviews focused on development of learning games with a specific focus on how the designers had worked with bridging the game development with the pedagogical content knowledge in the development process. The interviewees all reflected on and described how they involved professional participants from different domains within game development, subject matter content and when developing digital learning games. Before the interviews, each game designer was asked to select two learning games that they had designed for K-12 to secure reflections on specific games and create possibilities for comparison across the interviews. The interviews lasted from 48-106 minutes. All interviews were recorded, transcribed, and translated into English. See table 1 for an overview of the interviews.

Table 1: Overview of the interviews.

Informant	Length	Context for interview	Information
A	106 min.	Participant's workplace	CEO and founder of a learning game company. PhD in games and learning. Does sales and more client-oriented tasks. Starts the scope and concept phase.
B	48 min.	Online interview	CEO and founder of a learning game company. Holds a Master's degree in Educational Technology. Focuses on the financial parts of the company, marketing, HR, and administration.

Informant	Length	Context for interview	Information
C	59 min.	Online interview	Co-founder and Creative Director of a learning game company. Holds a Master's degree in Media Science. Does creative development, concepts, designs and production.
D	57 min.	Online interview	Self-employed and former Principal Designer at a learning game company. Holds a Master's degree in Entertainment Technology. Was in charge of managing the overall design process, pitching ideas and concepts to clients and establishing best practices when designing and developing learning games.
E	43 min.	Online interview	Owner, co-founder, and Creative Director of a learning company. Holds a Master's degree in Interaction Design. Does sales and more client-oriented tasks. Starts the scope and concept phase.

As illustrated in the table above the interviewees' both academic and professional background have a large range of similarities, including years as owner or founder of a learning game or serious game company. Furthermore, they have an average of 10 years in developing learning games. However, Informant D's professional background differs from the rest as this informant has not been the owner or founder of a larger learning game/serious game company. We still find this informant relevant as the criteria stated above is met.

It is important to highlight that one of the authors of this article has been working in informant A's company since 2020. All the interviews were conducted in 2021. To establish an open and honest interview situation, the other informants were informed by this professional relationship before conducting the interviews. However, the author's own position in the field and her professional relation to informant A may have influenced the data.

Having transcribed and coded the interview data, we conducted a thematic analysis (Braun & Clark, 2006) to answer our research question. The thematic analysis involved going through the following six steps: 1) Becoming familiar with the data through transcription, reading and re-reading the data, 2) Generating initial codes by coding interesting features of the data in a systematic fashion across the entire data set, collating data relevant to each code, 3) Searching for themes by collating codes into potential themes, gathering all data relevant to each potential theme, 4) Reviewing themes by checking if the themes work in relation to the coded extracts and the entire data set, generating a thematic map of the analysis, 5) Defining and naming the themes by refining the specifics of each theme, and the overall story the analysis tells, generating clear definitions and names for each theme, and 6) Producing the report, which include selection of vivid extract examples that relate back to the research question and relevant research literature. Based on the thematic analysis, we identified three analytic themes central to the learning game design process, which we will unfold in section 5.

4. Theoretical perspectives

In order to address and understand the challenges involved in designing learning games, we will use domain theory as an analytical lens (Hanghøj et al., 2018). According to domain theory, the design and use of games for learning are always enacted within and in relation to particular domains understood as "structured, patterned contexts", in which specific practices unfold (Barton & Hamilton, 2000, p. 11). Building on the domains identified by Hanghøj et al. (2018) and the design challenges described above, the specific domains involved in the process of designing learning games involve:
1. *Pedagogical domain*, which refer to how teachers conceptualise, adapt, and use games as a part of their pedagogical practices in a classroom context.
2. *Disciplinary domain*, which refer to specialised knowledge practices within disciplines such as mathematics, history or science, or expert knowledge of cross-curricular topics such as immigration or health, which may be embedded in a specific learning game.
3. *Game design domain*, which refers to the specialised practices of conceptualising and developing games.

We assume that the process of designing games for learning requires a complex interplay between these three domains, which often require negotiations and close alignment of different interests and knowledge types. As an example, it is often emphasised that learning game designers should strive for *endogenous* game designs,

where the learning aims is closely integrated with the game mechanics, in contrast to *exogenous* game design, where there is no or only limited link between the two aspects (Squire, 2006; Habgood & Ainsworth, 2011). Moreover, we assume that the process of designing learning games tends to involve different actors from three domains, e.g., teachers, subject-matter experts, and game designers. The relationship between the three domains is shown in Figure 1 below:
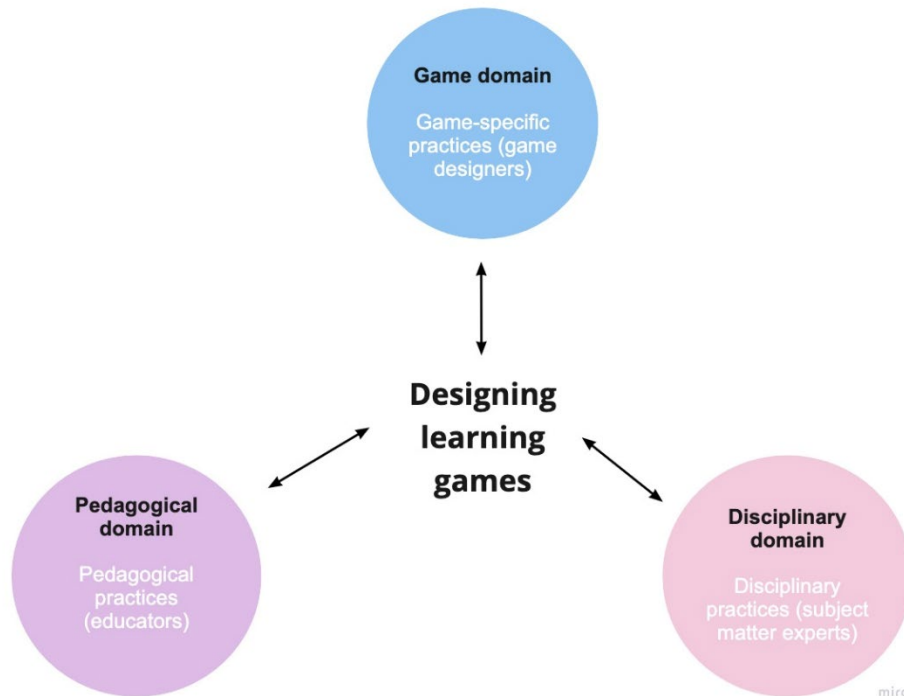

Figure 1: The domains involved in designing learning games

In practice, it may be difficult to draw clear boundaries between the three domains as they are often blurred, e.g., a teachers' use of a specific game in the pedagogical domain will also depend on the teachers' disciplinary understanding of the specific topic of the game. However, through the analysis we show that the three domains make sense as analytic and conceptual categories, which are all highly important to the learning game design process.

5. Analysis

We will now introduce the three themes, which we identified through our thematic analysis of the transcribed and coded interview data.

5.1 Theme 1: The trinity of designing learning games

Patterns across the interviews show that the design of a learning game calls for close involvement of actors across the three main domains - the game design domain, the pedagogical domain, and the disciplinary domain. As A describes it, someone must know how to design a game, someone must know something about the specific curricular content of the game, and someone must be knowledgeable about the context in which the game is going to be played.

C confirms A's statement about bringing together the subject matter experts, who hold the specialist content knowledge, the educators/teachers, and the game- and interaction designers. He argues that they form "the trinity of learning games" and that they need to be brought together in the beginning of the process and then touch base regularly to keep the process on track (Interview with C). This shows that it is key to involve actors from all three domains when designing a successful learning game. Each domain covers a range of different actors spanning from game designers to teachers and subject matter experts within a specific field. When developing a learning game, according to A and C it is essential to collaborate across the domains, but also to get a mutual understanding of not only the game but also each other's domains and how they can contribute to the game development process.

However, bringing experts together from different domains might also be problematic. B argues that the *exchange* of knowledge across domains can be difficult as actors from a certain domain might not be able to transfer or translate their knowledge to other domains. This could be subject matter experts or educators trying to apply their subject specific knowledge into a game format:

> *"Oftentimes, experts, like traditional experts in teaching a particular subject, can be as much of a liability as an asset. It just sort of depends on the extent to which that individual has the literacy that makes the jump from how that subject is traditionally taught, whether lectures or books or movies or what have you, to the game-based format" (Interview with B).*

This quote shows how bringing educators or teachers into a game development process has its pros and cons. The outcome of the collaboration between the experts is highly dependent on the extent that the actors from the domains outside the game design domain manage to "bring" their knowledge into the game domain.

A worst-case scenario could be that the game designers will not have access to experts from the subject matter expert domain. Consequently, the designers will have a difficult time figuring out how and what content that is relevant to meet the learning goals of the game. In that case, the game designers will not be aware about what areas of the subject that are interesting to include in the game but also what is important to include in the game's learning goals. One learning mentions a specific project, where his company failed in getting hold of relevant subject matter experts and had to start the design process before they had knowledge about the subject matter:

> *"That meant that the whole game got turned upside down. It is a flawed game because you start designing a game before you even know what problems to solve. That is not the optimal process" (Interview with A).*

This quote puts an emphasis on how the disciplinary domain is linked to framing the problem, i.e., the main challenge in the game as starting point for the learning game development.

The presented perspectives in this theme underline the importance of involving actors from both the pedagogical, disciplinary, and game design domain. All the informants agree on this matter and stress that all domains can contribute with valuable knowledge throughout the whole game development process. At the same time, there may also be highly problematic and challenging areas of collaborating across domains as all actors might not have a common understanding of how much and to what extent they can contribute to the design process.

5.2 Theme 2: Combining game elements and learning elements is key

The access to and understanding of specific learning content plays a significant role when developing learning games. Patterns across the coded data show that the learning game designers all assign the learning content and learning objectives an important role in the development process. However, acknowledging the importance of learning content alone does not make a learning game. Rather, it is essential to combine the learning elements with game elements when designing learning games. There must be a meaningful connection between what players do and experience in a game and what they are supposed to learn.

As an example, A explains that it is very important that the learning goals and the goals for the game overlap, so the game play and the learning are not decoupled. On top of that he uses the term exogenous design, cf. Squire (2006), to explain that learning game design must focus on connecting the learning content to the game contexts in which the player participates in. B confirms this statement by saying that when going into a design process the company always asks themselves:

> *"What are the learning objectives and then what are the game play mechanics that's going to serve those objectives? (...) so that it is by mastering the game [that] the players master those objectives" (Interview with B).*

Thus, B points to the relation between the disciplinary domain (learning objectives) and the game domain (game mechanics), but also indirectly to the pedagogic domain (by mastering the game process you master the objectives) meaning that the game mechanics are integrated with the learning approach.

As explained in the previous theme, actors from the game design domain are highly reliant on actors from the disciplinary and pedagogical domain being able to contribute with relevant subject matter knowledge and pedagogical knowledge to the design process. But the collaborations between the three domains can be challenging:

> *"...one of the challenges is like teasing apart their expertise ... whether it's a faculty or an educator or a subject matter expert in the field, or a researcher teasing apart their expertise on the domain and how to teach the domain, using things other than games, and then translating that in the best way possible into an interactive digital experience. And it's as much about figuring out what to discard as it is about what to be influenced by" (Interview with B).*

In this way, the content subject matter experts and educators must contribute with the most important knowledge, but the collaboration between actors from the different domains also includes discussions around what knowledge to keep and what to discard. E has faced similar challenges when working together with historians when designing a game about WW2:

> *"For them [the subject matter experts], everything needs to be in the game (...) So, I think the most pain that we have in that process is that we need to eliminate, eliminate, eliminate, and eliminate, because it is not about historical correctness. It's about the experience of the child." (Interview with E)*

In this quote we get a sense of how complicated the process of both collaboration between domains can be, but also how difficult it can be to select the specific subject matter knowledge that will add value to the game experience, which itself lies within the pedagogical domain in the context of learning.

Like E, B also have had challenging experiences when working with subject matter experts. When researching and developing a biology game for children, the game developers collaborated with scientists. This resulted in discussions about the level of detail in the learning content of the game:

> *"... it was very important to him [the scientist] ... how what we displayed in the game was exactly how it worked in the real world, which, you know, if you're overzealous about that, you can blow your entire budget on fidelity that doesn't actually contribute in any meaningful way to the learning objectives. So, there was a lot of give and take in that process" (Interview with B).*

This example shows how game designers and the scientist needed to collaborate across domains and agree upon what subject matter knowledge is important to include in the game.

When developing learning games not only the game design, but also the learning content and the learning objectives must play an important role. Other than that, the focus must be on how to integrate and connect the subject matter knowledge into the game context and the game mechanics. The theme also highlighted that the collaboration across domains can be challenging when deciding what and how much of the subject matter knowledge to include in the game. They had to find the pedagogical domain as the potential middle ground between subject matter and the game domain.

5.3 Theme 3: The school as context for learning games
The context is an inextricable part of all educational games. Across interviews, informants describe the school context and the teacher as something that weighs in on the development of learning games played in K-12 educational contexts. This highlights the pedagogical domain as an important part of the design process.

The pedagogical domain is not only something to consider and involve at the end of the process but must be given a place from the get-go. Especially E stresses the importance of including the context early in the design process:

> *"I would say that 60% of the success of your serious game is the context in which it's played. So, it's even more important than the game that we design ... And this is something that we try to get our clients involved in as soon as possible" (Interview with E).*

E clearly considers the context to be crucial for the learning outcome and that the context is even more important than the games itself. This argument is confirmed by an utterance by A that describes how his view on the context has changed from seeing the game as an isolated artefact detached from the context to now

considering the context even more important than the game itself. This is supported by B that explains how he views the context when designing learning games:

"Context definitely weighs heavily into the early design decisions, and everything is bespoke, right? So, it's all: What's the best design for the envisioned context in which the user is using the game and who is that envisioned user and what are their needs" (Interview with B).

Like the other informants B also gives the context a prominent place in the development process which again underlines the importance of including actors from the pedagogical domain early on in your development process. Regarding this specific domain, you cannot get around the teacher and her role in using games in the classroom. When using games in a K-12 educational context the teacher plays an essential part of facilitating and guiding the students' use of the game.

"Well, the fact that you have a class with a facilitator is a God-given opportunity to create unique and game and educational experiences" (Interview with A).

But giving the teacher such an important role also challenges the development process and the actual design of the learning game:

"[Y]ou have to understand as a designer that the teacher in front of the class is vulnerable in a way. She's exposed. And this means that the interaction of the application that you are creating should be so clear that no mistakes can be made." (Interview with E)

Furthermore, using games in the classroom is a lot different from using traditional teaching materials like books. Therefore, using especially digital games in the classroom can potentially be a dangerous experiment for teachers:

"[U]sing a game in the classroom is ... a very dangerous experiment because many things can go wrong. Technology can fail, kids can become way too enthusiastic so that takes you at least two hours to get them focused again. So, there are so many aspects that make it for the teachers a high-risk experiment, so that even if they sort of, fakely like to do it, then they rather just pick a book and read to the group because there is no risk in that. So that makes it a harsh environment" (Interview with E).

Here, E sees the risk of using educational games when teaching. A risk that teachers must consider taking. Again, that stresses that the teacher's role must be taken seriously in the development and design process, because using games in teaching requires different and other competences from the teacher than traditional teaching materials do.

The way the informants describe the context and the teacher's role shows us that the pedagogical domain is highly important when designing learning games. Developing games for a school context is not only about designing a fun, challenging and visually appealing game, but knowing that the context affects both the development and the actual usage of the game directly. Furthermore, the above underline the significant role that the teacher's plays when using learning games in the classroom. Therefore, teachers and their professional practice must be taken into consideration in the design process.

6. Discussion

According to Baumgartner and Bell (2001), it is crucial that educational researchers can articulate and work with specific *design principles* to guide their design experiments and development of educational technology. Similarly, we wish to argue that the findings from the three analytical themes in the analysis can be used to articulate three generic design principles, which may inform learning game designers when scoping, researching, conceptualising, and developing learning games. The first design principle relates to the need for collaborating across different domains and may be phrased as *the importance of creating a shared language and repertoire for the involved actors (e.g., game designers, subject matter experts, and educational practitioners) across different domains*. The second principle, which builds on findings from the next analytic theme, concerns *the need for establishing meaningful links between educational aims and game elements*. Finally, the third design principle concerns the importance of *considering the educational context of the learning game as a key aspect of the design process*.

6.1 Limitations of the study

There are important limitations to the study. First and foremost, the data reported in this paper is solely based on interviews. The interviews were conducted during a COVID-19 lock-down period, which made it impossible to make observations of the informants' daily work routines, development process and workplaces. Therefore, the data only builds on the informants' own reflections, descriptions, and recollections of their professional design practices. That makes it impossible to get a full overview of the design process and the context they refer to in the interviews, which then only shows us how the informants reflect on the knowledge they use when developing learning games. Moreover, we cannot tell if there are important discrepancies between what the learning game designers say and what they do (Brinkmann, 2013).

Secondly, there may be an issue with biases in the interviews. One example of this is that one of the authors of this paper has a close relationship with informant A as she has been working at A's company since 2020 and had therefore been a part of the learning game development field for over one year when conducting the interviews. This has given the specific co-author a dual role, as she was both a researcher and a participant in the field that she was researching. All informants were informed about this dual role of the interviewer before conducting the interviews. However, it is difficult to say, if informants would have responded otherwise, if the interviewer had not been affiliated with a learning game developer.

7. Conclusion

In this paper, we have analysed how five different learning game designers experience and reflect key aspects of their daily design practices when trying to design learning games for K-12 educational contexts. The study finds that learning game design is a highly complex and challenging process, which requires close interplay of different types of knowledge across different domains (game design, pedagogy, and disciplinary knowledge) to create a shared understanding of the game to be designed. We found that it is especially important to create meaningful links between learning goals and game mechanics as well as ensuring relevance of the game design to the pedagogical context in which the game is used. In our future work, we would like to further elaborate and validate design principles, which address these aspects.

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