Gender Differences When School Children Develop Digital Game-Based Designs: A Case Study

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Abstract. With the increased emergence of digital technology in the school context it is important to be aware of the fact that children's use of digital technologies is conditioned by gender. In this paper we investigate how gender differences emerge in collaborative interactions between 9 to 10-year-old school children while collaboratively working on developing digital game-based designs. The unit of analysis is game design activities with a focus on children's gendered actions, positionings and agency while collaborating and working with problem solving activities. The research questions posed in the study are: (1) What gender-related patterns emerges in collaborative interaction exhibited by 9 to 10-year-old school children while collaboratively engaged in a digital game-based design workshop involving problem solving activities? (2) How do 9 to 10-year-old girls and boys position themselves while collaboratively engaged in a digital game-based design workshop involving problem solving activities? (3) How do 9 to 10 year-old girls and boys employ their agency while collaboratively engaged in a digital game-based design workshop involving problem solving activities? The results of this study imply that children's agency oscillate between individual freedom and the constraint of traditional gender patterns while collaboratively engaged in a digital game-based design workshop involving problem solving activities. As a consequence, this tends to affect the children's participation and contribution to the given task.

Keywords: Agency · Collaboration · Digital game-based design · Gender differences · Problem solving · School children

1 Introduction

1.1 Children, Technology and Gender

Since quite some time now, there is an increased presence of digital technologies such as digital game-based learning in classroom contexts [1, 2]. Given this fact, children are bound to encounter digital technologies as part of their learning activities [3]. With the introduction of digital technology in teaching situations, it would be desirable to create

awareness of gender differences in order to avoid reflecting and reproducing traditional gender patterns. However, since this transition is yet still in its initial phase, there is a need for research addressing the issues concerning gender differences [4, 5]. Rubegni et al. [6] claims that gender is a major variable affecting identity and life opportunities from a young age. Gender is present everywhere in society and affects our daily and social life, the use of digital technology is no exception. On the contrary, much research indicates that there is a pertinent gender difference in terms of technology use, which also includes different types of digital media [7–9]. For example, Admiraal et al. [8] claims that boys show a stronger preference for digital entertainment games than girls, which might have an impact on game-based learning as being more acceptable to boys than to girls. In their quasi-experimental study, however, they found that girls seemed to profit more from searching the Internet to complete assignments and boys from competing with others and in that sense they mean that game-based learning might improve the performance of both boys and girls, depending upon the instructional design [8]. Other studies show gender differences when it comes to game preferences [10, 11].

A decade ago, Jenson and de Castell [12] wrote: "It is difficult, if not outright impossible, to shake loose deeply ingrained, hegemonic normative discourses and practices that demarcate, delimit, and predominate everyday gendered subject positions, especially in relation to technologies" (p. 53). There is not much evidence that matters have changed for the better since then. One aspect of concern is that digital technology often is gendered as a male domain [13], and considering the fact that digital technology is increasingly being used within a school context this needs to be addressed. Wong and Kemp state that "There remains a particular concern that girls lack the aspirations to position themselves (and be positioned by others) as potential creators of digital technology" [13]. This evidently, becomes especially important to point out now when subjects such as programming and coding are being established in curriculum from an early age in school.

1.2 Children, Technology and Gendered Agency

The creative production of digital games and artefacts in learning activities has made it possible for children to engage in creative game development activities. Such productive activities have been linked to children's agency where a study by Petersen [14] shows how an understanding of children's agency may be expanded by investigating how children as designers make use of affordances of digital technologies as they act in new material and agentive ways. Correspondingly, research suggests that creative development activities raise awareness of technology, especially in female students [15]. Children's use of digital technologies is gendered [9], some researchers even conceptualize it as a gender digital divide which is the cause for a genuine concern [13], as do OECD [16] who discusses the matter in a recent report. Such circumstances reflect that an individual is not always free to choose an agentic position. Kinnula et al. [17] exemplifies this by describing how children's roles can be defined for them by adults, but how they also adopt various roles in situ by themselves in a technology design process. Positioning is considered as a linguistic practice producing the self in encounters. In terms of agency, this is how girls and boys "do" gender by taking specific positions.

While it is important to promote children's agentic processes in learning, it is only recently that agency in children has been acknowledged in educational practices. Baker-Sperry [18] investigated how children exert agency in a classroom setting. The findings showed that gender influence children's agency. Moreover, that gender is negotiated among peers, and is particularly evident when children engaged in actions associated with the opposing gender. In the present study, we investigate agency as relational and contextually situated, emerging from children's interaction with each other, and the social and material environment [19]. The analysis pays attention to children's doings and interactions; e.g. what is possible to do, what is not possible to do, what kind of position do the participants take on - or not, and what promotes or constrains this? There is however a problem regarding how concepts such as "children as social actors" and "children's participation" are transcribed into practice [20], hence children's agency is not always an easy concept to comprehend. It has to be put in relation to the constraints by the surrounding adult world. In this paper we are using the definition of agency as explained by Katsiada et al. [21], where children's agency means their capacity to make autonomous decisions and choices in all matters affecting them according to their dispositions.

1.3   Aim and Research Questions

The motivation behind this study lies within the concern of digital technology as a gendered domain [13], which can be argued having important educational implications [22], and the aligned need of creating awareness of such gender differences. Accordingly, this paper investigates how gender differences emerge in collaborative interactions between 9 to 10-year-old school children while collaboratively working on digital game-based designs. It departs from two separate studies involving two classes of third grade school children, from north Jutland, Denmark and from south-west Halland, Sweden. Each class was involved in a creativity workshop case designed to provide a playful and creative atmosphere inspiring children to collaborate to create ideas for new games and/or game designs. The following research questions have been formulated: (1) What gender-related patterns emerge in collaborative interaction exhibited by 9 to 10-year-old school children while collaboratively engaged in a digital game-based design workshop involving problem solving activities? (2) How do 9 to 10-year-old girls and boys position themselves while collaboratively engaged in a digital game-based design workshop involving problem solving activities? (3) How do 9 to 10 year-old girls and boys employ their agency while collaboratively engaged in a digital game-based design workshop involving problem solving activities?

In the following, we present the theoretical framework of the study focusing on collaboration and gender differences in relation to interaction and agency. Next, the methodology is described, which is based on a case study approach using video observations and interaction analysis. Thereafter, we introduce the findings of the study followed by a discussion and conclusion.

2   Theoretical Perspectives

This paper focuses on gender differences in children's collaborative interaction while collaboratively engaged in a digital game-based design workshop involving problem solving activities. Here, collaboration refers to the social dimension of collaborative learning situations, with a particular focus on gender. Research shows that gender is crucial to a child's everyday life [23]. In educational activities, gender influences, for example, children's performance at school. Theories on collaborative learning, however, have ignored social aspects of collaborative learning situations, such as gender [24, 25].

2.1   Collaboration and Gender Differences in Social Interaction

In line with Damsa et al. [26], we propose an understanding of collaboration, wherein aspects of social and relational issues while involved in a learning activity are taken into consideration. In doing so, social interaction becomes central to the analysis, where different types of knowledge, attitudes, and expectations characterize how collaboration is performed and, in turn, requires participants to align with the demands of a certain task. Research has shown that gender has an impact on how boys and girls interact in a classroom setting as well as on their conversations in small groups [27, 28]. In her book, Howe [27] identified three general conclusions regarding boys' and girls' classroom interaction, where the first was that, in general, boys contribute more than girls, for example by dominating discussions concerning curriculum content. The second referred to the predominance of boys' contribution, which the author found was a result of teachers' selection and, also, of student-initiated interactions. This is confirmed also by other studies that found boys more likely to initiate interaction than girls [29]. Howe's third general conclusion was that boys received more feedback, both positive and negative, compared to girls. Research by Leaper and Smith [28] has also found that gender influenced boys' and girls' ways of expressing themselves. They found that girls were slightly more talkative and used more affiliative speech (showing support, expressing agreement, or acknowledging others' contributions) compared to boys. Leman et al. [30] investigated the relationship between gender and children's conversational styles in problem-solving tasks. In their study, children were introduced to three different kinds of counters (triangles, squares, and circles), where each kind of counter had a different value. The task for the children was to, in pairs, add the counters together to arrive at the value of 100. However, the children had been told different values of the counters, which resulted in conflicts among the pairs of children. Here, Leman et al. [30] found that the children used gendered ways of communicating, for example, boys interrupted their co-partner more if their co-partner was a girl compared to if the co-partner was a boy. This resulted in that the conversational tone was more negative when a pair of children consisted of a boy and a girl.

Leman [22] argues that effects of gender in different settings have important educational implications. If boys are perceived as more experts related to a certain activity or task, they may dominate the interaction in mixed-gender group interactions and, conversely, girls may dominate the interaction if they are perceived as the experts. Joiner and Littleton [24] found that gender had an impact on children's conversations. More specifically it had an impact on the disagreements in problem-solving activities.

For example, female same-gender pairs disagreed more compared to male same-gender pairs in problem-solving activities. This is known to be important in children's learning. However, the authors underline that more research is needed to further study the impacts of gender on collaboration and how it eventually impacts on learning.

2.2   Collaboration and Gender Differences in Agency

When children work together on collaborative tasks they have to try to get on with doing the task. Consequently, the way that they do things together is dependent on interrelations between the task in question and socio-relational issues. We relate this to how children through interaction and circumstances offered in different settings, establish agency. One of the conditions had to do with the fact that the children were placed in groups by their teachers and were not allowed to form groups themselves. Their ability and willingness for collaboration was bound to the participants within these groups, as was their sense of personal agency [31]. Another condition was that in both cases there was a majority of boys in the classes. However, in line with Baker-Sperry [18], our approach to agency refers to how children, through interaction and conversation (verbal and non-verbal) negotiate meanings inherent to the problem-solving task they were engaged in. In other words, we did not expect that the children should accept what they were instructed to do, but based on their own standpoints and as familiar of their position in the group they were assigned to, we acknowledged that they were able to understand and influence the collaboration within the group. In this way, our interest was directed towards how the children engaged in meaning-making with others, like in relational agency [32]. Accordingly, the setup of the problem-solving activity included opportunities for the children to interpret and approach the game design problem as well as for reading the environment, for drawing on the resources available, and for being a resource for others. The question is how such relational agency is exerted by boys and girls respectively in collaborative situations.

According to Edwards [32] relational agency captures a capacity to work with others and to draw on the resources they offer. It recognizes the importance of pre-existing personal understandings gained in other situations in mediating interpretations of new situations and argues for attention to the negotiations that individuals make as they work in and with the social [33]. Thus, relational agency helps to understand how boys and girls negotiate and reconfigure the tasks involved in the game design activity. In particular, we are interested in how the children negotiate and reconfigure responsibilities in the activity and how the children's actions are elicited by their interpretations of and their engagement with the game design activity as such.

3   Methodology

The present paper is referred to as a case study and it includes two separate research cases involving two classes of third grade school children, one from Denmark and one from Sweden. The case study methodology is frequently used to obtain knowledge about phenomena connected to individuals, groups and organizations [34] and as such it plays a significant role in research related to educational and social issues [35].

The purpose of a case study approach is to explore contemporary real-life phenomenon within its context and the relationships of a limited number of events or conditions through detailed contextual analysis [34]. Even though this study is not able to make any claims for generalizations (due to the moderate sample of empirical material), the results can however provide important indications within a limited area of interest. In this case, the aim of the study was to investigate how school children 'do' gender while collaboratively designing games. Thus, it is interesting to take a closer look at how children communicate with each other in game design activities and, moreover, how these activities are framed by the context. We are aware of that when approaching the issue of gender in our research, we are ourselves influenced by a range of factors including, amongst others, personal experience, gendered identities, and theoretical beliefs [36].

3.1 Participants

Case 1 included a class of 28 children from a third grade school in north Jutland, Denmark, north Jutland. The participants were divided between 19 males and 9 females between 9–10 years of age. Case 2 included a class of 22 children from a third grade school in south-west Halland, Sweden. Here, the participants included 16 males and 6 females between 9–10 years of age. Each class was involved in a creativity workshop case designed to provide a playful and creative atmosphere inspiring children to collaborate to create ideas for new games and/or game designs. Both workshops were carried out in research laboratory settings, and the participants were supplied with a wide range of analogue materials (in both cases) as well as digital technology (in Case 2) for creating stop-motion videos of the children's game design solutions. The two workshop cases were carried out in the form of a design experiment [37] in the sense that it was designed to control some variables emphasizing the availability of resources that the children can draw on and use, as well as allowing for situated interpretations related to the chosen theoretical framing. The authors of this paper designed the set-up of the study and the sessions were conducted by two research assistants to make it possible for the authors to observe the game design activities (the procedure is further elaborated below, Sect. 3.3). In Case 1 the workshop session took place in one room (approximately 90 m^2), which created a lively and slightly loud environment. In Case 2, the groups were divided into two rooms, which created a more calm atmosphere compared to the other case.

In both cases the children's teachers participated in the activity, which helped to create a safe learning environment; in Case 1, there were three teachers and in Case 2, there were two teachers. In addition, the two authors of this paper participated in both cases together with three assistants who assisted when the children needed help, kept an eye on the cameras, and supplied the children with water and fruit during the session. The teachers had on beforehand divided the children into six groups of either 5–6 (Case 1) or 3–4 (Case 2) children and each group had their own work station. Each of these work stations was equipped with a video camera, recording the whole game design session; what happened around the table as well as between the group members, other members and material available.

3.2 Video-Observations and Data Collection

To get access to as much multifaceted empirical material as possible, we chose to employ video-observations in this study. To record videos is especially useful when social interactions are in focus [38] and, also, an effective way to catch details that otherwise would have been missed out [39], since video recordings offer opportunities to review social actions and interactions. As mentioned previously, each of the work stations in both workshop cases was equipped with a video camera, recording the whole game design sessions. Accordingly, both cases used six cameras, which were operated by the research assistants, and produced empirical data consisting of 12 video observations (in total 25.8 h). In addition to the video observations, casual conversations with teachers and children, and field notes have continuously been recorded during the course of the study. In this way, our study included different types of knowledge representations (written, spoken as well as visual forms of text), which we put in relation to one another to represent various but interwoven stories of the research. This enabled a deeper insight into the context of our study.
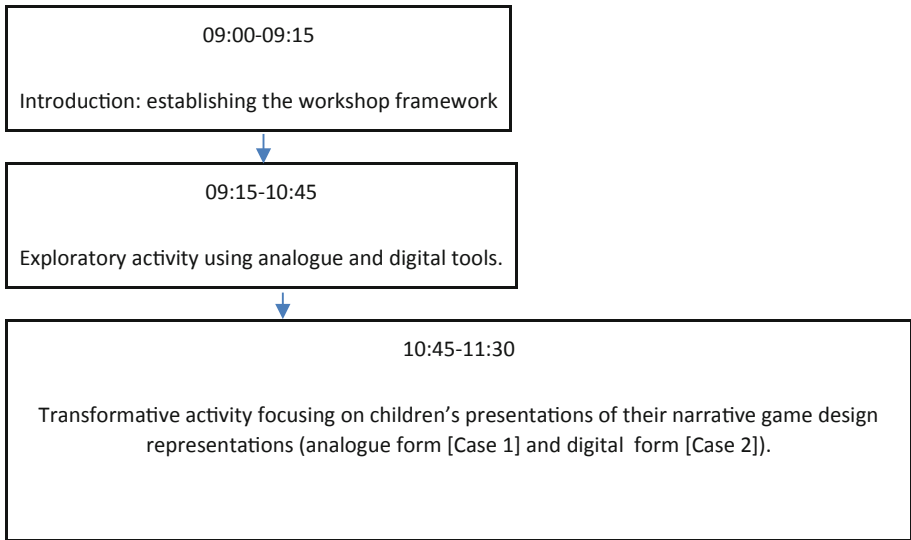
Compared to more structured methods, such as interviews, video observations can capture complexity and nuance of people's interaction to a higher extent [40]. Video observations are also useful when it comes to analyzing verbal and nonverbal contexts in which a study takes place. Without video recorded material, it can be problematic to reliably analyze nonverbal communication, such as body language, gestures, posture, gaze, and mimicry [41]. This was especially important in this study as we were looking into how children communicate with each other through verbal as well as non-verbal interaction such as intonations and positioning. Video recording as a methodological tool can thus be seen as a reliable tool, but at the same time it is possible to question objectivity as video recording always includes a range of choices among different possible and interesting situations in an activity. The present study was set up in the form of a workshop carried out in two research laboratory settings, where the participants were divided into groups and supplied with creative material and digital equipment to produce stop-motion videos.

3.3 Procedure and Ethical Considerations

The present study is presented as a qualitative study where game design workshops were applied to enhance opportunities for collaboration and communication among the participating children. The game design workshop was structured in different phases intended to offer space for the children to express and position themselves, individually and as a group and in this way influence the collaboration with their peers in the group. The structure was there to motivate the participants' minds to exercise the collaborative game design process.

The workshop ran for half a day between 09:00–12:00 h and was divided into two distinct phases following the timings and activities depicted in Fig. 1, below.

In both cases, the research assistant introduced the game design activities to the children by telling them that they were going to be game designers and in groups create games based on a specific theme. The game design task was grounded in a narrative approach, where the authors, on beforehand, prepared six different themes locating the

09:00-09:15
Introduction: establishing the workshop framework

↓

09:15-10:45
Exploratory activity using analogue and digital tools.

↓

| 10:45-11:30 |
|---|
| Transformative activity focusing on children's presentations of their narrative game design representations (analogue form [Case 1] and digital form [Case 2]). |

Fig. 1. Schedule of the game design workshop.

game design in different settings: Desert; Jungle; Woods; City; Under water; Space (one theme to each of the groups). The narrative as such, i.e. the game design, was developed by the children and, here, we also framed the activity for them. Each group received an A4 sheet of paper where the theme was written together with open space for the children to develop classical narrative content [42, 43], namely the plot, characters involved in the gameplay, and objects/props (Fig. 2, left) (storyboarding). The children were then introduced to the creative material (Fig. 2, right), for instance foam clay, modelling clay, crayons, markers, LEGO, cardboard, different kinds of papers, yarn, glue, tape, scissors, and post-its. The Case 2 children were also introduced to the stop motion equipment. The children were told that they were free to explore and use all materials at hand; there were no rights or wrong.

All teachers and parents were informed about the study in writing and the parents agreed to let their child participate by signing informed consent forms. The children were informed that they could withdraw from participation in the game design workshop at any time if they e.g. felt uncomfortable in any way. In line with ethical guidelines, all the names of the children as well as of the school are anonymized and, thereby, no identifying information is provided.

3.4 Analytical Approach

The analytical method applied for this study is interaction analysis [44]. This analytical approach is especially appropriate when working with human interaction, including verbal and non-verbal expressions (such as facial expressions, gestures and postures) as well as para-verbal expressions (where elements of speech such intonation, tone, stress, and rhythm are used). Jordan and Henderson writes: "Another topic of inherent interest for Interaction Analysis concerns the extent to which co-present individuals share
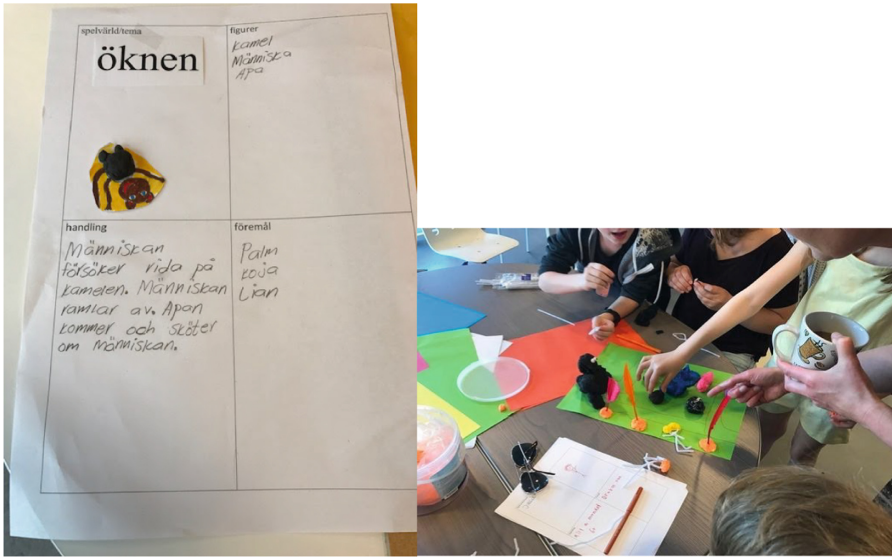
Fig. 2. The storyboard: instructional material provided in the initial phase of the workshop (left). Some of the creative material available for the children (right).

a common task orientation and attentional focus" (p. 67). Parts of the video recordings have been transcribed and analyzed in accordance with the theoretical principles of participation structures in interaction analysis [44]. Prior this process, the video recordings were repeatedly reviewed by both authors in order to identify recurring patterns of gendered interaction in verbal and non-verbal actions and interactions between the children and the analogue and digital game-based design activities. The transcriptions were then organized in different categories focusing on participation structures specifically related to gender differences. In total, four analytical steps were conducted throughout the process (see Table 1). From this analysis we identified three overall themes: (1) Gender-related patterns; (2) Gendered positionings; and (3) Gendered agentic actions, which are presented in the next section.

Table 1. Analytical steps in interaction analysis.

Steps	Activities undertaken	Foci guided by analysis
Step 1	Repeatedly reviewing video recordings	Overall view of the material
Step 2	Transcription of specific excerpts	Identifying recurring patterns of gendered differences
Step 3	Organization of excerpts into categories	Analyzing excerpts in accordance to participation structures
Step 4	Checking the categories guided by questions regarding the participation	Deciding which excerpts to include

4   Results

4.1   Gender-Related Patterns

Excerpt 1.

Actor	Verbal	Nonverbal
Alice	Cars, coins and a treasure chest	Writes on the storyboard
Ben	But we must also have houses!	Leans towards the storyboard
Alice	Houses, you don't have to have houses?!	Makes a frown, putting her arm between the storyboard and Ben
Carl	Yes, but we do!	
Alice	But how is it (all) going to fit?	Throws a skeptical glance at the table where they have placed a large sheet of paper
Ben	They (the houses) are up there, but in the background	Gesticulates on the sheet of paper on the table
Carl	They are here, you are filming up there, and they are driving like this	Showing on another piece of paper
Alice	But can't you just have a small house in a corner or something like that?	
Carl	I want quite a few houses	
Alice	But we write, like, two houses, because otherwise we will not have enough room for the roads, because the roads cannot be too narrow	Starts to write on the storyboard again

A recurring gender-related pattern was that in mix-gender groups, girls became leaders in the group, either by choice or by the others in the group appointing them to the task. Most often the leadership was initiated by the girl's way of expressing her beliefs effectively to influence the others. Excerpt 1 represents an interaction in a mix-gender group consisting of two boys and a girl discussing what their game's background should look like. Their game design theme is "the city" and they are filling in the storyboard. The girl was in charge of the pencil and the one who wrote details into the storyboard sheet of paper. The girls as leaders applied an assertive participation structure rather than an affiliative. As is shown in Excerpt 1, Alice expresses directive statements in her attempts to convince Ben and Carl that just a few houses are possible in order to have enough room for wide roads, which she considered more important than many houses. Through these assertive participation, Alice is reluctant to Ben and Carl's ideas and finally rejects their viewpoint by informing them what she wrote into the storyboard.

Another recurrent pattern of interaction related to gender in mix-gender groups was that girls were appointed as administrators of the group work, and as such responsible for the administrative part of the work, e.g. to fill out the storyboard for the task (like in Excerpt 1), to keep track of time, and to ensure that all the steps in the task were carried out.

4.2   Gendered Positioning

Excerpt 2.

Actor	Verbal	Nonverbal
Charlie	Should we make a tree out of clay?	Looking at Mary, working with clay, making a tiger
Tom	Nope	
Charlie	No. Couldn't we come up with another character so we can…or do you need…	Looking at both Tom and Mary
Tom	No, it's going to be too hard, this is enough	Looking at Charlie
	But it's enough with one tiger, that's enough!	Turning towards Mary, sharp glance
Mary	The only thing strange about just having one (tiger), because there are two monkeys and it can only chase after one at a time and in that case…	Looking at Tom
Charlie	Can't we make a jaguar?	Looking at both Mary and Tom
Tom	But we only have one	Facing Mary, ignores Charlies question
Mary	Now, but then that sort of can only be one monkey as well, otherwise it will be really weird because it can't chase both	Also ignoring Charlie
Tom	Yes, but it will chase both and, but, then you can see who is taken by it and they win…	Pointing at the material on the table
Mary	A but it will be a bit strange because it will say "victory" in the end and…	Pointing at the storyboard

In Excerpt 2, Tom and Mary have slightly different views on what to do regarding the characters to include in the game. According to their particular game design, a two-player design, there should be two tigers chasing two monkeys (player 1 and player 2) but Tom does not seem to want to do more than one tiger. Charlie very much wants to make something out of clay. The interaction shows how the participants by having different views, position themselves, in particular Tom and Mary, by trying, more or less strongly, convince the other person to agree with their specific standpoint. These positioning interactions lean towards a competing discourse where Tom and Mary try to come up with arguments to become the most powerful by controlling and decide what kind of and how many characters the game should include. However, they do this without stepping out of what could be considered as correct participation behavior. One reason why the interaction between Tom and Mary does not lead to a conclusion, is that both of them know what to do to produce their game idea and are prepared to lead the necessary actions to complete it. Clearly, Charlie had difficulties in gaining a constructive position in the group. One explanation to this is that his input to the interaction, by proposing the making of a jaguar, was totally outside the scope of conversation that engaged Tom and Mary.

4.3   Gendered Agentic Actions

Excerpt 3.

Actor	Verbal	Nonverbal
Alan		Drawing a tree on a piece of paper
Sarah		Is studying Alans drawing
Sarah	Remember not to draw too far out for you are also to do that banana bunches. You can think like two bunches on each tree	
Alan	No, one!	Looks up from the drawing, irritated look
Rick	No, we're just doing one bunch	
Sarah	But, like one bunch here and one there	She shows with her hand on the drawing
Alan	But it will be too much, with those lianas as well	Points in the air, towards the drawing
Sarah	But can't we have that, then you can, like, swing in them and it's just great fun!	Again, shows with her hands on the drawing, gesticulates and smiles
Alan	But not bunches of bananas, I mean lianas. We are going to have lianas. And bunches as well	Continues to draw on the tree
Rick	No bunches of bananas, that will be too hard, can't we skip bananas?!	Shakes his head
Sarah	But can't we have one (tree) with lianas and one with bananas	
Rick	But no, you should have lianas on all of them so you can swing from tree to tree, like this. See?	Showing with body movements how it should be done
Sarah	Okay, we take lianas then	Leans back heavily on her chair

In the specific context of this study, with its explorative and creative setting, the children's agency seemed to oscillate between individual freedom and the constraint of traditional gender patterns (as well as the set conditions for the task itself). In Excerpt 3, one of the groups, consisting of two boys and a girl, has "the jungle" as the theme for their game. They have jointly come up with a game narrative, the storyline (i.e. what will happen in the game), and are developing the background material. Initially, before the conversation taking place in Excerpt 3, the three participants of the group have discussed what makes trees significant for a jungle and concluded different standpoints whether lianas or bunches of bananas are most characteristic of jungle trees.

In their interaction, Sarah, Alan, and Rick are at the borderline of a conflict, but by the end of the conversation Sarah reaffirmed her understanding of a jungle tree and the conflict was avoided. At the start of the interaction, Sarah expresses her own standpoint about what a jungle tree should look like; it should be represented by both lianas and

a couple of bunches of bananas. She instructs Alan, slightly assertively, by correcting his way of drawing the tree. Alan and Rick reply to this correction according to a gender-expected conversation style. For example, their argumentation tended to become assertive by closing rather than opening up for negotiation about the look of a jungle tree. However, all three children were eager to utilize their agency. This can be explained by the fact that the task, to produce a game design, offered both genders opportunities to contribute with their individual experiences in the field of game play. Sarah, in a gendered way, indicated collective agency by, from the start of the interaction in Excerpt 3, applied an affiliative interaction style where she targeted a mutual affirmation ("But can't we have one [tree] with lianas and one with bananas") and ended up with a willing submission ("Okay, we take lianas then").

We could identify that gendered agentic actions and participation structures may be influenced by different processes, such as negotiation, non-verbal meanings, routine actions, and relational aspects of agency. For example, when Sarah by being affiliative, introduced alternatives and negotiated meanings to address more than one possibility to represent a jungle tree.

5 Discussion

5.1 Emergent Gender Differences

In this paper, we set out to investigate how gender differences emerge in collaborative interactions between 9 to 10-year-old school children while collaboratively working on developing digital game-based designs. The results show that the participating girls, even though being in minority in both cases, put on a leading role in the groups where they secured an effective working structure so that the production process kept on track, as well as contributed practically in all phases of the design process. In some groups their role was negotiated and in some groups it was not acknowledged, but rather an obvious social contract in no need for negotiation. This corresponds to traditional gendered inter-action in school settings where girls tend to take a responsible role, either by their own choice or ascribed by others. In either case it is a socially rooted phenomena. However, the participation culture within the group work also included incidents showing non-expected gender differences. While Wong and Kemp [13] state that girls lack aspirations to position themselves, our study showed the opposite. This could be explained by the setup of the workshop and the material available (creative as well as technology-based) where we had considered children's pre-existing experiences of playing games. This kind of workshop design seemed to promote both boys' and girls' aspirations of contributing to fulfilling their game design ideas as well as influencing the collaboration in the group while engaged in meaning-making with each other. This is in line with Edwards [19, 32] who states that relational agency should capture a capacity to work with others by being attentive in and with the social. The relational agency was exerted in expected gendered participation structures, but in some instances also with non-expected interactions. For example, the girls as leaders used a combination of assertive and affiliative interaction patterns. In part this follows Leman et al. [30] who found that children use gendered ways of communicating in group-based problem solving activities, but it is also different from it as we could see that, in particular girls' gendered participation structures showed

instances of unexpected gendered ways of interaction within their groups. Further, the participating girls contributed slightly more than the boys, for example through their leadership but also by dominating the content discussions concerning the game's storyline. This differs from Howe [27], who found that boys contribute more than girls in small group interactions and confirms Leaper and Smith's [28] study, stating that girls were slightly more talkative compared to boys in group-based interaction.

5.2   Conclusion and Implications for the Field

The ambition of this study is to contribute to the research field of children's learning conditions by highlighting gender differences in collaborative settings orchestrated by the school. Gender is ever present [6] and predominated everyday gendered subject positions are hard to overlook [12]. In addition, we hope to contribute to the field of human-computer-interaction (HCI), by illustrating how gender differences within the field of design and digital technologies with school children as actors might unfold. The results in this study imply that children's agency oscillate between individual freedom and the constraint of traditional gender patterns while collaboratively engaged in a digital game-based design workshop involving problem solving activities. As a consequence, this tends to affect the children's participation and contribution to the given task. In our case, we argue that the organization of the workshop, with creative elements and a large measure of freedom within a given framework, was beneficial for how the interactions between the children unfolded. By allowing the children, together in groups, to design digital games based on a given structure, where digital games are considered an interest for mainly boys [8], both boys and girls were allowed to exercise their personal agency [31], which had positive effects on participation on both parts. For example, in the groups that worked with the creation of stop-motion films to visualize their digital games (Case 2), both girls and boys clearly exercised their personal agency [31] by adopting the digital material. Even though technology is seen as a male domain [13], it was evident in the present study that the girls saw it as natural for them to interact with and use the digital technology, as did the boys. Pedagogically, the study challenges designers and teachers to rethink how they design learning activities in order to strengthen children's sense of personal agency [31] and to raise an awareness of gender differences that might have an impact on those. Considering that HCI becomes increasingly important in a school context (e.g. related to programming and computational thinking), this study aims to emphasize the importance of a gender conscious approach.

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