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Playfulness and Creativity as Vital Features when School Children Develop Game-based Designs

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COLLECTION:
DESIGN, LEARNING
AND INNOVATION:
FRAMEWORKS AND
USES

RESEARCH

**STOCKHOLM**
UNIVERSITY PRESS

ABSTRACT

The presence of digital technologies in classroom settings is relentlessly getting stronger and has shown to have powerful playful qualities. In recent years, digital game-based learning (DGBL) has been introduced in schools. In this paper we explore game-based design activities to unfold playful and creative actions and interactions among children. The study is based on two cases, where game design activities were applied in both analogue and digital form. The unit of analysis is game design activities. The research questions posed in this study are: (1) What activities develop when school children design games in two similarly framed workshop cases, where one included analogue material and the other a combination of analogue and digital material?, and (2) How do children interact in a learning environment framed by purely analogue-based material as opposed to a learning environment framed by a combination of analogue and digital material? A thematic analysis identified three themes: exploratory activities; combinational activities; and transformative activities. These themes suggest that the game design workshop sessions including only analogue material facilitated playfulness promoting creative actions in children's production of different ideational considerations. In a mixed activity combining analogue and digital material, creativity in the form of fluency was represented by the way the children produced their ideas, which opened up for playfulness, e.g. in the form of humour. The analysis showed that a procedural activity design including pre-designed theme framing children's constructions facilitated an open-ended activity.

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KEYWORDS:

Playfulness; Creativity;
Game-based design activities;
Learning environment;
Learning resources; Primary
school children; Exploratory
activity; Transformative
activity

TO CITE THIS ARTICLE:

Brooks, E., & Sjöberg, J. (2022).
Playfulness and Creativity as
Vital Features when School
Children Develop Game-based
Designs. *Designs for Learning*,
14(1), 137–150. DOI:[https://doi.
org/10.16993/dfl.170](https://doi.org/10.16993/dfl.170)

1 INTRODUCTION

The traditional setting for children's learning has changed in recent years due to advances of digital technology and new learning environments have emerged. In recent years, digital game-based learning (DGBL) has been introduced in schools (Van Eck, 2006) and is considered an effective pedagogical tool for facilitating learning processes if implemented in education in a correct and student-centred way (Wahyutama et al., 2021). The impact of these new conditions and multimodal learning environments provides and evokes different opportunities of learning (Bajovic, 2018; Harwood, 2014), but research in this area is still in its infancy and more research is needed. Based on Van Eck (2006), Nousiainen et al. (2018) have identified four different approaches for game-based learning, namely: using *educational games*, using *entertainment games*, learning by *designing games*, and using game elements in non-game contexts (i.e., *gamification*). The authors explicate that *playfulness* creates a mindset and as such crosscuts all four game-based approaches. Corsaro (1997) claims that playful activity is indicative of children's ability to create and participate in their own peer cultures. Play-activities where people are enabled to express their playfulness foster creative processes (Smith and Simons, 1984). This has been investigated in the field of design, where findings show that activities based on playfulness might contribute to creative and productive outcomes (Lucero and Arrasvuori, 2013). Playfulness is essential also from a learning perspective as it enables a child to be flexible and imagine "what if". Thus, by stretching their boundaries on what is possible, children demonstrate their understanding of "what might be" and, thereby, generating new and creative understandings of a situation (Meek, 1985). Based on a literature review, Proyer et al. (2019) argue that there is a robust relationship between playfulness and creativity, where playfulness constitutes a facilitator of creativity and creative expression in a given setting (Bateson & Martin, 2013; Pellegrini, 2009). However, there is a lack of research when it comes to investigating the conditions under which playfulness facilitates creativity and which aspects of playfulness can foster which types of creativity (Proyer et al., 2019).

Compared to playing games, designing games is suggested to provide greater engagement and learning (Vos et al., 2011). Romero and Lambropoulos (2015) have analysed a team-based serious game design process of 24 graduate students, focusing the game design activity itself as a sociocultural and knowledge modelling activity. Results of the study show that the students reported a high level of engagement in the activities, due to the creative form. In such game design activities, children can learn how to synthesise and express information in the design of an original game (Navarrete, 2013). Moreover, it engages children in decision-making

processes of a complex system including narrative, representation of characters and their actions, and the mechanics allowing a player to reach certain game objectives (Romero and Lambropoulos, 2015). Digital game design processes engage children in meaningful activities, which require creative and collaborative approaches (Hassan et al., 2015; Wingrave et al., 2012; Romero et al., 2015). Gallagher and Grimm (2018) who have examined if game-making could lead to cognitive improvement in creativity and spatial abilities in addition to its attitudinal effects, propose that the making of computer games can be considered a potential avenue of creativity training. Furthermore, they claim that the effects of making games is largely unexamined.

Designing games as a creative activity is mediated by tools. By using tools in playful, creative ways, children can develop their understanding on tools and of emergent ideas. We agree with Baynes (1992, p. 28) that manipulation of objects is "a way of having new ideas: it is part of the equipment which supports the imagination." The present study explores game-based design activities, which includes different tools, to unfold playful and creative actions and interactions among school children. By this, our intention is to contribute to the contemporary debate on the increased use of digital game-based learning in schools and its potentials for learning. The study is based on two cases, where game design activities were applied in both analogue and digital forms. The unit of analysis is game design activities. The research questions posed in this study are:

1. What activities develop when school children design games in two similarly framed workshop cases, where one included analogue material and the other a combination of analogue and digital material?
2. How do children interact in a learning environment framed by purely analogue-based material as opposed to a learning environment framed by a combination of analogue and digital material?

2 CREATIVITY AND PLAYFULNESS

The theoretical framework of this study proposes that game-based design activities by means of playful ways of expressing ideas have embedded creative qualities and thus a potential to find new ways of approaching problems and challenges, which, among others, entail the following propositions:

- Creativity and playfulness are mediated by artefacts and results in a transformation of the physical world. Artefacts provide essential resources for children to communicate, store, catalyse, evaluate, and reflect on ideas while trying to overcome indeterminate situations. Artefacts, from this perspective, are

not mere carriers of information, but enable and constrain a child's actions (Brooks and Sjöberg, 2020; Biskjaer and Dalsgaard, 2012).

- Creativity and playfulness go along with the generation of new knowledge. As creative practices attempt to act upon a hitherto undetermined situation, the outcomes of this attempt necessarily add to a child's body of knowledge either in those assumptions about the situation are contested or supported. Thus, creative practices can be understood as desire-driven imaginative situations, where a child combines imagination and cognition to critically and reflectively inquiry the world (Sullivan, 2011; Carroll et al., 2010; Schön, 1992).

Together with communication, collaboration and critical thinking, creativity has become one of the core 21st century competencies and understood in terms of engaging “productively in the generation, evaluation and improvement of ideas, that can result in original and effective solutions, advances in knowledge and impactful expressions of imagination” (OECD, 2019, p. 8). Related to this is Torrance's (1969) definition of creativity as a capacity to detect gaps, propose various solutions to solve problems, produce novel ideas and re-combine them, and initiate novel relations between ideas. Since the time of Torrance's definition, different conceptions of creativity have emerged (e.g. Csikzentmihalyi, 1988; Almeida and Prieto, 2007; Hennessey and Amabile, 2010). A main dimension included in the majority definitions of creativity is the generation of new products, ideas, original inventions, re-elaboration and improving existing products or ideas. The idea of novelty and original products is also included in Torrance's (2008) consolidated definition of creativity as: fluency (production of ideas), flexibility (production of different ideational categories), originality (production of unusual ideas), and elaboration (persistency on introducing details to products). Creative thinking lies at the core of complex problem-solving and technological innovation (Gallagher and Grimm, 2018). Bottino et al. (2012) regard creativity as “a potential skill that can be supported and enhanced by means of appropriate educational interventions” (p. 745). They also conclude that computer games affect creativity of students, and they consider game creation as a “valuable educational activity, provided, of course, that it is adopted within specific learning contexts and that it is aimed at reaching specific learning objectives” (Bottino et al, 2012, p. 745).

Creativity is often related to playfulness, but nevertheless not so often defined in terms of how the two concepts relate to each other. Youell (2008, p. 122) considers playfulness as a state of mind, where “an individual can think flexibly, take risks with ideas (or interactions), and allow creative thoughts to emerge”. This suggests that being playful promotes creativity

but could also imply the other way around. McGhee (2010) proposes that a playful mind enables humour to emerge. Getzels and Jackson (1962) state that playfulness might contribute to creative performances in positive ways, but it seems to vary with contextual matters. Smith and Simons (1984) argue that using play-oriented activities can allow people to express their playfulness and support creative processes. This is also noted in design-oriented studies stating that playfulness can contribute to a creative outcome (Lucero and Arrasvuori, 2013). Another application field is in educational settings (Toft Nørgård, Toft-Nielsen, and Whitton, 2017). Proyer et al. (2019) refer to a growing interest in interventions to enhance playfulness in group settings and state that more research is needed to identify long-term effects. It is not the goal of this paper to study the associations between playfulness and creativity, our interest lies in uncovering the ways playfulness can create conditions in which children have opportunities to combine existing knowledge in new or unusual ways and use their playfulness in many ways to find *new solutions for existing problems*. This is aligned with Bruner's (1962) notion of *combinatory playfulness* and Proyer et al.'s (2019) emphasis on the conditions under which playfulness facilitate creativity and which facets of playfulness that can foster creativity. In this way, our interest relates to an intended contribution with insights regarding the interplay between creativity and playfulness and to discuss theoretical implications. In other words, our concern was to provide conditions for a playful and creative design process that was based on both analogue and digital forms allowing the children to create game ideas according to their own imaginations.

3 METHOD

The study is based on two creativity workshop cases designed to provide a playful and creative atmosphere inspiring children to collaborate to create ideas for new games. The workshops were carried out in two research laboratory settings in Sweden and Denmark, where the participants were supplied with a wide range of creative materials (Figure 1 – to the left). One of the cases also included digital technology for creating stop-motion videos of the children's game design solution (Figure 1 – to the right). Both in Sweden and Denmark, digital competence and technology understanding are important focus points in the current curricula. In Sweden, the concepts of programming and digital competence were included in the national curriculum in 2018. In Denmark, there has been an ongoing process focusing on whether frameworks of technology literacy should be introduced as a separate subject or integrated in specific subjects. Hence, the importance of carrying out a study like the present one is aligned with the urge to introduce



Figure 1 To the left: Case 1 experimenting with different creative materials to represent their game design idea. To the right: Case 2 experimenting with the tablet to record the stop-motion video representing their game design idea.

novel ways of introducing these new curricula concepts, since these are scarce.

Case 1 included 28 children from a third-grade school in Denmark. The participants were divided between 19 males and 9 females between 9–10 years of age. Case 2 included 22 children from a third-grade school in Sweden. Here, the participants included 16 males and 6 females between 9–10 years of age. 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. In case 1 the workshop session took place in one room (approximately 90 square meters), which created a lively and slightly loud environment. In Case 2, we divided the groups in two rooms, which created a calmer atmosphere compared to Case 1.

The two cases were carried out in the form of a design experiment (Krange and Ludvigsen, 2009) in the sense that it was designed to control some variables emphasising the availability of resources that the children could draw on and use, as well as allowing for situated interpretations related to the chosen theoretical framing. The empirical data consist of video observations and observer notes by the two authors. Video recordings offer opportunities to review actions and interactions and to discern minute details that otherwise can be missed out (Knoblauch, 2009). The teachers had on beforehand divided the children into six groups of approximately five children and each group had their own workstation. Each of these workstations 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 (Figure 2). 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 hours).

3.1 PROCEDURE

To enhance creativity, the game design workshop was structured in an easy-to-understand manner offering spontaneity. In other words, rather than suppress playfulness and creativity, the structure was there to motivate the participants' minds to exercise a creative game design process (see also Biskjaer and Dalsgaard, 2012). The workshop ran for half a day between 09:00–12:00 and was divided into three distinct creative periods following the timings and design activities depicted in Table 1.

In both cases, the research assistant introduced the game-based design activities to the children by telling them that they were going to be game designers and in teams create games based on a specific theme. The above-mentioned controlled variables (Krange & Ludvigsen, 2009) are grounded in a narrative theme approach, where the authors, on beforehand, prepared six different themes locating the game design in different settings: Desert; Jungle; Woods; City; Under water; Space (one theme to each of the groups). The narrative emerging from the theme, i.e., game design idea, 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 (Greimas, 1973/1987; Propp, 1928/1968), namely the plot, characters involved in the gameplay, and objects/props (Figure 2, left). The children were then introduced to the creative material (Figure 3, mid and 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 (iPads and the Stop Motion Studio app). The children were told that they were free to explore and use all materials at hand; there

was no right or wrong. This was important to establish trust among the participants (Heath, Hindmarsh and Luff, 2010).

3.2 ETHICAL CONSIDERATIONS

The study was subject to common research-ethical principles of transparency in the research process and quality of documentation as well as the protection of sources and individuals (Danish Code of Conduct for Research Integrity, 2014; GDPR, 2016). All teachers and parents received information about the study in

TIME	DESIGN ACTIVITIES UNDERTAKEN
09:00–09:10	<i>Introduction.</i> Establishing creativity framework and climate.
09:10–09:30	<i>Sketching activity</i> using an A4 sheet to develop a game-plot and deciding upon characters and other objects/props to include in the game design.
09:30–10:45	<i>Exploratory activity</i> using analogue and digital tools to develop different features from the sketching activity.
10:45–11:30	<i>Transformative activity</i> focusing on children's presentations of their game design represented through their game narratives (analogue form [Case 1] and digital form [Case 2]).
11:30–12:00	Joint lunch and informal conversations about the activity.

Table 1 Overview of workshop design activities and timetable.

writing, explaining how the data should be collected, analysed, used, and stored as well as how their child's anonymity should be protected (Neill, 2005). Based on this information, the parents signed and returned informed consent to the teacher. Since the project involved vulnerable user groups (minor children) special ethical considerations were made by the authors in addition to general legal standards, especially regarding child-computer interaction and data collection methods (Alderson and Morrow, 2011). Furthermore, the participatory approach to the workshop design required open, democratic processes with continuous child and teacher involvement to continuously consider the children's safety and well-being. In this regard, the children were informed that they could withdraw from the game design sessions at any time if they felt uncomfortable in any way (Simons and Usher, 2000).

3.3 ANALYTICAL APPROACH

The analysis method applied for this study is theme analysis (Fereday and Muir-Cochrane, 2010; Braun and Clarke, 2006). The transcripts were reviewed and coded by both authors to find patterns and initial themes in verbal and non-verbal actions and interactions between the children and the analogue and digital game-based design activities. The initial themes were then reviewed and defined by both authors (see Table 2).

From this analysis we identified three overall themes: (1) Exploratory activities; (2) Combinational creations;



Figure 2 A typical workshop environment representing the initial phase of the children's game design idea generation. Video cameras can be seen to the left on the pillar and on the wall (far left).



Figure 3 A 4 sheet for the Desert gameplay theme and space for the children to specify the plot of the gameplay, characters, and objects and/or props (left). Mid and right pictures show a variety of the creative material available for the children.

PHASE	DESCRIPTION OF THE ANALYSIS PROCESS
Getting to know the data	Watching and re-watching the video data and observer notes.
Generating initial codes	Systematically coding interesting features of the data and gathering data relevant to each code.
Searching for initial themes	Synthesising codes into initial themes and gathering relevant data to each initial theme.
Reviewing themes	Checking if the themes work in relation to the coded data and the whole data set, generating a thematic map of the analysis.
Defining themes	Iteration of the analysis to refine the details of each theme in relation to the research questions, generating definitions and names for each final theme.

Table 2 Overview of the analysis process (adopted from Braun and Clarke, 2006).

and (3) Transformative activities, which are presented in the next section.

4 RESULTS

The design activity was divided into three main phases: the sketching activity, the exploration activity, and the transformation activity. Each type of design activity included different types of decisions that required some sort of collaboration, distribution of tasks to get closer to a solution. The groups approached the three phases in a task-oriented way, and they were eager to accomplish it all. The analysis identified how children in different ways approached the task and encountered obstacles such as time-related issues, division of sub-tasks and management of these. In the following subsections, we present the outcomes of our analysis.

4.1 EXPLORATORY ACTIVITIES

Exploratory activities refer to how the children made use of the creative material to develop a game-based design (Figure 4). The creative material as well as

digital stop-motion technology used for the analogue and digital activities were familiar to all participants, and as such there was not much basic functionality for them to discover and interpret, leaving room for playful creativity through lots of exploration of what the children themselves could do with the different materials and digital technology. The following example from Case 2 shows a dialogue between the group members having the jungle as their scenic game-based design.

Excerpt 1

Luke: /.../ my monkey is finished. There.

Anne: Put it over there.

Luke: Okay, what can I do to help?

Sarah: Listen, we are skipping the stripes in the face [of the tiger] because it gets too difficult. But we should have ears anyway. Otherwise, it doesn't look like a tiger really.

Here, Charlie is drawing palm trees, Sarah is occupied with making a tiger out of clay, and Luke and Anne use clay to create a monkey each. They are concerned about the details of the tiger as they think it takes too long to



Figure 4 An example of children's exploratory activities, where they are exploring possible game designs (left) and where the girl in the right image is showing her group how she explored the sound designs to find the one fitting their game design the best.

make them so that they would have no time left to create the stop motion video; they do not want to compromise too much on the details in case the prop should not be recognisable as what it should represent. However, Charlie wanted to get the opportunity to explore the clay material:

Excerpt 2

Charlie: Couldn't we come up with another character so we can ... or do you need ...

Luke: No, it's going to be too hard, this is enough [directed towards Charlie] ... But it is enough with one tiger, that's enough [directed towards Sarah].

Sarah: 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... [directed towards Luke]

Charlie: Can't we make a jaguar?

Luke: But we only have one [tiger]

Sarah: Now, but then that sort of can only be one monkey as well, otherwise it will be really weird because it [the one tiger] can't chase both [monkeys].

Charlie: Can't we make a jaguar?

Luke: Yes, but it will chase both and, but, then you can see who is taken by it and they win...

Sarah: Ah, but it will be a bit strange because it will say "victory" in the end and ...

Luke: Yes, but we shouldn't do the whole game

Sarah: No, but a part of it

Charlie: Can't we make a jaguar too?

Sarah: But it won't take long to do two tigers.

Luke: Not two more!

Sarah: One more!

Anne: I can make one more. Can I do one more then?

Charlie: But then I haven't done anything in clay.

Luke: But now we are thinking too big!

Charlie: No, we are not! It is easy. Can't we make a jaguar?

Luke: No, we will not add another animal!

Sarah: One more tiger.

Luke: Yes, that's enough.

Sarah: Because otherwise it will be strange, for that

Luke: If we are having too many animals, we will not be able to make it in time.

The time designated to the sketching activity, filling in the storyboard, to some extent restricted the groups in terms of having time to explore the material in relation to what they wished to design. In case 2, this resulted in that groups put more focus and effort into creating the final stop motion video than to decide upon the game's design in terms of the plot, gameplay, characters, and props. The above excerpt exemplifies how Sarah returns to the storyboard when she argues that it would not take long time to do two tigers and that it would look weird

if the game design only included one tiger as the game idea represented in the storyboard should include two monkeys and two tigers.

The set-up of the environment as well as the creative material and digital technology allowed for instances peer learning, where the children jointly explored possible game designs (Figure 4). One of the groups having the desert as game theme (Case 1), carefully explored the qualities of different creative materials to find what best could represent their game idea. They were fascinated by the foam clay, in particular its soft tactility. However, while investigating the opportunities the foam clay offered, they found out that it was too soft to be robust enough for the background of their game design. They wanted the background scene to be mobile, i.e. they did not want to stick the clay to the table, but rather be able to move it around while developing the game design. Coping with this tension between the desire to use foam clay and the critical robustness and immobility problem related to the material, they jointly inquired about different ideas and ended up with flattening the foam clay on a LEGO platform. This material solution enabled the group members to build a mobile background scene including both larger and smaller details (Figure 4).

Dividing the whole task into smaller modules (plot of the gameplay, characters, and props) helped the children to explore the borders of the design activities. Moreover, it increased the children's knowledge and understanding of the possibilities and limitations of the material. In Case 1 the children's explorative activities had a playful process-oriented character, where the children spent lots of time exploring the different materials. In Case 2 the exploration was directed towards the end-goal to create a stop motion video and thereby more of a linear process compared to Case 1, which had a more open-ended character.

4.2 COMBINATIONAL CREATIONS

Combinational creations represent a synthesis of the group members' different individual ideas. They represent the process of the group's new insights, or additional or alternative views on existing ideas based on this combination. The combinational creations generally emerged from the storyboard where the children had structured the overall content of the game including the game design's plot, characters, and other objects. This activity contributed to the children's elaboration of ideas, which challenged them but most often did not constrain the creative process. In other words, the children were able to synthesise their individual ideas on the storyboard sheet and by taking these notes further by trying out if their ideas or solutions worked to form the game they intended to do. For this, they used creative material alongside discussions, clarifications, and negotiation. These combinational creations were characterised

by children's imagination and free, often humorous, associations, but also by goal-oriented decision-making.

By moving from their individual thoughts to a combination of some of these, the children became more and more aware of what they wanted to create, which is shown in the following excerpt (Case 2):

Excerpt 3

Anne: 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.

Charlie: No, one!

Luke: No, we're just doing one bunch.

Anne: But, like one bunch here and one there (she shows with her hand on the drawing).

Charlie: But it will be too much, with those lianas as well.

Anne: But can't we have that, then you can, like, swing in them and it's just great fun.

Charlie: /.../ Of course, we are going to have lianas. And bunches as well.

The excerpt shows that when the children started to materialise the lianas and bunches of bananas their design became even clearer and certain while they continuously combined their different viewpoints. The discussion continues in Excerpt 4, now including Charlie and Sarah who are involved in a joint decision making. Together with the other two members of their group (Luke and Anne) they constantly discussed and negotiated different aspects of their game design (see also Excerpts 2 and 3), where the verbalisation of tensions and obstacles helped them to make meaning of their targeted design, e.g. how the characters and props should be designed to communicate their narrative. The group's discussions were process-oriented, e.g., when the groups checked on strategies to solve the problem at hand so that the game could be sufficiently demonstrated in the stop motion video.

Excerpt 4

Luke: No, bunches of bananas, that will be too hard to create, can't we skip bananas?!

Sarah: But can't we have one [tree] with lianas and one with bananas?

Luke: 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.

Another group in Case 1, who had the city as a theme, was inspired by a traditional board game design. Each of them had an idea about what this game design might be, and they discussed these ideas, including how they

together could make sense. Instead of spending time on exploring different material resources, they simply used pens and white papers to get going with their ideas. They were engaged in negotiating their individual ideas into combined solutions. In doing so, they sketched their solutions and step-by-step discussed the resulting drawings to secure that all group members were aligned. They used several sheets of paper, which they put together into a big board game. This act of putting together the papers exemplifies a combinational process, where the expansion of the game design reflects how individual ideas merged into collective combined solutions.

In sum, this theme primarily focuses on the narrative content creation of the children's ideas and how they were combined individually and collectively through different phases of the game design process. The combinational creations enabled the groups to move from uncertainty and disagreements to more firm and certain insights involving the children's imagination, i.e. playfully synthesising what was apparent in the situation to what might be. One of the excerpts also exemplifies an instance where the children did not have a joint idea and, thereby, no real combination took place.

4.3 TRANSFORMATIONAL ACTIVITIES

Transformational activities refer to instances where a group of children, individually or jointly, change actions or perspectives into a new way of approaching the design activity. For example, when a group redefines their narrative or the goals of their creations, which emerge from a new way of understanding about how things work or should be carried out. Expressed in other words, the key activity within this theme concerns the groups' visioning of new possibilities. Most often such opportunities emerged from children's experimentation through which they found new ways to do things.

During the game-based design activities in groups, we could identify that the children changed their ideas or solutions in a way that things, which from the beginning were considered as impossible, changed to become possible. This was demonstrated in one of the groups designing a space game (Case 1), where the group members initially could not come up with a joint narrative for their game; they found it difficult to put together their individual ideas into a joint one. To assist them in getting on with the storyboarding, one of the research assistants encouraged them to start using the creative material and construct their ideas to come closer to a possible game idea. They started to map out their ideas by making space representations in foam clay (planets, stars, and rockets) and through this 'making', they found out that it was possible, and joyful, to do something together (Figure 6). This is an example of what we conceptualise as a transformational activity, where the group members repeatedly verbalised the narrative and their, from the beginning, impossible ideas developed

into possible ones. In doing so, they constructed a space for joint critical thinking allowing them to see new and possible options.

The final design phase, the transformation phase, included that the groups should present their game designs for each other. These presentations should include the groups' game design idea, the game play, and the choices they made during the design process. It was primarily through these presentations that transformation could be identified. The following example illustrates how the children within one of the groups had agreed on designing a multi-player digital game, which should end with a game-over scenario where a tiger fails to catch a monkey resulting in the tigers falling dead to the ground. This scenario grew out of the group's storyboard, in which the children extended their ideas and tried out different endings. Previous excerpts from this group (excerpts 2–4) show how the group went from envisioning the impossible to end up with new possibilities. This included several discussions and experimentations through which they extended their learning about the material and about the fundamentals about narrative structures, and game design features. In general, and despite frustrations, it was apparent that the children enjoyed the overall activity, which was visible throughout the process, but in particular in the transformation phase of the activity. The enjoyment was manifested through the groups' surprising and humouristic endings of the gameplay (Figure 5). The group members enjoyed the ending characterised by an improbability and surprise, since it would have been more probable that the monkeys would fail to escape from the tigers compared to the opposite.

Summing up, it was notable, particularly in Case 1, that the children's ideas generated structured outputs that aligned with, not only the use of different creative material, but also with the knowledge they developed through experimenting with the materials. Furthermore, here children's friendship constituted a shortcut to transformative actions. This was visible through their way of challenging each other, for example by saying that "this is not possible, come on". This was also seen through the way the children identified each other's strengths and encouraged each other to keep on trying, or allocated work to each other in a supportive manner, which positively determined the interaction between the group members.

5 DISCUSSION AND CONCLUSION

To address the first research question, the game design activities developed differently between the two cases. In case 1 it was primarily the creative material that enabled the children's actions. This was shown in the ways they used the creative material to discuss and



Figure 5 An example of children's combinational activity, where a 'game over' scenario was represented by a tiger hunting a monkey (Figure 5, left), but where the tiger fail to catch the monkey and, thereby, died and caused game over for the player who represented the tiger and victory for the player representing the monkey. The dead tiger is represented by a red spot (Figure 5, right).



Figure 6 An example of children's transformative activity, where an impossible solution to a space game through materialisation was transformed to a possible game design.

catalyse their ideas, and to assess and critically reflect upon how the material could mediate their intended game design creations (Author; Biskjaer and Dalsgaard, 2012). In this way, case 1 was characterised as a more open-ended and process-oriented activity compared to case 2. The participants in case 1 spent qualitative time on experimenting with and learning about what the material could and could not do as well as what they concretely could use it for in their game designs, where they stretched their boundaries and generated new approaches to "what might be" possible (Meek,

1985). This indicates that creative material can create a playful setting enabling children to express themselves creatively (Bateson & Martin, 2013; Pellegrini, 2009; Lucero & Arrasvuori, 2013; Proyer et al., 2019). In line with Youell (2008), in case 1 the participants applied a playful flexibility and originality in their interactions with each other and with the material allowing creative thoughts to develop. Thus, playfulness facilitated creative actions, in particular by the children's production of different ideational considerations (Torrance, 2008).

In case 2 the participants were concerned about having time left to create the stop-motion video. This resulted in activities where the children continuously spent time on making critical design decisions to, as a group, be as efficient as possible trying to overcome indeterminate situations, which to some extent constrained the children's actions (Brooks and Sjöberg, 2020; Biskjaer and Dalsgaard, 2012). Furthermore, the children within this case were continuously dealing with effective decision-making processes to reach the workshop objectives and to keep up with the time available for the different phases of the workshop (Romero & Lambropoulos, 2015). This is aligned with research stating that game design activities which are based on a creative form can promote children's expressing and synthesising of content and their engagement in complex decision-making processes including narrative details (Navarrete, 2013; Romero and Lambropoulos, 2015). While engaged in these kinds of processes, the children often were desire-driven, where they combined their critical inquiry of each other's ideas with imagination and humourful content solutions (Sullivan, 2011; Carroll et al., 2010; Schön, 1992), which seemed to promote playfulness. In this case, creativity, primarily in the form of fluency and elaboration, represented by the way the children produced their ideas (Torrance, 2008). This process opened up for playfulness, e.g. in the form of humour.

Furthermore, the analysis showed that even though the activity had a procedural design accompanied with a pre-decided theme, it was not completely directed by this framing. Rather, the content emerged through the children's talk and playful states of mind. This was characterised by combinational and transformational ideation in the form of e.g. negotiations, joint experimentation and decision-making (Youell, 2008). In line with Smith and Simons (1984), we argue that through an open-ended framing of the game design workshop alongside its procedural design, children were enabled to playfully express themselves, which encouraged creative processes. This, in turn, contributed to that the children could make decisions about characters, props, etc. (Romero and Lambropoulos, 2015). This kind of playful framing clearly contributed to the children's creative actions and ownership of the game-design activity. The study thereby supports studies stating that imagination can support experimentation and simultaneously stretch learning to higher levels (Meek, 1985).

In relation to the second research question, the analogue and digital material mediated the design activity in different ways (Sullivan, 2011; Carroll et al., 2010; Schön, 1992). Case 1 was primarily characterised by a playful 'stretching boundaries' approach to the game design activity through which they developed knowledge about material as well as about handling of ideational considerations. Case 2 was primarily illustrated by a 'creative thinking' approach in the form of complex

problem-solving (Brooks and Sjöberg, 2020; Biskjaer and Dalsgaard, 2012), through which the children generated knowledge about how a design setting can be both challenging and supportive (Sullivan, 2011; Carroll et al., 2010; Schön, 1992). The commonality between the two conditions (analogue or a mixture of analogue, digital) lies in the game design activity itself, which in both cases iteratively contributed to positive outcomes among the children. We suggest that in case 1 playfulness facilitated creativity and in case 2 it was the other way around, creativity nurtured playfulness. Deriving from this is a position where playful interaction with materiality can promote more complex combinations of materials than would be the case in non-playful activities (Bruner, 1972; Cheyne and Rubin, 1983). It should however be noted that this study is based on a small sample of children and accordingly more research is needed to validate these conclusions.

To conclude, this study contributes to the question of the conditions under which playfulness facilitates creativity and which aspects of playfulness can promote which types of creativity, i.e. the interplay between creativity and playfulness and its theoretical implications. Furthermore, the study contributes to the question of what the activity of designing games, including a multimodal design, can offer. These contributions add to existing knowledge by detailing in what ways materials promote playful and creative activities. The analogue material facilitates a playful mind, which in turn promotes creativity in the form of flexibility and originality. The combined analogue and digital material foster creativity in the form of fluency and elaboration, which enables playfulness to emerge. This also renders material possibilities in digital game-based learning activities, where designing games is core of the activity, hence this has implications for learning and teaching in educational settings.

ACKNOWLEDGEMENTS

We thank all the children, teachers, and workshop facilitators. We gratefully acknowledge the grant from Nordplus Horizontal, NPHZ-2016/10071.

COMPETING INTERESTS

The authors have no competing interests to declare.

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TO CITE THIS ARTICLE:

Brooks, E., & Sjöberg, J. (2022). Playfulness and Creativity as Vital Features when School Children Develop Game-based Designs. *Designs for Learning*, 14(1), 137–150. DOI: <https://doi.org/10.16993/dfl.170>

Submitted: 17 February 2021

Accepted: 01 February 2022

Published: 28 October 2022

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Designs for Learning is a peer-reviewed open access journal published by Stockholm University Press.

