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Game jams in general formal education

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ABSTRACT

This article summarises three years of studying game jams. Rooted in extensive field work — participating, organising, studying and discussing game jams — and multiple methods, we have explored different digital and non-digital jamming formats to apply in educational settings, especially in the Finnish context of general formal teaching for 16–19 year olds. This paper sums up our main findings arranged thematically. We claim that game jamming is a viable method in general formal education, and that although the learning outcomes vary and can be difficult to verify, the participants themselves report perceived learning and increased motivation. We also discuss the values present in our research project and the inclusivity of game jams. We describe various ways to organise game jams in classrooms, along with teacher competencies and resources needed. Based on these viewpoints we provide recommendations, grounded in both research and practice, on how to use game jamming in schools to teach, for example, STEAM and other 21st century skills.

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1. Introduction

During the 2010s game-making as a hobby has proliferated (Kultima, 2018b) and become an important part of many game cultures. This trend has been accelerated by *game jams*, events where participants design and create a game in a limited time frame and share the results (Kultima, 2015). Simultaneously, collaborative and creative project-based teaching and learning have been successfully implemented increasingly as part of formal learning, for example in the form of robot-building, different types of crafts, and hackathons (see e.g. Korhonen & Lavonen, 2017; Sormunen, 2020). Collaborative game-making as part of formal education draws from these two traditions.

Purely recreational game jams are common and popular (Grace & Gold, 2018; Kaitila, 2012), yet even recreational game jams are often attended for learning purposes (Fowler, Khosmood, Arya, & Lai, 2013; Smith & Bowers, 2016). Game jams have a history also within formal vocational learning dating back to at least 2006 (Fullerton et al., 2006), even if it has taken a decade for the work of the early pioneers to spread (e.g. Fowler et al., 2016; Hrehovcsik, Warmelink, & Valente, 2016). In a learning context, game jams connect to a larger framework of playful learning (Whitton, 2018), and educational game jams are a concrete example of constructionist pedagogy (see Kafai & Burke, 2015). Although game jams and learning have been discussed in earlier literature, much of this literature focuses on game development students and game jam hobbyists (e.g. Arya, Chastine, Preston, & Fowler, 2013; Hrehovcsik et al., 2016). Our work addresses a gap in the research by focusing on general formal education, and provides both theoretical and practical perspectives on game jams as a pedagogical method.

In this article, we present a multi-faceted examination of game jams in general formal education. The article provides an overview of three years of field work conducted between 2018 and 2020, during which different data sets were collected while organising, studying, and reflecting on game jam events in educational contexts (see Table 1). By basing our research in diverse field work, we present a view of educational game jams that is firmly grounded in both theory and practice.

Our research question is: "How can game jamming be applied in formal education?" The question has a theoretical and a practical side: our design goal was to develop a model of a game jam event suitable for formal education, and our theoretical goal was to produce scientific results regarding game jamming in formal education. To answer the broad research question, we address the following subquestions:

- What pedagogical implications and effects do game jams have when applied to general formal education?
- What format of a game jam would best fit school settings?
- Which ethical aspects should be considered when organising game jams in general formal education?
- What kinds of competencies do teachers need when organising game jams?
- What resources are needed in order to organise game jams in schools?

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Table 1
Game jams and jam events organised 2018–2020. (GUSS = general upper secondary school).

Event #	Event name	Participants	Duration	Game format	Data collected
1	EduGameJam (2018)	Teachers, experienced game jammers (N = 16)	48 h	Digital	Observation data, games made by the participants
2	Utan Jam (2018)	GUSS students (N = 9)	48 h	Digital	Observation data, qualitative pre- and post-jam survey data (N = 8, N = 7), quantitative non-participation survey data (N = 218)
3	FGJ Tampere 2019/Global Game Jam 2019	Jam hobbyists, students and researchers (N = 60)	48 h	Digital, non-digital	Observation
4	Board game jam (2019)	University students (N = 25)	6 h	Non-digital	Observation data, presentations of the games by the participants (text and photos)
5	Salajamit (2019)	General education teachers (N = 12)	10 h	Digital	Observation data, audio from the end discussion, video from the group presentations, post-jam survey data (N = 10)
6	Jamology research paper jam (2019)	Researchers, university students (N = 18)	5 h	Other	Observation data
7	Growing Mind research paper jam (2019)	Researchers (N = 30)	2 h	Other	Observation data
8	DigiErko game jam training (2019)	Teachers, teacher students (N = 12)	2 h	Digital, hybrid, and non-digital	Observation data
9	GBP and games (2019)	Teacher students (N = 24)	2 h	Non-digital	Observation data
10	Digitutor game concept workshops (2019)	Digital tutor teachers (N = 48)	4 × 2 h	Non-digital	Observation data, team presentations (text and graphics)
11	Physical education jam (2019)	GUSS students (N = 10)	6 h	Non-digital	Observation data, qualitative post-jam survey data (N = 5)
12	Game culture course jam (2019)	GUSS students (N = 35)	6 h	Digital and non-digital	Observation data, games made during the jam and video of the team presentations
13	Twine jam (2019)	GUSS students (N = 14)	6 h	Digital	Qualitative pre- and post-jam survey data (N = 15, N = 12)
14	Game concept jam (2019)	GUSS students, basic education students (N = 20)	6 h	Non-digital	Observation data, game concept presentations by the participants (text and graphics)
15	Board game jam (2020)	University students (N = 25)	4 h	Non-digital	Observation data, team presentations (text and photos)
16	DigiErko game jam training (2020)	Teachers (N = 12)	7 h	Digital	Observation data
17	Turku EduGameJam (2020)	GUSS students (N = 12)	48 h	Digital	Observation data, video of the team presentations, games made by the teams, qualitative pre- and post-jam survey data (N = 11, N = 8)
18	Games Now! Online Game Jam #1 (2020)	University students, jam hobbyists (N = 38)	6 days	Digital	Observation, participant survey, specialist interview, submitted games
19	Games Now! Online Game Jam #2: Sad Games (2020)	University students, jam hobbyists (N = 59)	6 days	Digital	Observation, participant survey, specialist interview, submitted games
20	Games Now! Online Game Jam #3: Board Game Ecologies (2020)	University students, jam hobbyists (N = 17)	6 days	Digital, non-digital	Observation, participant survey, specialist interview, submitted games

The paper starts with contextualising our research by presenting previous research on game jams and especially learning in game jams, and the pedagogical theories related to game jam learning. Next, we describe our methods and data. We then move to our results and discussion, arranged into five sections which reflect our subquestions: (1) learning and motivation in school-related game jams, (2) description of various game jam formats, (3) value questions that need to be addressed by organisers, (4) teacher competencies required in organising jams in schools, and (5) the resources needed for organising them. In the conclusions, we express our recommendations for game jamming in schools, along with our key findings.

2. Background

The findings and discussion presented in this paper result from the first half of the Academy of Finland funded six year research project Growing Mind (Growing Mind, 2020), which seeks to support learning and school development in the digital era. The project brings together researchers in the fields of education, psychology, and game studies, and is conducted in close collaboration with schools in Helsinki, the capital of Finland. Our part of the larger project is to study game jams as a pedagogical tool. We explore the relationship between game jams and learning in order to discern the applicability of game jams in formal general education and to develop pedagogical approaches. The study on online game jams was conducted in Aalto University's Games Now! Community pilot initiative (Games Now!, 2020). Next, we will first review existing research on using game jams in learning and teaching, and then discuss game jams from the point of view of pedagogical theory.

2.1. Game jams in learning and teaching

Game jams, intensive and opportunistic game creation events, have garnered increased interest in recent years. They have made creating games as a hobby visible. Simultaneously, as the software tools that enable digital game making without extensive coding skill have proliferated, game jams and game making as a hobby have become more widespread (Kultima, 2018b). Today game jams are a key site for game creation in Finland, and they are an important part of the game industry ecology (Kultima, 2018b). One aspect of this spreading of game jam practice has been their use as sites of learning, both as places of practising and informal learning, but also as part of formal education (see Fowler et al., 2013; Smith & Bowers, 2016).

Academic interest in game jams has been growing slowly. Thus far game jams have been studied, for example, from the angles of playfulness (Goddard, Byrne, & Mueller, 2014; Grace, 2016), community (Kultima, Alha, & Nummenmaa, 2016a), and labour (Kennedy, 2018). In our extensive literature review (Meriläinen, Aurava, Kultima, & Stenros, 2020) conducted as part of this research project, we identified both considerable pedagogical potential and challenges in educational game jamming: Game jams offer opportunities to further game development skills (e.g. Arya et al., 2013; Macklin, Martin, & Dikkers, 2012), *STEAM* (science, technology, arts, engineering, mathematics) skills (e.g. Fowler et al., 2016; Pollock, Murray, & Yeager, 2017), and inter- and intrapersonal skills (e.g. Meriläinen, 2019; Smith & Bowers, 2016). They can also heighten participants' self-efficacy (Meriläinen, 2019) and increase learning motivation (Arya et al., 2013; Meriläinen, 2019). Game jamming itself is also a skill, and with experience, participants become more adept at navigating jam events (Kultima, 2019). However, game jamming also presents challenges: assessment of learning outcomes is difficult (Hrehovcsik et al., 2016), there are internal and external barriers to participation (Aurava, Kankainen, & Murray, 2020a; Meriläinen & Aurava, 2018; Wearn & McDonald, 2016), and it can be difficult to integrate jam events into rigid school structures (Aurava, Meriläinen, & Stenros, 2020b). It is clear from these issues, that the application of game jams in formal education is not a trivial task.

It is important to note that the focus of our project is not in using game jams to learn how to create games, or even how to develop specific skills used in creating games such as programming or sound design. No, our project aims to help students develop so-called soft skills, such as metareflection, epistemic flexibility, and other 21st century skills by creating games together. *21st century skills* is a term that refers to a set of skills or competencies seen as important in the post-industrial, rapidly developing world, where an individual and society will benefit more from constant learning, adaptation, and innovation than a fixed set of information (European Union, 2006; Organization for Economic, 2013; Organization for Economic Co-operation and Development, 2013; Trilling & Fadel, 2009). Game jams employ and develop several of these skills, e.g. communicational and co-operational skills, learning-to-learn skills, problem solving and critical thinking, STEAM and ICT skills, and creation and innovation skills (Meriläinen et al., 2020). Indeed, the overall inclusion of arts in the more traditional *STEM* (science, technology, engineering, mathematics) learning has been used as motivation to get students interested in learning 21st century skills (Liao, Motter, & Patton, 2016).

In the past, game making has been used to teach programming and to support the critical understanding of games and new media (Kafai & Peppler, 2011). While that has not been the focus of this work, we do not want to diminish such uses of game jams. In fact, programming or the ability to use a game making software are the most commonly reported learning outcomes in our participant post-event surveys. However, a game jam event cannot provide all participants with these skills as the tasks are divided in the group.

Gaming and game making cultures tend to have gendered structures, which game jams risk replicating (Gee & Hayes, 2010; Kennedy, 2018; Taylor, Jenson, & de Castell, 2009; Tran, 2016). However, there have also been tentative results in earlier literature that game jamming would motivate STEM learning in groups like women and minorities, which are underrepresented in the gaming industry, and in STEM careers more generally (Fowler & Schreiber, 2017). Interest in problem-solving, creativity, and design have also been seen predictive for girls' interest in STEM learning (Cooper & Heaverlo, 2013), while collaborative learning has been suggested to increase gender-inclusivity in science classes (Roychoudhury, Tippins, & Nichols, 1995). It needs to be noted that in our thinking, coding a new game is also a creative endeavour, and can be seen as an artistic expression (Peppler & Kafai, 2005).

2.2. Pedagogical theories related to game jam learning

In our pedagogical thinking, game jamming best reads as *collaborative learning* where two or more learners work together to reach a common goal (Dillenbourg, 1999). The cognitive and metacognitive gain in collaborative learning is not to solve a specific problem or, in game jams, to create a game, but in creating knowledge together and adding to each individual's skills (Dillenbourg, 1999; Renkl, 2007). Game jam learning can also be labelled as cooperational learning, problem-based learning, project-based learning, or co-creation, which all differ slightly from collaborative learning. In *cooperational learning*, the work is divided into specific tasks which the participants independently solve and which are then combined (Dillenbourg, 1999). While some game jam groups work like this, especially when the participants are professionals or have very specific skills and know the general process of game creation, this is not typically the case when jamming with adolescents. In *problem-based learning* the students face a complex problem with no single correct answer, and often work collaboratively to solve the problem, with the teacher providing facilitation rather than information. Dewey (1938) and Hmelo-Silver (2004). *Project-based learning* refers to learners solving their own research questions with the teacher acting as a tutor, and is also framed as a pedagogy supporting the 21st century skills (Bell, 2010). With *co-creation*, we refer to the practice of collaborative creating, or distributed creativity, much like jamming music (see Jaffurs, 2004; Karlsen, 2010) or improvising a theatre performance (Sawyer & DeZutter, 2009).

Previous research shows that collaborative learning, where learners work together to further not only their own learning but that of their partner or group, enhances the learners' (meta)cognitive performance and social skills (see e.g. Järvelä, Volet, & Järvenoja, 2010; Ruys, Van Keer, & Aelterman, 2011). There is strong evidence that collaborative learning is highly effective (Kyndt et al., 2013; Slavin, 1980). For any kind of collaborative learning to be successful, the teacher's skills in fostering beneficial student interaction are important (Kaendler, Wiedmann, Rummel, & Spada, 2015). Kaendler et al. (2015) have identified five phases of teacher competencies in collaborative learning: planning, monitoring, and supporting student interaction, consolidating learning, and reflecting. All of these are present in game jams, with consolidating occurring at the end of the event, when all the projects are presented and discussed. Furthermore, Nousiainen, Kangas, Rikala, and Vesisenaho (2018) have studied teacher competence in game-based pedagogy, and identified four aspects of teacher competencies: pedagogical, technological, collaborative, and creative. Of these, the pedagogical and collaborative competencies include elements Kaendler et al. are discussing.

3. Methods and data

Data collection for this study has taken place in 2018—2020. During this time, we have participated in ten different game jams and hackathons and organised seventeen on-site game jams and other related events, such as game concept jamming or jam events for writing research papers, and three online game jams (Table 1). These jams have ranged from 45 min to 48 h; while some have been with professional educators and researchers, most of the participants have been students in either general upper secondary education or higher education. In addition to organising game jams, we have been involved in eight game jam events either as participants or as mentors and observers. As part of these events, we have collected plural, mainly qualitative, data consisting of pre- and post-surveys with adolescent participants, interviews of participating teachers and hobbyists, and observations of events. We have also interviewed hobbyist game jam organisers with varying levels of organising experience. As a whole, these data paint a detailed and nuanced picture of educational game jamming. Parts of this data have been used in previous publications (Aurava et al., 2020a, 2020b; Kankainen, Kultima, & Meriläinen, 2019; Meriläinen, 2019), with more forthcoming.

We have employed a variety of methods in our analyses. Data consisting of open-ended questionnaire responses and interviews have been subjected to thematic analysis , in which data is iteratively coded and re-coded to identify and construct thematic wholes which are then in turn used to build broader themes. Thematic analysis is well-suited for constructing new knowledge on a previously underexplored topic (Braun & Clarke, 2006). The thematic analyses were conducted using *Atlas.ti*, a qualitative data analysis software.

We have adopted a hermeneutic approach (Ramberg & Gjesdal, 2014) when developing our understanding of educational game jams. In practice, this means that we have continuously iterated our process, making field notes, collecting data sets, discussing, reflecting, constructing theory, reworking and rethinking. In the process we realised that we were doing *educational design research*, which is a procedural, iterative, and self-correcting approach to education design, set in an authentic educational context. Each phase is slightly different due to changes in the design, and the end product is twofold: both theory and educational application are enhanced in the process (Collins, Joseph, & Bielaczyc, 2004; Design-Based Research Collective, 2003; Sandoval, 2014), Additionally, we are not investigating existing realities but exploring possibilities, as is the case in design research (Euler, 2017). As Collins et al. (2004) describe, the data collected in such research is most often abundant and consists of various materials: observation, artefacts made by participants, research journals, surveys, interviews, videos. The role of the researcher is also manifold: the researcher is both a designer and a mentor for educators (McKenney, 2017; McKenney & Brand-Gruwel, 2018). This process, in a game design context, would be characterised as an iterative cycle (Kultima, 2018b), in academic context our work is similar to the hermeneutic circle or spiral (Ramberg & Gjesdal, 2014), where examining pre-understandings, reflection, and considering the whole in light of the parts and the parts in light of the whole.

Three important contextual factors that affect the limitations of the study must be noted here. First, our work is situated in Finland, and in the context of the Finnish national curricula. While the curricula do not mention game-based pedagogies (Aurava, 2018; FNAE, 2016a, 2016b), Finnish teachers have significant leeway in deciding how they teach their subject matter. The goals of Finnish national curricula reflect a wider global shift in education towards meta skills like learning-to-learn skills and communication skills, and the Finnish educational system can be seen as an example of modern formal education practices.

Second, we mostly organised the game jam events we studied. This has granted us essential insight into both complications and possibilities related to organising jam events in schools and has allowed us to epistemically anchor our knowledge in practice. However, us being in a dual role of jam organiser and jam researcher plausibly affects some of the data and our interpretation of it.

Thirdly, the teachers and students who have taken part in our events have been volunteers, and as such, motivated and interested, and have had positive attitudes even before the events. This affects the research but is also a strength — the participants have been interested to develop game jamming and their insightful feedback has driven us forward in the process. To get other voices heard, we have also collected data from students who did not attend our events (Aurava et al., 2020a).

It is a challenge to condense nearly three years of qualitative and reflective research into clearly delineated results and discussion sections. Because of this, in the following sections we have elected to present and discuss five thematic facets of our findings on educational game jamming: Learning and motivation in game jams, the plurality of game jams; values in game jams, required teacher competencies, and required resources. In these thematic sections, we present a combination of results and discussion.

4. Learning and motivation in game jams

Learning is a common motivation for organising game jams and participating in them (Arya et al., 2013; Fowler et al., 2013; Kankainen et al., 2019; Smith & Bowers, 2016; Wearn & McDonald, 2016), and the question crucial to the use of game jams in education is whether game jamming is a viable pedagogical method. Based on our field study as well as previous research (see Meriläinen et al., 2020), we claim that *game jamming is a suitable method for teaching and learning in formal education*. Participants report that they have learned in jams (Meriläinen, 2019), teachers feel that when wielded smartly game jams work as a pedagogical tool (Aurava et al., 2020b), and game jams fit well with constructivist and constructionist pedagogical theory (Meriläinen et al., 2020). The students we have encountered in our game jams have given predominantly positive feedback: in the post-surveys from three game jam events (events 2; 13; 17), participants (n = 27) reported experiences of learning, increased self-efficacy, and increased or continuing motivation to learn more game creation or to participate in other creative projects.

The students we have studied have reported learning e.g. programming and other ITC skills, group work skills, self-regulation, and time management. Because of the creative, constructivist learning taking place in game jams, we cannot show with evidence the change in participant knowledge or skills. Whereas post-jam survey responses such as

> My technical skills moved in a positive direction. Earlier I had no experience of programming. Now having taken my first step I have looked for programming tutorials on Youtube. (Student participant, event 2)

illustrate concrete learning, others leave much more to interpretation:

> Group work skills do develop with every experience, so I feel that this [event] provided new experience in that regard. (Student participant, event 13)

Reports of student learning are all self-assessments, and do not always prove that learning has happened during the jam event (see also Arya et al., 2013). Situations in which a respondent reports learning a completely new skill or learning the basics of using a particular software are clear-cut, but the more abstract the learning experiences become, the more difficult learning is to assess. However, we argue that regardless of actual learning, *experiences* of learning are important from the perspective of motivation, as these experiences can drive future learning and have a positive impact on self-efficacy (Meriläinen, 2019).

Teachers participating in our game jam workshop unanimously reported that game jams as a method of learning suit their pedagogical thinking, and could realistically be used in their classroom, albeit with caveats. The concerns they most expressed were the lack of resources and that game jamming as a method might not suit all students or all groups of learners (Aurava et al., 2020b). Organising game jams was most typically seen as extra, as a special event, within the day to day activities of the school, and thus requires extra effort from teachers. This may influence learning outcomes as well. We discuss this aspect of educational game jamming in more detail in Sections 7 and 8.

Not all students are interested in creating games, or even playing them. As part of our project we conducted a survey for students who were invited to attend a game jam but did not do so ($n = 218$), with the aim of both mapping general interest amongst the students and identifying possible barriers to entry. Of the participants in the survey, 39% were not interested in making games, and 36% not interested in games in general (Aurava et al., 2020a). *The popular idea that games are a motivational silver bullet, something that will always render an uninteresting subject matter fascinating, is simply not true.*

In game culture at large, game jamming is a voluntary activity. In a school setting, this might be compromised. Self-selected participants are highly motivated, but will we lose positive learning outcomes if the students are participating as part of required formal learning? In our research, the students have attended the jam events voluntarily but have received study credits for participation. In the Finnish national curriculum for general upper secondary schools (FNAE, 2016b), there are also optional courses the student can choose from, and these courses may vary locally. Participation in our jam events has been regarded as an optional course but it is still not entirely voluntary, since the students need to study a certain amount of these courses. Applying game jamming in primary education might complicate this even further. In Finland, typically a group of children studies all subjects with the same teacher. Organising a game jam for the whole group would probably lead into a situation where not everyone is highly motivated, as not everyone is interested in games (Aurava et al., 2020a).

5. The plurality of game jams

Game jams are much more varied than we initially expected. While we had examined the literature, we were expecting that the 48 h long Global Game Jam (GGJ) style format, that appears to be a key template for on-site game jams in both Finland and globally (see 1, pp. 141–147], would be the best fit. It quickly became apparent from both our 2018 Utan Jam (event 2) and teacher interviews (Aurava et al., 2020b) that such a long event was a poor fit for formal general education, an issue identified in other problem-based learning projects (see e.g. Hmelo-Silver, 2004).

Another challenge we encountered early on was the participants' uneven base skills.

There are numerous game-making platforms available, but this variety of different tools can be a hindrance if participants do not know the tools well enough to make an informed choice. Despite tutorials and beginner-friendliness, game creation platforms such as *Unity* (Unity Technologies, 2005/2020) and *GameMaker* (YoYo Games Ltd., 2013) proved difficult and time-consuming for first-time game creators to grasp, despite on-site help (events 2; 12). Focus tended to shift from creating a game to learning to handle a specific tool. We quickly moved from allowing the use of any and all tools to first encouraging the use of specific tools, and then to choosing the key tools. We also started to organise workshops for the participants before the event (events 12; 13; 17) to ensure they had at least a rudimentary grasp of the chosen tools before the event itself. This allowed the jammers to focus more on the content creation during the jam and proved to be beneficial for both the advancement of technical skills and for alleviating any social anxiety (see Meriläinen & Aurava, 2018) the participants might have.

> [The organisers] should present the game making tools *before* the jam or at least in the beginning of it. (Student participant, boy, event 2)

> I liked that we had the workshop the previous day, it prepared us for the longer session and then there were not so many technical problems. (Student participant, boy, event 13)

The observed difficulties in our early game jam (event 2), combined with student feedback, led us to experiment with a variety of jam formats, which proved to be a fruitful approach. We condensed events to six hours (events 4; 11; 12; 13; 14) to make scheduling easier and to better integrate game jams with students' school days, and switched to platforms that were easier, available online without downloading, and took less time to learn, namely *Twine* (Interactive Fiction Technology Foundation, 2009) (events 8; 13), *Construct* (Scirra Ltd., 2011) (event 17), and *Bitsy* (Adam LeDoux, 2017) (event 8). We experimented with removing the digital element altogether, and organised short non-digital game jams (events 4; 8; 9), including a sports game jam where the students created new games for physical education classes (event 11). We even discarded games completely and experimented with jamming academic papers (events 6; 7). In collaboration with Aalto University's Games Now! open lecture series (Games Now!, 2020), we tested six-day online jams (events 18; 19; 20) combined with streamed talk shows in order to study their suitability for university education.

Many of these different formats proved much more viable than our first effort, yet in hindsight it took us surprisingly long to understand and accept that. It must be noted that none of these steps were ground-breaking. Instead, we had encountered arguments suggesting them in discussions with game jam enthusiasts and researchers, as well as research literature (e.g. Cornish, Farber, Fleming, & Miklasz, 2017; Macklin et al., 2012). While following these suggestions outright would have saved time and effort, arriving at similar conclusions through a hermeneutic process of experimentation allowed for a situated expertise to grow, and enabled a more nuanced analysis of the benefits and difficulties of different approaches. In existing research, reflections of why certain game jam practices in a pedagogical setting are better than others are rarely explicit. This process also helped us identify issues contingent on setting: game jamming with game development students familiar with game creation tools (e.g. Hrehovcsik et al., 2016), that a large part of previous research focuses on (Meriläinen et al., 2020), is different from jamming with general education students completely new to game creation and development.

Our experiences highlight the plurality of game jams. As has been pointed out in previous research, there is no one way to jam (Eberhardt, 2016; Kultima, 2015). When organising an on-site

game jam, there is nothing that necessitates following the typical GGJ template — especially when the jammers have no previous experience and thus hold less specific expectations about participating in game jams. Although this might seem obvious, the influence of the Global Game Jam cannot be ignored, and in our case, it limited our perception of game jams despite our being aware of other formats. There are numerous ways to execute an on-site game jam (e.g. Gaudl et al., 2018; Kultima, 2015), and when online game jams (Faas, Liu, Dombrowski, & Miller, 2019) are considered, the possibilities increase even further.

6. Values in game jams

The plurality of game jams is not just an issue of length of time, tools used, or setting. Game jams differ also in relation to what they mean, what kind of culture they encourage, and who they welcome (Kennedy, 2018; Kerr, Savage, & Twomey-Lee, 2020). This is important to acknowledge when designing any game jam, and especially important when planning an educational jam. Values tie into important ethical and practical questions: is the event accessible and welcoming to all participants? Is there sufficient rest and recuperation time for underaged students? Is the focus of the event on playfulness or competition? What are the pedagogical goals of the event? Questions like these render visible that organiser values are not simply abstract ideals, but concretely impact event design and execution (Kultima, 2018a).

Game jam culture has a strong connection to the game industry, and the values of the game industry often penetrate jams as well. Some of these values are incompatible with the ideology of Finnish formal public education goals and *Bildung* ideals of personal growth, maturation, and fulfilment of human potential (Meriläinen, 2020). For example, working rapidly and intensely for long stretches of time in a jam, driven by enthusiasm and excitement, can be seen (Borg, Garousi, Mahmoud, Olsson, & Stalberg, 2019) as glorification of *crunch culture*, a structural game industry problem of working excessively on a game in order to finish it on time (Peticca-Harris, Weststar, & McKenna, 2015). In the Finnish context crunch culture is not as widespread as in the American context, and the Finnish Game Jam association has for years sought to actively foster more collaborative jam cultures (Kultima et al., 2016a), an approach we consciously adopted.

In our experience game jams, especially ones focused on digital games, may stereotypically be perceived as something mainly for boys and men, reflecting broader biases in tech culture (Alfrey & Twine, 2016) and ICT-related STEM fields (Cheryan, Ziegler, Montoya, & Jiang, 2017). In addition to reinforcing negative stereotypes, views like this may discourage girls, women, and non-binary students from participating, in effect becoming a self-fulfilling prophecy and further reinforcing the idea of a male-centred activity (see Cheryan et al., 2017; Kerr et al., 2020).

According to our experiences, even when jams attract participants from all genders, if tasks are divided unreflectively, men and boys often gravitate towards coding whereas women and girls gravitate towards art and story. In the pre-survey before our first game jam event for students (event 2), all the participants reported an equal interest in coding. However, when we started the event, girls took on the roles of illustrators and story creators, while boys started coding. This is in line with previous research regarding gender roles in STEAM learning (see e.g. Brotman & Moore, 2008; Herbert & Stipek, 2005). Our initial experiences led us to organise workshops to lower the threshold to experimenting with game creation software. We also chose platforms such as *Twine* and *Bitsy*, which do not require extensive technical skills.

We took concrete steps to address gendered attitudes and structures, explicitly bringing up the risk when discussing game jams with teachers and principals aiding in the advertising of our game jam events. Our game jam posters and invitations distributed in schools highlighted a wide variety of skills useful in game jams, such as writing, design, and art. We encouraged non-gamers to participate, knowing that despite an interest in games, many girls, women, and non-binary game players do not identify as gamers (Shaw, 2012). Our voluntary jam events attracted girls and boys quite evenly. There were also several non-binary students in some of the events. Notably, in one of the events (event 17), a third of the participants identified as non-binary, a much higher representation than average.

> In my opinion, everything was well managed and the atmosphere [of the event] was inviting and safe. (Student participant, non-binary, event 13)

Still, more often than not, the roles taken in the groups tended to be traditional, with boys in charge of coding and girls and non-binary students focusing on graphics and narrative, although based on our pre-jam surveys, a considerable part of this is due to existing student interests.

The element of *competition* can be a defining characteristic of game jams. On one hand game jams have been described as "highly competitive" (Kennedy, 2018, pp. 715), on the other it has been suggested that it is the precedence of playfulness over competition that defines game jams (Grace, 2016). While competition has a dual meaning here — competition between teams and the collective competition against time — these conflicting views indicate differences in game jamming cultures. Before and during our events, in line with the Finnish game jamming tradition, we emphasised and encouraged playfulness, non-competition, and collaboration. There were no prizes awarded, and finishing a game was not a requirement. This was a conscious decision, as the lack of competition helps reduce stress and encourages participation, especially in the case of first-time jammers (Meriläinen, 2019; Meriläinen & Aurava, 2018). Based on our observation combined with post-jam survey data, we argue that peer learning is also more common if the students help each other beyond their own group, especially if the participants have very uneven base skills.

> I received help from other participants when I encountered problems, both from other teams and my own. (Student participant, boy, event 2)

> I received help whenever I needed it — for example, I got to borrow the computer of a participant from another team when my own was not working, and opinions, when I asked for them. (Student participant, non-binary, event 13)

In game jams, it is quite common that some teams do not finish their games in the time given. As discussed above, while some participants may view an unfinished game as a sign of a failed jam (Faas et al., 2019), not requiring a finished, polished end product may reduce stress and self-criticism in others (Kultima, Alha, & Nummenmaa, 2016b; Meriläinen, 2019). Most of the students in our game jam events did finish their game projects, even if in several cases the end results were not as polished as they would have hoped for. Finishing the project was satisfactory, according to the post-jam surveys:

> Best [game jam] moments were the ones when games were presented and our game was praised. It was nice to see our game finished. (Student participant, girl, event 13)

> In the jam, the worst moments were the ones when an encountered problem could not be solved even with tutoring and all the help we received. Giving up felt bad. (Student participant, boy, event 17)

We consider this "freedom to fail" to be a key part of jamming culture and an important part of creating a safe and relaxed atmosphere (see also Arya et al., 2013; Guevara-Villalobos, 2011). We feel the need to stress that *even when school norms require evaluation, it should not be based on finished games, in order to avoid focusing on the product over the process.*

7. Required teacher competencies

Based on our experiences and data, we argue that organising game jams, particularly with a pedagogical focus, requires a set of competencies — the skills of organising game jams. As with any game-based pedagogy, teachers need pedagogical, technological, collaborative, and creative competencies (Kaendler et al., 2015). Of these, the pedagogical competencies such as curriculum-based planning, tutoring, and evaluating, are essential, based on our fieldwork with teachers (see Aurava et al., 2020b). Additionally, the teachers need to know how to organise the game jam event in practice, what tools are available and would fit their needs, and how to navigate issues related to school administration, such as acquiring permissions from young students' parents for working outside regular school hours.

When game jams are used as part of formal education, they must be connected to the aims and goals of the curriculum. This planning phase occurs before the jam event itself and requires pedagogical expertise. The Finnish national curriculum for general upper secondary schools defines the main goals of education "to enable the student to grow into an educated member of the society, acquire knowledge and skills required by the changing operating environment, and improve his or her capabilities for lifelong learning" (FNAE, 2016b, pp. 53). Thus, even if the jam event would not have subject specific content, it could still be argued to further the main goals of education. The teacher can introduce elements of their discipline as a design constraint, if needed.

During the game jam event, the teacher needs tutoring and mentoring skills to create a safe environment (Kaendler et al., 2015; Nousiainen et al., 2018). In a creative design project, the participants should feel free to try, fail, and try again, which is also the case with game jams (Arya et al., 2013; Kultima et al., 2016a). Organising an event where games can be created without fear of failure combines pedagogical, collaborative and creative competencies (see Nousiainen et al., 2018).

As participants set their own goals and choose their own tasks inside the group, the social dynamics are important. Many students in our pre-jam surveys (events 2; 13; 17) reported that meeting new like-minded people and making new friends were key reasons for attending, highlighting the need for the teacher to facilitate positive social interaction (see Kultima et al., 2016a). If the students know each other, existing friendships can affect the formation of groups instead of the interests and skills of the participants (Meriläinen, 2019). Based on our survey data and observations, this is not necessarily a negative issue, but can create problems if, for example, all the students who would like to draw are in the same group. Facilitating the forming of groups in a way that ensures a diverse distribution of skills, working social dynamics, and agreeable sharing of tasks, requires both pedagogical and social skills.

During the jam event it is important to regularly monitor the jam's progress. In on-site jams, this can simply mean walking around and checking in on teams, while in online jams the organiser needs to be active on the discussion channels. Our own organiser experiences and discussions with teachers (see e.g. Aurava et al., 2020b) suggest that scaffolding is needed when the participants are children, adolescents, or simply inexperienced (see also Hmelo-Silver, Duncan, & Chinn, 2007; Pea, 2004). In a school environment, the teacher needs the pedagogical competence to know their students well enough to know whether they would see an unfinished project as a failure, and if they need extra support to get it done in time or to cope with disappointment.

In formal education, learning is typically evaluated. Game jam learning is plausibly very hard to evaluate, since the students are performing different tasks and learning different skills. Furthermore, evaluating so-called soft skills is harder than evaluating memorised information, behaviour, or performance (see Hmelo-Silver, 2004; Hrehovcsik et al., 2016). In any case, the learning goals and evaluation should be clear for all participants before jamming starts.

In our experience, organising a game jam event requires time and effort, but the organiser does not necessarily need to have an extensive experience of attending jam events themselves. There are several guide books for organisers (e.g. Cornish et al., 2017; DMG Toronto Member Manual, 2020; Global Game Jam, 2020; Kaitila, 2012; Macklin et al., 2012), and while they are not specifically written with educational settings in mind, they provide a general understanding of other aspects of game jams.

Technological teacher competencies (Nousiainen et al., 2018) are highlighted when the games created are digital or hybrid which combine analog and digital elements. Inexperienced game creators, such as most general education students, likely need support in choosing and using different software or other tools, and thus teachers benefit from technical skills (Aurava et al., 2020b). It helps if the teacher is familiar enough with different software to choose the right tools for a given purpose, and prepared to offer support if and when technical problems arise — or at least has the knowledge to start identifying the problem and seeking the answers e.g. from tutorials and game making communities (Aurava et al., 2020b; Nousiainen et al., 2018).

8. Required resources

The resources required for organising a game jam depend on the ambition of the organiser. At the minimum, there should be jammers, tools to create games with, an online or offline space to jam in, and time allocated for jamming. Depending on the event, human resources need to be considered: one person organising the jam is seldom enough.

Game jams, as a part of maker pedagogy and DIY culture, require specific material resources (e.g. Cipolla, 2019; Hsu, Baldwin, & Ching, 2017; Mehto, Riikonen, Kangas, & Seitamaa-Hakkarainen, 2020). Depending on the jam, these resources can be non-digital, digital, or both. Typically, in game jams it is expected that the jammers bring their own tools. In a school environment this cannot always be expected. While in Finnish general upper secondary schools, students carry their own laptops to class, in basic education not all students have their own computers. Pupils use computers provided by the school, and as they are in communal use, downloading software is restricted, even if the software would be free of charge. Thus, we have tried to find good game making software that could be used online.

We have also experimented with jamming non-digital games (events 3; 8; 9; 10; 12; 14), which answers some of the issues regarding resources — paper, pens, scissors, sticky tape, etc. are common accessories of most any school. In the sports game jam we organised (event 11), we had the use of the school equipment from different kinds of balls to basketball hoops. However, creating a working analog game (e.g. a board game or a new game for physical education) from scratch, poses its own challenges. Digital tools offer shortcuts, and it is easy to create interactive content, as the platform itself (the computer) is designed to be interactive in another way than cardboard and pen. Also, in analog games nothing gets hidden under the hood, so the flaws of the game

can be more distinct than in a digital game. This could be the reason why in one of our jams (event 12), the digital games were ambitious and most of the analog ones lacked imagination and effort. In this case, analog games could have also been used as an easy way out. Still, the jams where we guided the jammers to combine and modify various board games (events 4; 8; 15) or board games and applications on their own mobile phones (event 8), were typically successful, and the jammers came up with original and inventive ideas. This is a practice we intend to continue and spread, as well as a way of discussing game mechanics, enhancing social interaction and group dynamic, and as a formative exercise into jamming games.

Freedom of tools and methods is a luxury for longer jams with a pool of participants that have at least some game creation skills. In the context of education, it makes more sense to select the tools (such as specific game creation software) or limit the kinds of games that can be created (such as limiting the jamming to modifying and combining existing board games). Finding the right balance between the liberty and luxury of choice, and the support given by stipulated structures, is the key question of designing a successful game jam for specific participants. We can offer suggestions on this, but each teacher needs to ponder what their students and their game jam requires.

In an on-site game jam, the quality of the jamming location is also very important. In our interviews of game jam organisers, this was the most important issue for them, and was also emphasised in several game jam guidelines (e.g. Climate Game Jam, 2018; Cornish et al., 2017; DMG Toronto Member Manual, 2020; Global Game Jam, 2020) we analysed. First, the site should be large enough to accommodate the amount of jammers expected. The basic infrastructure consisting of electricity, online connectivity, and working places for the jammers is required. Having a place to store and prepare food is also very much recommended, as well as quiet places and other features supporting inclusivity for e.g. neurodivergent or disabled participants.

The tasks related to preparing the jam, however minor they might seem, require a surprising amount of time when combined. The teachers in our surveys and interviews frequently brought up the lack of time as the most pressing reason for not organising a game jam event (e.g. Aurava et al., 2020b). Besides the preparation time, it can be hard to find a time slot for the event. In Finnish secondary education, pupils are taught by subject teachers, who each teach their own discipline. The days are divided into 45 to 90 min long lessons. The schedules do not easily allow for a cross-disciplinary, creative process.

When game jams are organised outside of formal education, the organisers often have volunteers to help with the running of the event (Kankainen et al., 2019). The teachers involved in our game jam events have also expressed the need for "an extra pair of hands": another teacher to help run a jam event or some mentoring help from outside the school (Aurava et al., 2020b). However, they did not consider finding a suitable place to jam as a challenge. While schools in Finland most often fill the basic requirements for a jam site, this might not be the case everywhere. Organising a jam in the school might introduce new considerations as well, if the school building is normally closed after school hours and during weekends.

Different forms must be used in different situations. It is easier to mold jams, than to mold schools. However, the idea of making school conform to jams should not be abandoned — new pedagogies are meant to drive progress in schools, not conform to existing practices.

9. Conclusions

Game jams in their various forms are a suitable, customisable, and potent pedagogical working method for use in formal education, for example to teach STEAM and other 21st century skills. Their use, however, needs to be carefully planned in terms of goals, values, and execution. Organising a game jam is demanding for teachers, as game jams require both personal and material resources, and limited support is available. If game jams would be widely used in schools, outside tutoring and mentoring would be needed. We encourage educators to collaborate with game jam communities, educational institutions providing game design education, institutions such as museums, or the game industry.

We want to emphasise that as with any pedagogical method, game jamming is not optimal for everything or everyone. A suitable format of game jam must be chosen depending on pedagogic goals and the teachers and students involved, and acknowledging limitations imposed by school structures such as schedules and physical facilities. The most time-consuming part of adapting game jams into school use has been navigating the practicalities of the classrooms and the rigidity of educational organisations.

In order to make game jams more inclusive, the organiser must be aware of existing gendered structures in game culture, which can exclude girls, women and non-binary participants. We stress the importance of communicating the various skills needed and useful in game jamming. When inviting students to a jam, it is crucial to point out that it is not all about technical skills. We also recommend organising workshops before the jam event to distribute technical skills and to reduce participants' stress regarding their skill level and social belonging. During the formation of the groups and dividing tasks inside the groups, facilitation is often needed to encourage students to take up tasks they might be interested in but not confident enough to volunteer for.

Evaluating learning processes initiated or fuelled by game jamming is difficult, especially in the case of more abstract, so-called soft skills or meta skills. Game jams can be framed in many ways, for example as playful co-learning experiences, creative endeavours, a group working method, or a combination of the above. Whichever frame is chosen, evaluation should follow the context of this framing and associated learning goals. We encourage the organisers of educational game jams to explicitly evaluate the process instead of the finished game, in order to lessen the fear of failure and to endorse creativity in the participants. Although game jams can also be organised as competitions, our data and observations do not support this — instead, an explicitly non-competitive approach is likely to encourage creativity and peer learning and to lower the barriers to entry.

This paper showcases the process we have thus far made in the project of researching game jamming in formal education. We have found beneficial solutions to some of the problems we have encountered, and plan to keep using and developing them (e.g. workshops before the event itself, the practice of combining board games or board games and mobile applications, and emphasising the artistic and creative side of game jamming).

An important area of future research is to critically explore the lived experiences of teachers utilising game jams in general formal education, and how they navigate issues such as introducing subject matter of the curriculum into game jams. To date, we have been researching jam events we have organised ourselves. To fully understand the implications of game jams in classrooms, we need to take the back seat, and observe game jam events organised by teachers.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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