University of HUDDERSFIELD
University of Huddersfield Press

**Journal of Play in Adulthood**
Available open access at: www.journalofplayinadulthood.org.uk

Journal of Play in Adulthood

# "You forget that you are learning because you are playing"! Playful learning in Early Childhood Teacher Education using Snakes and Ladders educational game.

*Annette Furnes*

**Western Norway University of Applied Sciences**

KEYWORDS

Early childhood teacher education
Educational game
Game-based learning
Mathematical learning concepts
Pedagogical innovation

ABSTRACT

In recent years, innovative approaches to teaching and learning in teacher education have been highlighted, and educational games have been used in various learning situations. However, despite the relationship between playing and learning, a playful learning activity is no guarantee that a specific learning goal will be reached. A challenge in higher education is to make playful learning activities intricately linked to the curricula and expected learning outcomes. To approach this challenge, a redesigned board game was used as a learning activity by first-year student teachers in early childhood teacher education (ECTE). The Snakes and Ladders board game was modified with mathematical concept questions on the squares. The game was assessed for potential for engagement, motivation, and learning outcomes of mathematical concepts about young children's numeracy development. A qualitative methodology comprising a survey and classroom observations was employed to identify the student teachers' perceptions and reflections on the learning activity. Findings reveal their engaged co-construction of mathematical knowledge. The board game is a small-scale pedagogic innovation that promotes engaged motivation and learning of mathematical concepts. These findings may inspire future game-based didactic designs in mathematics teacher education.

## Introduction

### *Game-based learning of mathematics*

Recent developments in educational research have heightened the need for more learner-centred approaches to teaching and learning in higher education, as opposed to traditional blackboard instruction. Many attempts have been made to develop various didactic designs in higher education, and particularly in teacher education. Contemporary Nordic research, such as Boysen et al. (2022), stated that "It is a widespread notion in educational research that learning occurs through playful activities". "We need a better understanding of how play is applied in higher education in an international context and how play is incorporated into didactic

Published under Creative Commons License 4.0

designs and related to learning experiences and learning outcomes. There is a need to develop teaching according to new knowledge about how student teachers learn" (Boysen et al., 2022, p.2). An organizational change emphasizing play, training, and learning is suggested (Boysen et al., 2023). Incorporating playful learning into higher education needs to be systematically explored (Boysen et al., 2023). In the book The Playful University, Nørgård and Whitton (2024, pp. 293-307) present principles for what the Playful University may be. Besides philosophical and political principles, the three pedagogical principles focus on incorporating playfulness into the curriculum and developing a relational pedagogy of care. As Plass et al. (2015) put it: play is the essential activity in games.

The approaches to incorporating game-based learning of mathematics into teacher education are summarised by Moon et al.'s (2024) systematic review. Utilizing game-based learning in mathematics teacher education may have outcomes not only for student teachers but also for future students. Education games, gamification, and game-based learning (GBL) refer to the learning tool, the learning process, and the didactical practice of teaching games for understanding, respectively. "Educational games are interactive media that allow students to engage in gameplay aligned with learning objectives", according to Moon et al. (2024). Game-based learning, in this study, is conceptualized as a "transformative educational strategy that employs gaming principles and interactions to facilitate individuals' knowledge and skill development" (Hamari, 2017).

### *Pedagogic innovation*

These attempts at educational change in teacher education are often described as pedagogical innovations. Pedagogical innovations in higher education are innovative approaches to teaching and learning that support learner involvement and engagement. It is defined as approaches to teaching that are "new, different or creative and that aim to promote achievement, engagement, autonomy, and enjoyment in learning and teaching" (Major et al., 2020, p. 7). Pedagogical innovations are requested in teacher education to benefit student teachers, including quality teaching, newness, learning outcomes, 21st-century skills, and autonomy. This includes co-creation (Ind & Coates, 2013), participating in processes of creating new ways of thinking.

Moon et al.'s (2024) scoping review of game-based learning for mathematics teacher education highlights the importance of mathematics teachers' development in game-based learning (GBL) implementation. "In the dynamic field of mathematics education, the integration of GBL stands out as a pivotal innovation, reshaping both teaching methodologies and educational outcomes" (Moon et al., 2024), besides "enhancing student engagement and motivation with mathematical concepts (Ebner & Holziger, 2007). Learning through games may facilitate an enjoyable environment for achieving learning outcomes. "GBL has been extensively employed

due to its benefits in facilitating students' comprehension of key mathematical concepts, but also deepens their pedagogical skills.", according to Moon et al. (2024). However, according to Whitton and Langan (2019), particularly mature students perceive play and games as "a waste of time". Yet, a playful environment does not guarantee that learning specific goals will be achieved (Bruckman, 1999).

Despite the various promising features of game-based learning, there are challenges in implementing it effectively into didactic designs. Firstly, the student teachers need to be motivated to play and willing to play to learn. Laine and Lindberg (2020) underline the importance of engaged motivation, explaining engagement as "the level of involvement that the learner exhibits toward the learning process" (p. 804), and motivation as "the reason for the learner to become and remain engaged in learning activity" (p. 804). Further, Laine and Lindberg stated, "To design an educational game that is capable of providing motivated engagement is a challenging task" (Laine & Lindberg, 2020, p. 804). Secondly, the challenge is to design a curriculum-relevant educational game. These are conditions to consider in design and implementation to foster a well-perceived and effective learning environment.

I intended to address this need for newness in mathematics teacher education by implementing a game-based learning design to enhance the student teachers' engagement, motivation, and learning outcomes. As a pedagogical innovation, I use a familiar board game in a new way to enhance learning. Snakes and Ladders is a traditional board game familiar in Norwegian kindergartens.

The pedagogic rationale for using playful and game-based approaches to learning in ECTE is twofold. Firstly, student teachers need to acquire competence to play games with young children to support their numeracy development. Secondly, by giving the student teachers an experience of playful and game-based learning (Bayeck, 2020), they will, presumably, gain insight into children's way of learning. “Thus, the need to introduce gamified practices in the field of teacher training is observed, providing an experiential learning that allows teachers to apply this methodology in a relevant way in their professional development, based on their own experience.”, González-Fernández et al. (2022) claim.

### *Literature review*

Utilisation of educational games in higher education has been examined by several studies (e.g. Whitton & Langan, 2019), and their findings indicate a relationship between gameplay, playing, and learning. Considering this, researchers have been increasingly interested in the specific effects of educational games. Even if game-based learning is acknowledged, both potentials (Bayeck, 2020; Laine & Lindberg, 2020) and challenges (Boysen et al. 2022; 2023) are highlighted in earlier research. On one hand, educational games may foster engagement

for the learning process, but on the other hand, they do not guarantee that specific learning goals will be achieved. Game-based learning may be studied from various perspectives. Firstly, the game-design process (Schell, 2019, Laine & Lindberg, 2020). Secondly, the teacher's capability of implementation (Rulyansah et al., 2023). Thirdly, as here, the student teachers' self-reported perception of the gameplay activity and learning outcomes.

Game-based teaching and learning mathematics has received increasing attention in recent decades. Several empirical studies have focused on educational games in teacher education and mathematics. Indeed, a scoping review of game-based mathematics learning in teacher education, by Moon et al. (2024), revealed a gap in the current literature regarding empirical studies on how game-based learning (GBL) have been developed for mathematics teachers. They identified "key trends and issues of GBL in mathematics teacher education", as well as suggesting "theoretical and design implications of GBL for mathematics teacher education". Further, their study revealed that the implementation of 'Digital games' was the most prevalent approach in their studies. Board games (13%) were the next prominent approaches (Moon et al., 2024). The results are limited by the fact that they only include a small percentage of early childhood teachers (15%). These studies indicate that learning mathematical concepts is enhanced by educational games. There are few Norwegian studies on game-based mathematics learning in higher education (Støckert et al., 2017) or teacher education (Furnes et al., 2026, forthcoming). Størksen et al. (2023), and Oo & Davidsen (2023) are examples of studies on playful learning in an ECEC context in Norway.

Educational games in general, and the familiar, analogue board game Snakes and Ladders, have been used for mathematical educational purposes. For example, the Snakes and Ladders game has been used to help students understand angle measurements (Vitoria & Ariska, 2020). Their results showed that implementing the Snakes and Ladders game improved their attention and learning outcomes (Vitoria & Ariska, 2020). Russo and Hopkins (2017) considered how Snakes and Ladders was used to teach a variety of number concepts for children ages 4-8. Puspita and Surya (2017) developed the Snakes and Ladders game as a mathematics learning medium for primary school students. To my knowledge, Snakes and Ladders have not been used in higher education. The findings of studies in the school context will likely not apply to teacher students in early childhood teacher education. However, no studies have investigated associations between the Snakes and Ladders board game, student teachers' engagement and motivation, and mathematics learning in early childhood teacher education (ECTE). This study addresses this gap by providing an example of designing a playful learning activity in ECTE grounded in mathematics didactical theory. Game-based learning of

mathematics in ECTE and the student teachers' perceptions. This paper will analyse the student teachers' perceptions of a redesigned Snakes and Ladders educational game for learning mathematics concepts in ECEC.

### *Research question*

To address this gap and to align with the study's objective, the research question is: How do Early Childhood student teachers perceive the redesigned Snakes and Ladders board game as a learning activity for mathematical concepts? The research question primarily concerns student teachers' motivation and engagement, and their learning process. This article reports an intervention study using an educational game to facilitate student teachers' learning of mathematical concepts related to young children's numeracy development. It examines the role of play and games in learning by contributing to the blossoming field of playful learning and game-based learning of mathematics in early childhood teacher education (ECTE)

## Materials and methods

### *Study context*

The trial of this learning activity was carried out in several groups subsequently. The study participants consisted of first-year students, young adults within a relatively narrow age range (19-22 years old). For this reason, age was not collected. The total number of student teachers who were eligible to participate was 60. Almost all students participated, about 90-95%. The first data material covered the main perceptions of the student teachers. After about 40 student quotes were analysed, saturation was reached. The mathematical content of the game was taught for the first time in one-hour lecture before the student teachers played the game. So, it was their primary exposure to the mathematical learning concepts (Table 1) (Bishop, 1988). The redesigned Snakes and Ladders education game was in the Norwegian language when the student teachers used it and translated it into English for the purpose of publication.

A qualitative methodology is employed in this study to answer research questions. This study is grounded in social constructivism and sociocultural learning theories, like Vygotsky (1978). My intention, as a teacher-educator in mathematics ECEC, was to design an enjoyable student-led activity to support their learning of mathematical concepts. They were first-year students enrolled in an interdisciplinary course, Language, Text, and Mathematics, in early childhood teacher education (ECTE) at Western Norway University of Applied Sciences . The expected learning outcome of this specific lecture is to learn about young children's development of number sense. This involves teaching and learning mathematical concepts, including one-to-one correspondence, cardinality, ordinality, number words, subitizing, etc. Table 1 presents the mathematical concepts the student teachers were expected to learn during this lesson.

**Table 1**
Mathematical concepts related to numeracy

| Cardinality | Number | Ordinality |
|---|---|---|
| Counting | Number series | Principle of pairing correspondence |
| Digit | One-to-one correspondence | Random arrangement principle |

### *The Snakes and Ladders Educational Game*

The redesigned Snakes and Ladders is an educational board game with questions on the fields (Figure 1). These are open-ended, one-sentence tasks, suitable for mathematical concepts and directly linked to the course content and expected learning outcomes. The Snakes and Ladders game was redesigned using the Word editor program on a personal computer. The outline of the game was a table with five rows and seven columns. Like the original Snakes and Ladders game, the play elements consisted of the board game, two dice, and game counters (Schell, 2019). Unlike the American version of Snakes and Ladders Game, the Norwegian version has no snakes, only ladders. They were represented by arrows pointing upwards or downwards, implying that players may be sent forward or backward on the game board. The redesigned Snakes and Ladders education game is unlike the entertaining Snakes and Ladders number game. This study focuses on the perceptions of student teachers and not children's learning. The Snakes and Ladders game was selected because it is a familiar board game in Nordic kindergartens, and student teachers will apply the game in their future profession to support young children's development in numeracy. Firstly, it is a traditional board game, part of the kindergarten culture, for which many student teachers have nostalgic memories. Secondly, despite some cultural context (Boysen et al., 2023), the threshold for participating is low. The rules are simple so that time and cognitive energy is spent on gameplay. Thirdly, the game was selected for its playfulness (Nørgård & Whitton, 2024). The design of the ladders invited players to have a playful attitude towards the gameplay. The educational games rules were implicit for most student teachers. Each student was a player who rolled the dice and moved their counter along the board. Using the education game involved answering the tasks on the squares and searching for knowledge cooperatively. Further, the players evaluate answers and search for knowledge in the course literature, notes, and other resources, such as PowerPoint presentations, short videos, etc. They are also permitted to adjust to their own rules. For example, some student teachers agreed that you had to return to your original position on the board game if you failed to answer a task. Others decided that they would help each other when someone needed support.

### *Data collection*

Data collection for this study has been carried out in 2022. The workshop method (Ørngren & Levinsen, 2017) was utilized to observe and collect student teachers' perceptions systematically. The strategies used to collect data were observations and questionnaires. Participating observations (Frønes, 2019) was used to complement and extend the questionnaires. The student teachers answered the survey after the play session. The survey asked the participants about their preferred study routine and perceptions of the learning activity. Moreover, they were asked to assess the learning potential of the Snakes and Ladders game compared to familiar learning activities, including guided reading. The student teachers answered these two questions anonymously using handwritten notes or digital assessment tools like Padlet (www.Padlet.com). All tasks were open-ended questions in the survey. The results were saved as digital documents (PDF). The answers were translated from Norwegian to English. All student teachers answered the questionnaire, with a few exceptions. To make an overview of the answers, I selected claims that were representative and covered the breadth of the perceptions. I read and analysed all the documents in one batch.

**Table 2**
A table of questions in the study survey

| | |
|---|---|
| Question 1 | What do you think about using Snakes and Ladders game as a learning activity? |
| Question 2 | How does playing the Snakes and Ladders game differ from traditional learning activities? |

### *Ethical consideration*

Ethical considerations were carried out according to national standards and guidelines. In the lecture, I informed the students that teaching is research-based and that research is carried out in the classroom to increase educational quality. Student teachers decided whether they wanted to take part as informants. Student teachers acknowledged informed consent when they answered the questionnaire anonymously. No names or personal information are linked to the study.

### *Analysis*

This study's underlying research values and philosophical assumptions are social constructivism and socio-cultural learning theories (Vygotsky, 1978). Thematic analysis is a family of methods (Braun & Clarke, 2006; 2023) and is widely used for assessing patterns and themes in the data. The present study utilizes Reflexive thematic analysis (Braun & Clarke, 2019; 2021) to gain insights into the student teachers' perceptions and reflections. An experiential orientation to qualitative research and TA centres on the meanings and experiences

articulated by participants (Braun & Clarke, 2022, 2023). Reflexive thematic analysis (Braun & Clarke, 2021) covers the process of data familiarization, data coding, and theme development and revision ( https://www.thematicanalysis.net/understanding-ta/). This process aims to identify patterns of meaning (themes). It is important to locate the use of TA theoretically, according to Braun and Clarke (2022). To analyse the breadth and depth of the data, the data selection of items captured the variety of responses. An inductive, bottom-up approach to reflexive thematic analysis is chosen for code and theme development.

The preliminary phase of coding was about the examination of the data and review of student teachers' answers to gain a deep understanding on the meanings and experiences articulated by participants (Braun & Clarke, 2022, 2023). It was about reading, familiarization, and taking notes of items of potential interest. The digital documents were manually coded, and no software was used. Coding was a descriptive approach to identify topics in the student teachers' perceptions. To ensure the representativeness of the student teachers' perceptions, I followed three steps:

In the first step of the analysis, keywords and core concepts were identified. I tried to uncover perceptions of themes within the findings. Initial codes were identified to categorize themes particularly representative of engagement, motivation, and learning. Categories have corresponding labels. The first steps of the analysis were bottom-up approaches. Data analysis followed an inductive approach where codes came from the data itself (Braun & Clarke, 2013). Inductive thematic analysis aims to generate an analysis from the bottom up; analysis is not shaped by existing theory, but shaped to some extent by the researcher's standpoint, disciplinary knowledge, and epistemology (Xu & Zammit, 2020).

The second step in the analysis was to search for patterns or tensions related to the research question. The initial dataset was coded related to motivation and engagement, but the themes were reviewed, defined, and named. After I had found the categories of motivating factors, I found Laine and Lindberg's (2020) systematic literature review of game motivators. They validated my initial codes/themes. Hence, the third step of the analysis was a top-down approach.

The third step of the analysis was to systematically categorize the student teachers' claims according to Laine and Lindberg's 14 categories of motivators. Then the coding was complete across the entire dataset. In the third step, I reflected on the categories from the theoretical perspective of the study. The resulting categories/themes of my thematic analysis fit into Laine and Lingberg's 14 categories of game motivators. In sum, data analyses followed an inductive analysis with deductive feedback.

**Table 3**
A table of 14 categories of motivating factors (Laine & Lindberg, 2020).

| | | | |
|---|---|---|---|
| Challenge | Control | Fantasy | Rules and goals |
| Competence | Curiosity | Feedback | Real World Relation |
| Competition | Emotions | Immersion | Social Interaction |
| | | Novelty | Usefulness |

### *Research trustworthiness*

*Validity.* The major objective of the reflexive thematic analysis was to uncover categories of student teachers' perceptions of game-based learning. I did the initial coding subjectively. The validity of the findings was supported by other studies and literature. A collaborative process, including more researchers, would potentially enhance the reliability of the categories and the analysis.

*Reliability.* The data selection is representative, with data from 60 informants collected over 12 months. Only a small percentage of the total dataset collected is presented. Nonetheless, almost all perceptions are covered. To ensure the reliability of the findings, broad categories with sub-categories are used. Since the sampling happened subsequently, the new data confirmed earlier data. Towards the end of the data collection period, hardly any additional information was provided in the dataset.

*Replicability.* Qualitative education in mathematics teacher education research studies is contextual. Therefore, classroom studies and educational research like this are hard to replicate. This paper is based on one author's experience, and the trustworthiness of the analyses would benefit if more than one researcher participated. The analytical process was discussed with some colleagues who gave feedback on the preliminary analysis. Yet, exploring the use of the redesigned Snakes and Ladders game is highly possible, even if the context may be different.

## Results

The redesigned Snakes and Ladders game (Figure 1) is perceived as engaging, motivating, and effective for learning by most student teachers. Representative excerpts of participants' anonymized comments are provided in the following text.

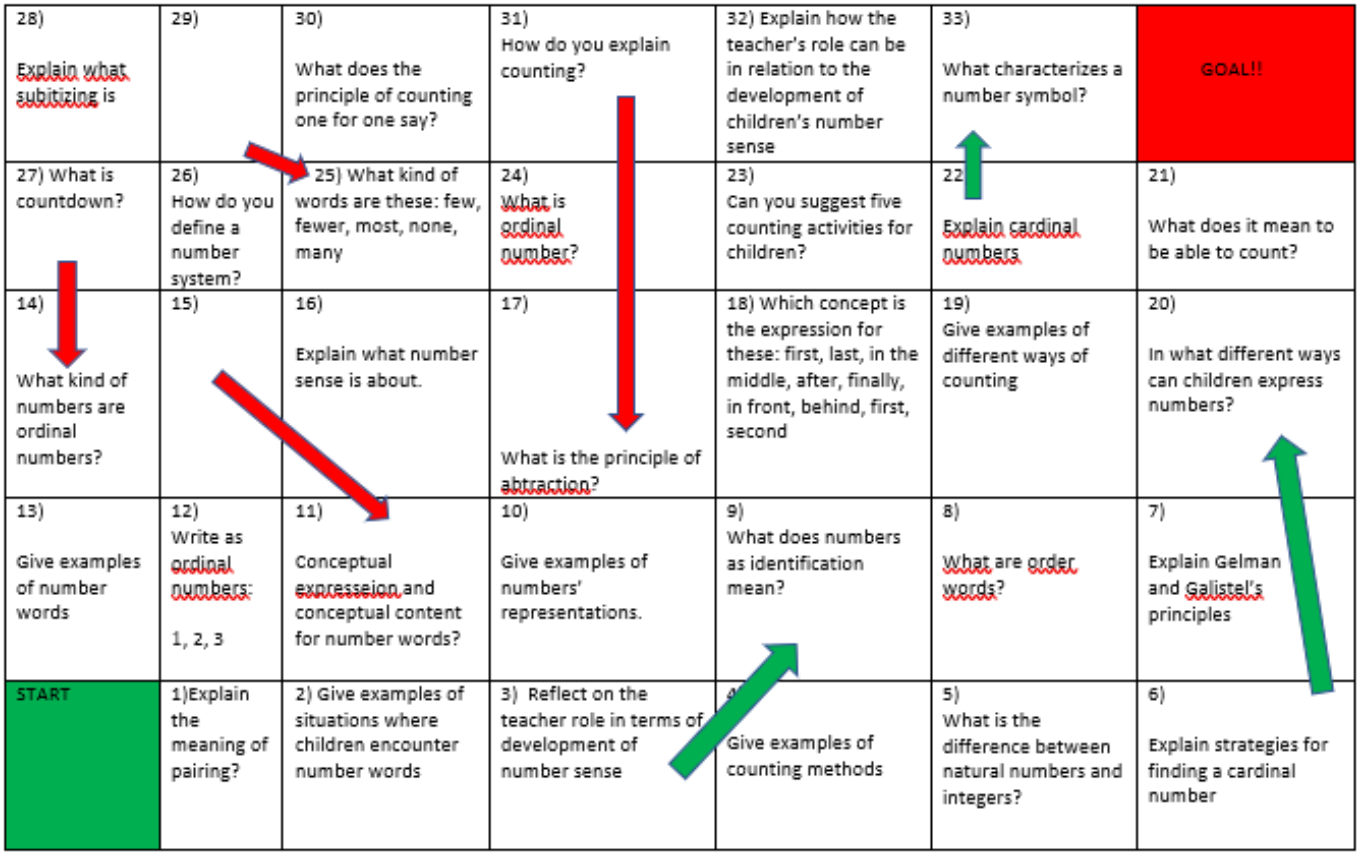


**Figure 1**
The redesigned Snakes and Ladders educational game

### *What do you think about using the Snakes and Ladders as a learning activity?*

The student teachers' perceptions after playing the re-designed Snakes and Ladders game (Figure 1) are presented according to the 14 motivating factors in the conceptual framework (Table 3).

*Challenge*

A challenge serves as a motivator when a player encounters a task that aligns with their skill level (Laine & Lindberg, 2020).

Tim: 'The board game is too difficult'.

Zoltan: 'It was fun to get new challenges. It was a bit difficult because this was the first time this topic was taught, and we did not have prior knowledge. But we shared the solving of questions (tasks) between us'.

One of these students perceived the tasks to be too difficult, while the other found it manageable, probably because they helped each other to solve the tasks. Since challenge functions as a motivator when the students' skill level aligns with the tasks, these students experience different levels of motivation. In this case, the tasks

seem too difficult for Tim. However, the game is meant to be a learning activity, where competence is built whilst playing.

*Competence*

Competence is related to acquiring new knowledge by conquering challenges and reaching goals (Laine & Lindberg, 2020). One student expresses knowledge improvement by claiming:

Anne: 'I learn something, and you learn something'!

Jenny: 'Yes, but I am not very good at it'.

When Jenny says that she is not very good at it, it points to the understanding of their status, perceived skills, and performance as a player.

*Competition*

Competition is considered a driving force in multiplayer games and a motivator when players must compete with other players to reach a goal (Laine & Lindberg, 2020). Eira's claim is an example of this:

Eira: 'It was a pleasure. My learning is enriched by the strong competition instinct'.

*Control*

The control motivator arises when players are granted the freedom to shape the game world and its events. The control motivator also emerges when players agree upon how to move the tokens and help each other solve the tasks. The students also modified the game and took control when they negotiated goals and rules.

*Curiosity*

Cognitive curiosity is the drive and fascination for learning that is sparked by the pursuit for new knowledge (Laine & Lindberg, 2020).

Sylvia: 'Variation is fun. It gives us pleasure to learn new things together'.

Alis: 'We got the repetition of the concepts since we arrive at the same field multiple times'.

In the redesigned Snakes and Ladders game, the tasks on the fields ask for an explanation of central concepts. Hence, some information in the game is incomplete, and it may stimulate the player's thirst for knowledge, as Laine and Lindberg (2020) describe as cognitive curiosity.

*Emotions*

Emotions are motivators rising from the expectations of what happens next in the game (Laine & Lindberg, 2020). It may be altruistic feelings of goodness when helping others, the thrill when something dramatic happens, or the fact that much is at stake in the game.

Anna: ‘It was fun but losing sucks’.

Playing the educational game evoked feelings of joy and frustration for this student, interpreted as the student teachers enjoyed participating in the learning activity per se, but felt disappointed when losing. The affective aspects of mathematics learning are illustrated in this situation.

*Fantasy*

Fantasy is internal pictures, and fantasy may facilitate curiosity about what comes next (Laine & Lindberg, 2020). When students believe that they will either fall downwards or move upwards on the ladder, this may be due to internal pictures driving their curiosity about what happens next.

*Feedback*

The literature review of Laine and Lindberg (2020) found feedback to be a motivator, especially when provided on performed challenges. Timely and clear feedback given during gameplay informs the player about how far they are from the goal, and when they have achieved it (Laine & Lindberg, 2020).

Johan: ‘I am not very good at the Snakes and Ladders board game and similar things’.

Inge: ‘That’s all right.’

This student, Johan, expressed their concerns about playing board games due to former experiences and says they are "not very good at it". The Self-determination theory of Ryan and Deci (2000) and their concept of 'low expectation of success' inform our understanding of Johan's expression. For this student and others, such learning activities may not be that engaging and motivating compared to students with higher degrees of expected success. These student teachers may need excessive support from their peers, as in this case, when playmate Inge says, "That's all right", it indicates that we will help each other out. Laine and Lindberg (2020, p. 809) point out that feedback is a key component of the flow state (Csikszentmihalyi, 2014), together with challenge and control. Feedback offered by the gameplay comes in various forms, both implicit and explicit. The player’s peers give feedback on the player’s level of knowledge. When the player answers the task, to what degree the subject matter is remembered and conceptualized becomes evident. Indirectly, this is also feedback on the outcome of the teacher's instructions for the lecture. Therefore, even if learning per se is not measured in this study, self-reported learning outcomes and formative assessment (Bennet, 2011) or feedback are provided in the play situation. One student voiced it like this:’

Kaia: ‘The game is very instructive. When playing, one realizes what one remembers from the lecture’.

Mina: ‘It was fun, but I was not very good at it’.

The student teachers' expressions show that they know the game situation and offer them feedback on their knowledge and memory of concepts mentioned in the lecture. Moreover, the student teachers show that they learn concepts by playing the game. Another student said:

Lena: 'It was fun, and I realized more about what I need to learn in education'.

This type of response aligns with formative assessment (Black & Wiliam, 1998) since it gives information about where you are, what you know, and what you need to know in the future.

Lotta: 'Since the learning activity is so fun, it makes it easier to stick to the subject matter and finish the task. We enjoyed ourselves and learned a lot, at the same time'!

*Immersion*

Immersion is a motivator when the player is so absorbed in the gameplay that they become unaware of themselves and the perception of time (Laine & Lindberg, 2020). Some student teachers continued to play during their free time between lectures. These were instances of immersion, also called the "one-more-turn" phenomenon (Laine & Lindberg, 2020). As one student put it: 'You forget that you are learning because you are playing'!

*Novelty*

The novelty of the game can be a motivator, particularly during the player's initial experience with it (Laine & Lindberg, 2020). The student teachers expressed that they appreciate doing something new, compared to traditional learning activities, like guided reading with lists of questions.

Tod: 'It was fun to do something new! A different learning activity, from which we learned a lot'.

*Rules and goals*

Laine and Lindberg (Laine & Lindberg, 2020) argue that all kinds of games have rules that govern the activity, outlining the objectives of the game and how to win. For games to be motivating, the rules must be clear, concise, and synchronized with the aims. Motivation appeared when the student teachers negotiated and played the game according to various sets of rules. For example, some student teachers made a rule that you had to return to your original position on the board game if you failed to answer a task. Others decided that they would help each other out when someone needed support.

*Real World Relation*

Motivators based on real world relationships arise from the connections between the real world and the game world (Laine & Lindberg, 2020).

Paul: 'I fell down the ladder, here, but I am all right'! [All student teachers are laughing.]

I observed that student teachers laughed loudly when their peer player fell down the ladder. Arrows of varying lengths, leading upwards or downwards, are located on the board game, symbolizing a jump or fall. These arrows represent ladders in the real world, resulting in motivators that emerge from linkages between the real world and the game world. Whether the player is lucky to jump upwards or unlucky and moves backward is a surprising element of the game. Consequently, the ladders serve as motivators which may lead to emotional reactions like thrill, joy, and despair (Laine & Lindberg, 2020)

*Social interaction*

Social interaction encompasses interpersonal motivators that arise from the psychological need of relatedness, as well as a desire to experience belonging and connection with others (Laine & Lindberg, 2020). Further, it involves building relationships, being part of a group, interacting with others, and collaborating to reach a shared objective. Social interaction is related to teamwork. When student teachers were asked about their study routines or their preferred way of studying, some of them answered like this:

Jo: 'I learn best when studying with peers'.

Jill: 'I think it is a nice approach to learning since we can help each other with questions we are not sure about, and we learn from each other. We help each other find the right answers, so we know them until the next time they appear. We repeat the questions by answering them several times or listening to each other several times'.

Bill: 'It is an interesting way to learn. Many of the questions appear several times, and it is fun to see how it is possible to transition from not knowing the question to remembering it quite rapidly because of the repetition'.

This points to the sociocultural perspective, namely that learning occurs in a social situation of knowledgeable students of varying degrees, who communicate and learn through verbal language (Vygosky, 1978). The distinctive design feature of the Snakes and Ladders game arises from the ladders, which promotes the type of repetition that students refer to. Repetition is a central part of their learning process.

*Usefulness*

Usefulness may function as a powerful motivator when the game has the purpose of knowledge improvement (Laine & Lindberg, 2020). I observed that the students occasionally took photographs of the game. This indicates that the student teachers find the game useful and valuable as a learning activity. Also, the student teachers are motivated to use the game several times.

Ronny: 'May I keep the board game'?

Teacher: 'Sure'!

Ronny: ‘Nice! I intend to use it myself’.

The motivator usefulness is strengthened when the player knows what they can acquire from engaging with the game, as indicated in this excerpt.

### *How does playing the Snakes and Ladders game differ from traditional learning activities?*

When the students were asked what they perceived as the difference between the educational game and other traditional learning activities, some answered like this:

Ronja: ‘The Snakes and Ladders game made the literature more exciting and easier to learn’.

Sylvia: ‘The game helped us learn mathematical concepts and their meaning. It is a more practical way to learn by talking about literature with my peers, in contrast to reading alone’.

Johanna: ‘It was very fun! It was a very different approach. When the activity is so fun, it is easier to keep working on the subject and manage it. We had fun and we learned a lot’!

In sum, they highlight the difference between individual study and the possibility of helping each other, collaborating, discussing, and learning mathematical concepts (Table 1) by repetition in a social setting.

These results were confirmed by participating in classroom observations. The presence of vivid sounds, laughter, and emotional expressions confirmed engagement as “the level of involvement that the learner exhibits towards the learning process” (Laine & Lindberg, 2020; Owney, 2025). They were eager to start playing the educational game, communicate, and collaborate, and some even continued to play during the breaks. Moreover, the students were actively using the teacher educator for explanations of concepts.

## Discussions

This study aimed to facilitate student teachers’ learning of mathematical concepts and explore their perceptions and reflections on game-based learning of mathematics in ECTE. The mathematical concepts was about young children's development of numeracy.

### *Student teachers’ perceptions of the Snakes and Ladders educational game*

It turned out that the educational game was well received by student teachers. The student teachers highly appreciated the novelty of the game-based learning activity. Most of them claimed that the game was both pleasurable and instructive. The most valued game motivators were novelty, competence, feedback, and social interaction. Gameplay evoked positive emotions whilst being perceived as useful for their knowledge building. The educational game provided the players with opportunities to learn mathematical concepts in a playful environment. In alignment with Laine and Lindberg's (2020) claim, "[...] games have been shown to possess

powerful motivators that fuel a person's desire to engage in unattractive activities, such as learning theoretical material". This study exemplifies how game-based learning may be a curriculum-relevant tool for student teachers' learning process. The Snakes and Ladders game and its content are directly related to the expected learning outcomes; to gain knowledge about young children's numerical development. Therefore, addressing the challenges of making playful learning in higher education related to subject matter and curricular learning outcomes (Boysen et al., 2023).

### *Pedagogic innovation*

The Snakes and Ladders board game is a new, small-scale pedagogical innovation (Major et al., 2020) for teaching and learning. Using a familiar board game in a new way of learning may be related to transformative educational practice. The game promotes achievement and enjoyment, successfully meeting the challenge stated by Laine & Lindberg (Laine & Lindberg, 2020), that "to design an educational game capable of providing motivated engagement is a challenging task". While Bruckman (1999) warns that "a playful environment does not guarantee learning outcome", students found the board game instructive. Moon et al. (2024) provide support for these findings by claiming: "In the dynamic field of mathematics education, the integration of game-based learning (GBL) stands out as a pivotal innovation, reshaping both teaching methodologies and educational outcomes", besides "enhancing student engagement and motivation with mathematical concepts" (Ebner & Holzinger, 2007). This aligns with Boysen et al.'s (2023) call for educational change emphasizing play, training, and learning. In short, the redesigned Snakes and Ladders game is suitable for learning mathematical concepts. Its conditions are discussed in the following.

### *Co-creation of knowledge*

The Snakes and Ladders game provided conditions for social interaction and knowledge building. The playful activity and educational game have facilitated a safe, humorous learning environment for knowledge co-creation (Ind & Coates, 2013). Student teachers mention that "it is a new way of talking together.", indicating both an individual and a collective construction or co-creation of knowledge (Kangas, 2010; Ind & Coates, 2013).

Whilst active in the game, the student teachers express their newly gained knowledge from the lecture. They listen to each other and share their perspectives, and understanding, as insights are made available for all players. The game context also provides conditions for equal participation in the conversations since all players take turns. Student teachers are generally motivated to collaborate with peers, and one would assume that social activities, in general, would be perceived positively. The post-pandemic context might also be considered. Vygotsky (1978) states that learning occurs during communication in a social context. However, it

is not known whether the learning outcome would be better in another oral activity.

Feedback, self-assessment, and self-reported learning outcomes all relate to student teachers' game-based learning experience. Firstly, the adult players provide instant and necessary feedback, including relevant formative assessment (Bennett, 2011). These findings align with Riquelme et al. (2024). Their project involved gamification methodology and learning through the design of a board game. They found that games "facilitated active study, teamwork, collaboration, and encouraged self-assessment. Learning through games may act as a catalyst to start the learning activity, and assess their learning, followed by studying individually. The game features facilitated a kind of summative assessment (Bennett, 2011) or "peer review" by their peer players, like decisions about whether the player 'passes' or 'fails'. The success of learning depends on the peers' mentoring role and feedback. Each player participates in two roles: player and peer-player. Compared to other traditional learning activities, the redesigned Snakes and Ladders board game facilitates different learning conditions and has an elevated potential to create motivated learner engagement. This is confirmed by the students' self-reported learning outcomes. This study illustrates the effectiveness of gamification in the acquisition of mathematical conceptual understanding. The game-based learning experience may be valuable for the student teachers' building of competence to fully apply the potential of game-based learning in their future profession. Adult play in higher education is perhaps especially promising in ECTE, due to the features of the profession.

### *Critical assessment of the methods*

The framework described in this study is appropriate for the analysis of student teachers' perceptions of the game-based learning activity since the student teachers' perceptions are covered by all Laine and Lindberg's (2020) motivators. As Braun & Clarke (2023) value the researchers' positionality, knowledge, and earlier experiences, reflexive thematic analyses were conducted by one researcher. Hence, the identification and analysis of themes relied on the perspective of one researcher. The combination of inductive analysis with deductive feedback allows for a dynamic adaptation of game motivators based on new findings, strengthens the validity of the former inductive categories, and provides a thorough and robust analysis of the student teachers' perceptions. I own my research perspectives (Elliott et al, 1999), and I am aware that my position in terms of social constructivism, epistemology, and ontology colours the analysis and links personal reflexivity to my analytical practice. I acknowledge that the study involved a single cohort and that future research with additional groups would strengthen the evidence base.

## Conclusion

This study sets out to systematically explore the education process of game-based learning of mathematics and the project was guided by a creative, small-scale pedagogical innovation. A redesigned Snakes and Ladders board game has been applied as a mathematical educational game in ECTE in Norway. A systematic exploration revealed that the game served several functions, such as providing relevant, curricular content, means for social communications, collaborations, motivation, and engagement. The student teacher's self-reported learning outcomes show that the educational game has the potential to facilitate the learning of mathematical concepts. Moreover, this study is an example of the successful integration of game-based learning for conceptual mathematical co-creation of knowledge. The findings suggest that this educational game is applicable in this context in ECTE, given that it promotes learning. The framing of mathematical questions in a board game made a substantial difference to the learning process and outcome. The design feature of ladders provided revisions and repetition of tasks. Adult feedback was necessary for formative assessment (Bennet, 2011) while playing.

The application of the Snakes and Ladders education game is promising since it is easily adapted to various mathematics learning contexts in teacher education, by adding subject-relevant questions in the fields. Even if the educational game is easily adopted for many disciplines and subject matter, levels, and student populations, educational games may not be appropriate for all kinds of topics. This study may be an inspiring contribution to practitioners and researchers in the mathematics education field. GBL for mathematics teacher educators may have both theoretical and practical implications. For example, student teachers who experience playful learning may be better equipped to facilitate playful learning environments for young children in their future profession. In terms of future research, students may create their own mathematical game content as a new approach to learning.

## Acknowledgements

I appreciate the willingness of 60 student teachers at Western Norway University College of Applied Sciences to participate in this study. I would also like to extend thanks to my outstanding colleagues for their useful comments on this manuscript.

## References

Bayeck, R.Y. (2020). Examining board gameplay and learning: A multidisciplinary review of recent research. *Simulation & Gaming*, 51(4), 411-431. https://doi.org/10.1177/1046878119901286

Bennett, R. E. (2011). Formative assessment: a critical review. *Assessment in Education: Principles, Policy & Practice*, *18*(1), 5–25. https://doi.org/10.1080/0969594X.2010.513678

Bishop, A. J. (1988). Mathematics education in its cultural context. *Educational studies in mathematics*, 19(2), 179-191. https://doi.org/10.1007/bf00751231

Black, P., & Wiliam, D. (1998). Assessment and Classroom Learning. *Assessment and Education: Principles, Policies and Practice*, 5(1), 7-74. https://doi.org/10.1080/0969595980050102

Boysen, M. S. W., Sørensen, M. C., Jensen, H., Von Seelen, J. & Skovbjerg, H. M. (2022). Playful learning designs in teacher education and early childhood teacher education: A scoping review. *Teaching and Teacher Education*, 120. https://doi.org/10.1016/j.tate.2022.103884

Boysen, M. S. W., Lund, O., Jørnø, R. L. & Skovbjerg, H. M. (2023). The role of expertise in playful learning activities: A design-based self-study within teacher education aimed at the development of tabletop role-playing games. *Teaching and Teacher Education*, 128. https://doi.org/10.1016/j.tate.2023.104128

Braun, V. & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Braun, V. & Clarke, V. (2013). *Successful qualitative research: A practical guide for beginners*. SAGE Publications.

Braun, V. & Clarke, C. (2019). Reflecting on reflexive thematic analysis. *Qualitative Research in Sport, Exercise and Health*, 11(4), 589-597. https://doi.org/10.1080/2159676X.2019.1628806

Braun, V. & Clarke, V. (2021). *Thematic analysis: A practical guide*. SAGE Publications.

Braun, V. & Clarke, V. (2022). Conceptual and design thinking for thematic analysis. *Qualitative Psychology*, 9(1), 3-26. https://doi.org/10.1037/qup0000196

Braun, V. &Clarke, V. (2023). Toward good practice in thematic analysis: Avoiding common problems and be(com)ing a knowing researcher. *International Journal of Transgender Health*, 24(1), 1-6. https://doi.org/10.1080/26895269.2022.2129597

Bruckman, A. (1999). Can education be fun. In *Game developers conference. 99*, pp. 75-79).

Csikszentmihalyi, M. (2014). Play and intrinsic rewards. In *Flow and the foundations of positive psychology: The collected works of Mihaly Csikszentmihalyi*, pp. 135-153. Springer Netherlands. https://doi.org/10.1007/978-94-017-9088-8_10

Ebner, M. & Holziger, A. (2007). Successful implementation of user-centered game-based learning in higher education. An example from civil engineering. *Computers & Education*., 49(3), 873-890. https://doi.org/10.1016/j.compedu.2005.11.026

Elliott, R., Fisher, C.T. & Rennie, D.L. (1999). Evolving guidelines for publication of qualitative research studies in psychology and related fields. *British Journal of Clinical Psychology*, 38(3), 215-229. https://doi.org/10.1348/014466599162782

Frønes, M.H. (2019). *Den observerende barnehagelæreren*. Fagbokforlaget.

Furnes, A.S., Haaland, S.A., Lossius, M.E.H. & Severina, E. (2026). Preservice kindergarten teachers designing and discussing mathematics in games. In T. Meaney, C. Benz, D. Di Paola, M. Fiorentino; A. Montone (Eds.). *Engaging with mathematics in the early years: Results from the POEM6 Conference*. Springer. https://link.springer.com/content/pdf/10.1007/978-3-032-16065-2.pdf

González-Fernández, A., Revuelta-Domínguez, F.I. & Fernández-Sánchez, M.R. (2022). Models of instructional Design in Gamification: a systematic review of the literature. *Education Sciences*, 12(1), 44. https://doi.org/10.3390/educsci12010044

Hamari, J. (2017). Do badges increase user activity? A field experiment on the effects of gamification. *Computers in Human Behavior*, 71, 469-478. https://doi.org/10.1016/j.chb.2015.03.036

Ind, N., & Coates, N. (2013). The meaning of co-creation. *European Business Review*, 25(1), 86–95. https://doi.org/10.1108/09555341311287754

Kangas, M. (2010). Creative and playful learning: Learning through game co-creation and games in a playful learning environment. *Thinking Skills and Creativity*, 5(1), 1-15. https://doi.org/10.1016/j.tsc.2009.11.001

Laine, T. H., & Lindberg, R. S. (2020). Designing engaging games for education: A systematic literature review on game motivators and design principles. *IEEE Transactions on Learning Technologies*, 13(4), 804-821. https://doi.org/10.1109/tlt.2020.3018503

Major, J., Tait-McCotcheon, S. L., Averill, R., Gilbert, A., Knewstubb, B., Mortlock, A. & Jones, L. (2020). Pedagogic innovation in higher education: Defining what we mean. *International Journal of Innovative Teaching and Learning in Higher Education*, 1(3), 1-18. https://doi.org/10.1109/tlt.2020.3018503

Moon, J., Yeo, S., Si, Q. & Ijeluola, A. S. (2024). A scoping review of game-based learning for mathematics teacher education. *International Journal of Mathematical Education in Science and Technology*, 1-29, https://doi.org/10.1080/0020739x.2024.2337934

Nørgård, R.T. & Whitton, N. (2024). Principles for the Playful University. In The Playful University; Routledge: pp. 293-307. https://doi.org/10.4324/9781003354956-25

Oo, A.T. & Davidsen, A. (2023). Play-based learning discourse in the Norwegian and English curricula. In *New Perspectives on Educational Resources: Learning Materials Beyond the Traditional Classroom*; Alvestad, K.C.; Roll-Hansen, H.; Nordberg, K.H., Eds.; Routledge: . https://doi.org/10.4324/9781003322696-12

Owney, A. (2025). *Joy in learning*. (Doctoral dissertation, Indiana Wesleyan University).

Plass, J. L., Homer, B. D., & Kinzer, C. K. (2015). Foundations of Game-Based Learning. *Educational Psychologist*, *50*(4), 258–283. https://doi.org/10.1080/00461520.2015.1122533

Puspita, D.M. & Surya, E. (2017). Development of Snake-Ladder game as a medium of mathematics learning for the fourth-grade students of primary school. *International journal of Sciences: Basic and Applied Research*, 33(3), 291-300.

Riquelme, A., de Prado, J., Bonache, M.V., Rams, J., Sánchez, M., Torres, B., ..., & Muñoz, B.K. (2024). Table Games as a Tool to Learn about Material Science in Engineering and Architecture Studies. *Education Sciences*, 14(10), 1054. https://doi.org/10.3390/educsci14101054

Rulyansah, A., Ghufron, S. & Mariati, P. (2023). Competencies of Teachers in Game-Based Pedagogy. *Pegem Journal of Education and Instruction*, *13*(2), 354-370 https://doi.org/10.47750/pegegog.13.02.39

Russo, J. & Hopkins, S. (2017). Get your game on! Snakes and ladders revisited. *Prime Number*, 32(1), 6-10.

Ryan, R.M. & Deci, E.L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. American Psychologist. , 55, 68-78. https://doi.org/10.1037//0003-066X.55.1.68

Schell, J. (2019). The Art of Game Design – A book of lenses. (3. Rd ed.). CRC press

Støckert, R., Thorseth, T.M. & Talmo, T. (2017). Bringing pre-school playful learning to the University. *Edulearn17 Proceedings*, 7914-7923. https://doi.org/10.21125/edulearn.2017.0440

Størksen, M., Rege, M., Solli, I.F., ten Braak, D., Lenes, R. & Gelhof, G.J. (2023). The playful learning curriculum: A randomized controlled trial. *Early Childhood Research. Quarterly*, 64, 36-46. https://doi.org/10.1016/j.ecresq.2023.01.015

Vitoria, L. & Ariska, R. (2020). Teaching mathematics using snakes and ladders game to help students understand angle measurement. *Journal of Physics: Conference Series*, 1460(1). IOP publishing. https://doi.org/10.1088/1742-6596/1460/1/012005

Vygotsky, L. S. (1978). Mind in Society: *The Development of Higher Psychological Processes*. M. Cole, V. John_Steiner, S. Scribner, & E. Souberman (Eds.). Harvard University Press. https://doi.org/10.2307/1421493

Whitton N. (2018). Playful learning: tools, techniques, and tactics. *Research in Learning Technology*, 26. https://doi.org/10.25304/rlt.v26.2035

Whitton, N. & Langan, M. (2019) Fun and games in higher education: an analysis of UK student perspectives, *Teaching in Higher Education*, 24(8), 1000-1013. https://doi.org/10.1080/13562517.2018.1541885

Xu, W. & Zammit, K. (2020). Applying thematic analysis to education: A hybrid approach to interpreting data in practitioner research. *International Journal of Qualitative Methods*, 19, 1-9. https://doi.org/10.1177/1609406920918810

Ørngreen, R., & Levinsen, K. T. (2017). Workshops as a research methodology. *Electronic Journal of E-learning*, 15(1), 70-81.