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Abstract: Even though there is a long tradition for letting students play and design board games in the classroom, there exist relatively few studies, which conceptualise how students can learn through designing educational board games. In this paper, I present a theoretical model, which can be used to understand and inform how students work with board game design activities, and how this may require them to address specific dilemmas and complexities in their design processes. The presented GEC model (Games as Educational Challenge) builds on earlier studies, but is presented here in an adapted version, which focuses specifically on students' game design processes. The GEC model is exemplified with empirical data from the large-scale intervention project GBL21: Game-Based Learning in the 21st Century (2017-2022), where Danish students (grades 5-8, age 11-14) across 19 schools worked with a design thinking approach to designing game tools that address specific challenges within the school subjects mathematics, Danish and science. The current study focuses specifically on a teaching unit with a 5th grade class, who had to design a board game that addressed challenges with toxicity in online communication. By using the GEC model as a framework for the analysis, the current study highlights three analytical themes concerning: 1) the students' ownership of their presented game design challenges, 2) balancing of game elements versus subject-specific aims, and 3) the legitimacy of creating board games within the context of specific school subjects. By stressing both design dilemmas and learning opportunities, the paper contributes to creating a more nuanced understanding of how students address and deal with different complexities, when creating educational board games.

Keywords: Board games, Learning game design, Primary school, Design thinking

1. Introduction

There is a long tradition in formal education for letting students play and learn through board games. However, until recently, board games have been relatively overlooked within research on games and learning, which has tended to focus mainly on digital games (Bayeck, 2020). Researchers in various fields are increasingly exploring board games as learning spaces (Horn et al., 2012; Zagal et al., 2006). Board games represent appealing spaces for learning because of the simplicity of the games' mechanisms, which are often fairly easy to understand and change, and the focused face to face communication that take place across the board. In this way, the affordability and accessibility of board games make them perfect for providing social and playful learning experiences (Wonica, 2017). The flexible and adaptable design of board games may also explain why this is a preferred game format among many student teachers (Lieberoth & Hanghøj, 2017).

In this paper, I wish to focus on *design-oriented approaches* to board games in the classroom, where primary students are invited not only to play and discuss games, but also to develop their own board game prototypes in response to subject-specific specific design challenges within e.g. mathematics, Danish (L1) or science education. By letting students take on the role as game designers, they are given opportunities not only to develop subject-specific understandings of the content of the game, but also to develop important design competencies such as empathy, modelling, ideation, and process management (Rusmann & Ejsing-Duun, 2020).

This design-oriented approach to working with board games in the classroom has been explored in other studies. One example is the Quest 2 Learn school, where grades 6-12 children work with a design thinking approach to game design, including board games, within a cross-disciplinary curriculum based on systems thinking (Salen et al., 2010). The Q2L school represents a rather unique example of rethinking games, learning, and design processes, which involved support from both game designers and educational researchers. Another example is a study by Cortés et al. (2022), which explores how adult participants are asked to "playfix" a broken game, where the players must eliminate waste material from various biomes of an interconnected water-based ecosystem such as a swamp, a beach, and a river. In the study, the participants knew outright that they would encounter design problems in the games such as ambiguous or missing rules that would interrupt their play, where there was no single correct way to fix these. The key results of the study were less about learning curricular aims, but more on (a) how the participants focused on problem identification, (b) demonstrated quick and sustained engagement with thinking as designers, and (c) drew from multiple designerly modes non-linearly. As these two examples show, the studies exploring design-oriented approaches to board games in the classroom tend to focus less on isolated curricular aims and more on learning general design competencies. In this way,

there seems to be less research on what learning opportunities and challenges K-12 students face, when asked to design board games within a curricular context.

The current study is based on empirical data from the large-scale intervention project GBL21: Game-Based Learning in the 21st Century (2017-2022, www.gbl21.dk), where Danish students (grades 5-8) across 19 schools worked with a design thinking approach to designing game tools that address specific challenges within the school subjects mathematics, Danish and science (Hanghøj et al., 2019). In this study, I focus specifically on a teaching unit with a 5th grade Danish class, who had to design a board game that addressed challenges with toxicity in online communication. In this way, I address the following research question: *How do 5th grade students experience the learning opportunities and dilemmas of designing board games within the subject-specific context of Danish?*

2. Theoretical Perspectives

Taking inspiration from the American philosopher John Dewey's (1933) pragmatism, design processes can be understood as forms of *inquiry* where you have to work with concrete materials as part of a questioning exploration of a specific problem (Rusmann & Ejsing-Duun 2021). Design problems are often complex and are also referred to as 'wicked problems', as it can be difficult to understand how the problem should be framed and where there are rarely obvious solutions (Rittel & Webber 1973). A design challenge can, for example, consist of developing a new food scheme for the elderly in a municipality or finding new ways to deal with problems with harsh language in online forums. Thus, design problems call for a special design skill or specific way of thinking, which includes the abilities to (Cross 2006):

- Solve ill-defined problems – e.g., how to get people to communicate properly on the Internet
- Apply solution-focused cognitive strategies – for example by removing the possibility of using certain words on social media that may seem offensive
- Use educated guesses and further substantiate them – for example by developing and testing certain functions on social media
- Use non-verbal media for modelling proposed solutions – for example by developing prototypes.

By enacting these design skills, design thinking constitutes a methodological framework that can help professional designers to create an overview and structure in the work of addressing complex design challenges (Rusmann & Ejsing-Duun 2021).

It is a key goal of Danish as a subject that students should be able to create multimodal productions, i.e., by moving from an initial idea to draft to final product, collaborating with others, presenting products, and getting feedback on them. At the same time, working with open-ended design processes may also easily become unmanageable or downright chaotic. This may explain why design thinking has started to become a mainstream pedagogical approach in school contexts as the methodology provides a structure that can break down unmanageable design processes into more tangible activities. This often happens by going through five design phases, which in the GBL21 project are described as: 1) exploration, 2) interpretation, 3) idea generation, 4) experimentation and 5) testing (www.gbl21.dk).

Understanding design processes as a form of inquiry means that for each phase of the design process the 'designer' (student) must be able to ask questions, form hypotheses which they test through a dialogue between ideas, preliminary testing of ideas through materialisations and feedback from the people, who the design is intended for. In the GBL21 project, the students worked with design thinking through the use of different game tools (both analogue and digital), which focused their investigations on certain types of game designs and at the same time enabled the students to subsequently test their concrete design proposals (Hanghøj et al., 2019). Design thinking thus framed a product- and development-oriented way of working, while the games constituted communicative and interactive tools which enabled the students to relate concretely and exploratory to complex design challenges.

3. Example: Design of Board Games About Online Communication

The current study is based on a teaching unit, which concerns the design of board games about online toxic communication. The teaching consists of 12-15 lessons aimed at 5th grade, where students work in groups of 4-5 members and start phase 1 by examining examples of positive and negative aspects of online communication. They do that, for example by examining comment tracks on YouTube channels of influencers or describing incidents on social media that they had experienced themselves, e.g., in the chat while playing *Counter-Strike*. In phase 2, the students must interpret the various statements and identify a more concrete problem that they

want to address in their design process. In phase 3, students get inspiration to come up with game ideas by trying out classic board games such as *Monopoly* or *Draw and Guess*. By brainstorming, students develop ideas for how to design their game, which they discuss before selecting an overall idea for their game design. In phase 4, the students experiment with developing a prototype for the game design, where they e.g., draw a game board, design game pieces, and make question cards that deal with their problem. The unit ends in phase 5 with the students testing each other's games and making suggestions to improve them.

Throughout the unit, the students work with online communication as a specific topic within Danish as a subject. At the same time, the unit can be geared towards a number of Danish subject goals, such as being able to search for and read online texts, understand board games as an interactive type of text, plan multimodal productions, write game guides, and make oral presentations of game concepts. During the unit, the teacher acts as a facilitator of the students' design processes, where she has an important task of driving the design processes forward and providing critical and constructive feedback along the way. From a design professional perspective, students work with various design skills that can be described as idea generation, planning, collaboration, and modelling of prototypes.

4. Methodological Approach

The current study is based on video observations and interviews in a 5th grade class during the unit of two weeks. More specifically, I followed the group of three Year 5 students (age 11-12) – two girls and one boy – in a teaching unit of work in their Danish L1 classroom autumn 2019. The group was designated by their Danish L1 teacher as a well-functioning group and chosen for this reason. Consent was obtained from both the teacher and the parents of all students in the class. The class was one of four classes at four different schools that we followed as part of the qualitative track in the research project Game-Based Learning in the 21st Century (GBL21, 2017-2023). Prior to my observations, the teacher had participated in project workshops, where she had been introduced to working with design thinking and game design. Based on the workshops, the teacher had asked the students to complete a simple game design challenge, where the students had to redesign tic-tac-toe from a two-player game into a well-functioning game for three players.

In the teaching unit, which I focus on in this paper, the students were faced with a specific assignment or design challenge: They were asked to design a board game that should address and potentially help players to understand (and manage) issues with online toxic language. In this way, the unit both aimed at developing the students' design competencies and their understanding of online communication. Following a design thinking approach, the unit of work consisted of activities in which the students were to: explore examples of online toxic language (e.g. negative comments on famous YouTubers' videos or use of toxic language during in-game chat when playing *Fortnite* or *Counter-Strike*), interpret their findings, try out different board games as inspiration, generate ideas for their board game, experiment with (re-)designing a board game prototype, and evolve the prototype by testing it with other students. It should be noted that the development of a board game in Danish (L1) is not a typical classroom activity in Denmark. Rather, students are more likely asked to solve assignments, which involve reading texts or writing answers to predetermined tasks in the Danish L1 classroom (Fougt et al., 2020).

The focus of the qualitative study was to concentrate on idea generation. Data in this study was collected at three visits during the two weeks in which the teaching unit was carried out in this class (around 18 lessons). The data consist of field notes written on a laptop and assisted by video and sound recordings of classroom activities and group activities, following specifically the group in focus. Furthermore, photos were taken of both classroom and group activities, and all students' board games in the class, as well as their drawings, writing and other products were likewise collected through photos. The three focus group students were interviewed individually about their developed board game, their experience with collaboration in the group, and their experience with the unit of work and the way of working. Finally, the teacher was also interviewed before and after the teaching unit about her overall experience of the students' participation in the board game design processes.

Based on transcriptions, coding, categorisation, and thematic analysis (Braun & Clarke, 2006), three analytical themes emerged, which concerned specific dilemmas and learning opportunities when students design board games within a curricular context.

5.   Theoretical Perspectives

In order to provide a detailed understanding of the learning opportunities and design dilemmas involved, when students design educational board games, I wish to conceptualise how students identify and frame *game design challenges* in relation to local educational aims.

Generally speaking, a challenge signifies a call or invitation to participate in a demanding situation. Consequently, games are designed to offer challenges that involve a sense of *agency* (Plass et al., 2015; Deterding, 2015). Often, design challenges involve coming up with possible design solutions to more or less open problems. However, the process of designing educational games can be viewed as a double design challenge, as the goal is both to create a playable and functional game on a given topic, but also to offer the player with meaningful challenges to be overcome (Deterding, 2015). In an educational context, the notion of a game design challenge might then refer to (1) the possible in-game challenges embedded in a specific game design by the game designer, (2) the players' interpretation, acknowledgement, and exploration of specific game challenges, and (3) the teachers' linking of specific game design challenges to educational aims (Hanghøj, 2022).

Following the work of Schön (1983) on how professional practitioners think and work, game designers should be able to address game design challenges by naming (identifying) and framing specific approaches that address unexpected situations or problems. In this way, game designers should not be seen as rational problem-solvers, as it is impossible to apply pre-defined knowledge which can cater to all the unexpected situations that arise when designing educational games. Instead, educational game designers need to *set* the problems for which they try to design solutions:

> When we set the problem, we select what we will treat as the 'things' of the situation, we set the boundaries of our attention to it, and we impose upon it a coherence which allows us to say what is wrong and in what directions the situation needs to be changed. Problem setting is a process where we name the things to which we will attend and frame the context in which we will attend to them (Schön, 1983, p. 40).

Moreover, educational game designers must be able to *reframe* problems or situations through reflection-in-action. Going through the processes of naming, framing, and reframing educational game design challenges is a highly complex practice and often involves considerable experience across game domains, subject-specific domains, and pedagogical domains (Hanghøj et al., 2022). In this way, there is a huge difference of expertise between being a professional designer of learning games and a 5th grade student trying to grapple with educational game design. Nonetheless, I argue that students will have to face some of the same challenges as professionals when trying to design educational games.

Drawing on the theoretical perspectives outlined above, I now present the Game As Educational Challenge (GEC) model in order to understand how students approach educational game design challenges. The GEC model (see Figure 1 below) is a general model developed for understanding how teaching with games requires the establishment of connections between game goals and curricular aims as well as design- and process-specific aspects of games, by taking departure in specific game challenges (Hanghøj, 2022). The adapted version of the model shown below is based on the assumption that students' design of educational games requires the participants to identify and to create meaningful links between selected game challenges and relevant educational challenges.

Figure 1: The Games as Educational Challenge (GEC) model. Adapted from Hanghøj (2022)

In this way, students need to orient themselves both to different types of aims shown on the vertical dimension (i.e., curricular aims and game goals) as well as different aspects of the design process shown on the horizontal dimension (i.e., the specific meanings, game elements and affordances of their game design and the different activities involved in making the game and how it should be played). The model is exemplified below in relation to the 5th grade teaching unit on designing games about online communication:
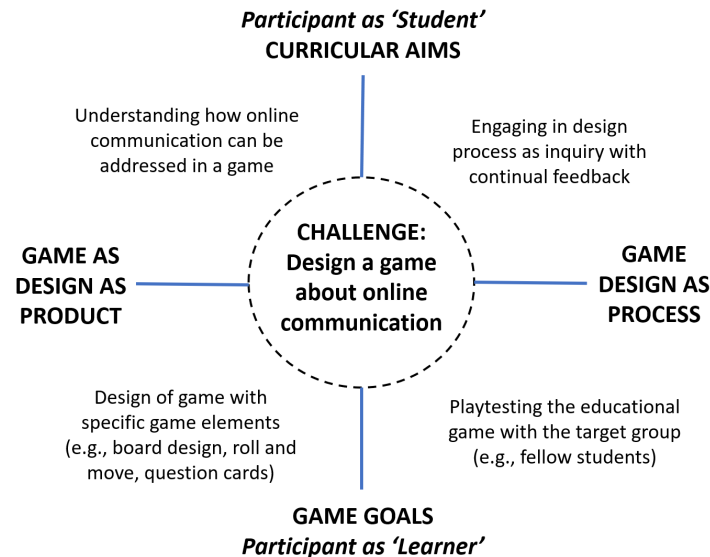

Figure 2: Exemplified GEC model in relation to the teaching unit

6.   Analysis

The analysis is structured as three analytical themes, which all address learning opportunities as well as design dilemmas when the 5th grade students design board games in Danish as a subject: *1) whose challenge?, 2) balancing games and learning*, and *3) how is this "Danish"?*.

6.1   Theme 1: Whose challenge?

The first theme revolves around the students' perception of the game design challenge presented to them. Based on observations and interviews, it was clear that students were highly engaged in the design challenge. However, they also clearly struggled with the high degree of complexity of the overall design challenge, which they tried to break down in order to make it manageable. The data for the theme mostly comes from the first phase of the design process, where the students were introduced to the game design challenge and explored examples of online toxic communication in order to identify the key game design challenge (centre of the model, cf. Fig. 2). The teacher asked the students to locate several examples of online communication in order to identify the challenge (this corresponds with Schön concept of "naming"). The students examined, among other things, the negative comments on the Danish influencer Fie Laursen's YouTube channel and their own experiences with communicating on the social media TikTok or in online computer games such as *Fortnite* and *Minecraft*. The students were quite engaged in locating these examples, which they eagerly wrote down on post it notes and put on display on a shared poster in the classroom.

In the classroom discussions that followed this first phase, some of the students were surprised by the harshness of the toxicity found in online communication, while others were already familiar with the phenomenon. As one of the boys explained, harsh things are written online because "you can't hit back". The game design activity made sense in terms of developing the students' understanding of and creating ownership of the design challenge. In the subsequent interviews, one of the students put it this way:

> *Marie: I went to Fie's TikTok profile, and there was also an awful lot of hate with "disgusting pig" and all sorts of ugly things... I think it's bad that people write so many ugly things. [...]*
>
> *Interviewer: What do you think you have learned from this process?*
>
> *Marie: That I shouldn't write bad emojis to my father! […] I used to just write… all those bad [emojis] that were [on my iPhone] …*

The quote is an example of the students experiencing the design challenge with online communication as a "felt problem" (Dewey 1933), which was both based on new experiences through the unit and their own experiences outside of school. In this way, it was meaningful for them to work on dealing with the general problem of harsh tone by examining different platforms for online communication.

At the same time, the students' professional examination of the problem showed that they had relatively different experiences with the various social media platforms. Some students had extensive experience with toxic language on TikTok, other students had only experienced unpleasant language use in *Counter-Strike*, while others had not experienced the phenomenon up close at all. This points to a significant educational design dilemma: How should the students experience the design challenge so that it has both subject-specific relevance and immediate appeal and at the same time makes sense in relation to the students' various interests and experiences with the problem being addressed? In short: How does the game design challenge also become the students' and not just the teacher's?

6.2   Theme 2: Balancing Games and Learning

The next theme is mainly based on data from the game design activities, in which the students had to develop and select ideas for their game designs. This part of the unit was demanding for the students, as they had to both test (e.g., by playing) and develop an understanding of the game and design elements available to them, and at the same time try to come up with their own suggestions on how they could develop a game that could address their overall design challenge. At the same time, the students also had to balance their ideas for game designs, so that they both related to the subject-specific objectives and to the objectives of the game. In this way, it was often difficult for the students to balance their game ideas, so that they both included a focus on curricular aims (e.g., understanding online communication) and on creating a well-functioning game with clear goals (e.g., to obtain points or to get first when playing) cf. the vertical axis in the GEC model in Figure 1.

During the observations, I saw many examples of how the students tried to come up with and realise their ideas together. Sometimes students' game ideas focused on answering questions about how to behave online. Other times, they focused on giving the player physical challenges, such as push-ups, that had little to do with the subject of the game, but were meant to make the game more fun. At other times, the students developed ideas that created an entertaining game and at the same time related to working with toxic communication as a topic. As an example, the group I followed, developed the *Happy Emoji* game, where the player had to make grimaces that corresponded to the emojis that you land on, and thus experience different emotions when communicating online (cf. fig. 3).

Figure 3: The *Happy Emoji* game

Given the high complexity of the game design challenge, it is not surprising that the 5th graders did not always succeed in designing games with a strong link between game elements and curricular content. The research on games and learning shows that even professional developers of learning games often find it difficult to balance the two aspects in a meaningful way (Squire, 2006).

The interesting thing here is therefore not whether the students arrived at a 'correct' game design solution. Rather, the point is that the teaching unit positioned the students as designers, where they were faced with a

well-known dilemma within learning game design: How to develop games that balance the relationship between the goals of the game and the goals of the school subject? The students thus sought to both invent, negotiate, realise, and test design ideas based on the intention of creating a playable game with a clear goal (e.g., to come first or get the most points) and at the same time develop a game that could provide professional insight in problems with online communication (curricular aim) - cf. the vertical axis in the didactic game model in figure 2. By working with the dilemma, the students thus had the opportunity to gain concrete design experience in relation to developing and testing possible design solutions.

6.3 Theme 3: How is This "Danish"?

The third theme deals with how teachers and students experienced the game design unit as relevant to Danish as a subject. In the teacher-led class discussions during the unit, there was a tendency among the students to focus mostly on the quality of their game prototypes (game design as *products*) and they clearly had more difficulty putting into words and reflecting on their design *processes* – cf. the horizontal axis in the model in figure 1. This must be seen in the light of the fact that it was the first time that the students tried to work with the design thinking phases and that they were therefore not used to justifying and considering alternatives to their design proposals. The teacher experienced that the students "were turned on by the very idea of investigating online communication" (teacher interview). At the same time, it also became clear in my subsequent student interviews that the students only perceived game and design elements, game design solutions and design activities to a lesser extent as Danish subjects.

During the unit, the Danish teacher had asked the students to write a guide for their game, which should instruct others to play it in order to create a link to more familiar activities in the subject. In my subsequent student interviews, it was primarily the written work with the guide that was part of the subject-specific design solution, which the students highlighted as the Danish curricular content of the unit. The students experienced the other activities – searching and reading texts on the internet, investigating board games as a text type, collaboration, generating ideas, producing multimodal products, and presenting in class – as interesting and engaging, but not as recognizable ways of "having Danish".

In this way, the students' design thinking activities marked a break with their existing ways of having Danish. They only experienced a connection between new types of game and design activities and more familiar Danish subject activities to a limited extent. The students' experience of the unit thus points to a significant curricular dilemma in relation to working with design thinking in Danish: How can the teacher help the students to expand their understanding of the subject's practical forms in relation to working with design challenges and at the same time maintain continuity in relation to existing subject-specific practices? In this example, the teacher chose to emphasise Danish competencies in the unit by strengthening the students' written work with their game guides. Another way to deal with the dilemma of the unclear professionalism could be to make it clear to the students that the game design unit focuses on multimodal production, oral presentation, and online communication, all of which are central content areas of the Danish curriculum.

7. Discussion and Conclusion

Overall, both teacher and students were engaged in the unit, but the three analytical themes presented above at the same time testify that design thinking can be a demanding method to use in the Danish subject. The students thus had to both investigate and develop a relevant understanding of the design challenge, work 'hands on' to understand and use materials (game elements) and balance the idea development so that it met both the expectations of creating an entertaining and an educational game. Correspondingly, the teacher had to both frame and facilitate activities, so that the students had the opportunity to immerse themselves in their research processes, and at the same time also help the students to understand how the work with design thinking related to Danish curricular aims. In this way, both teacher and students had to juggle with many balls when trying to implement and negotiate the meaning of the unit.

The unit thus also testifies that the teacher must be able to scaffold, structure and respond to students' processes in the design unit. The game tools helped to engage and support the students' inquiry so that they could reshape and further develop their game ideas with relative ease. In the group I observed, the students' work processes were often intense and characterised by disagreements as well as time pressure before they reached the goal of a product they were satisfied with. At the same time, many of the students' design ideas could have been improved if they had prioritised their time differently or had received more feedback along the way from the teacher and their classmates. Open and creative design processes are by definition contingent and thus difficult to predict. Therefore, it is important – both as a teacher and as a student – from time to time to

stop, reflect, and put into words what is particularly demanding in the design phase you are in, and what you can do going forward to deal with the design problems you come across.

In this paper, I have described how design thinking can function as a valuable methodology in relation to addressing complex problems through Danish curricular design challenges. As the example shows, design thinking can offer a relatively tangible form of inquiry where students can investigate a complex problem by designing proposed solutions to it. At the same time, the empirical examples in the paper show how teachers and students also face dilemmas in relation to experiencing the design challenges as authentic, when balancing the design processes in relation to game-related and professional goals, and when relating the design activities to other Danish subject activities. It is therefore a significant task for the teacher in relating the benefits of the students' creative and partly unpredictable design processes to other ways in which the Danish subject is practised and assessed.

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