



HAL
open science

Kindergarten preservice teachers' descriptions of the learning potential of mathematical digital games

Mona Karbaschi Vee

► **To cite this version:**

Mona Karbaschi Vee. Kindergarten preservice teachers' descriptions of the learning potential of mathematical digital games. Thirteenth Congress of the European Society for Research in Mathematics Education (CERME13), Alfréd Rényi Institute of Mathematics; Eötvös Loránd University of Budapest, Jul 2023, Budapest, Hungary. hal-04422835

HAL Id: hal-04422835

<https://hal.science/hal-04422835>

Submitted on 28 Jan 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Kindergarten preservice teachers' descriptions of the learning potential of mathematical digital games

Mona Karbaschi Vee

Western Norway University of Applied Sciences, Norway; Mona.Karbaschi.Vee@hvl.no

In Norway, the curriculum requires kindergarten teachers to use digital tools in their work. Therefore, teacher educators and kindergarten preservice teachers need to investigate what kind of digital tools can encourage children's engagement in mathematics. In this article, kindergarten preservice teachers' descriptions of how they used digital games with children during their internship period were analysed using Artifact-Centric Activity Theory. The preservice teachers seemed to justify digital games against the mathematics the children are required to engage with according to the curriculum. However, the pedagogical approaches encouraged by the curricula were not so evident in their descriptions.

Keywords: Preservice teachers, digital apps, ACAT, learning opportunities, critical perspective.

Introduction

In Norway, early childhood institutions, known as kindergartens, are expected to support children to engage with mathematical ideas (Ministry of Education and Research, 2017). The curriculum, known as the Framework Plan, states that kindergarten staff should use different tools, with learning expected to occur through play, experimentation, and everyday activities. Digital tools are specifically described as contributing to this play and learning, “digital practices in kindergarten shall encourage the children to play, be creative and learn” (Ministry of Education and Research, 2017, p. 44). Yet to enact these requirements, kindergarten teachers need to evaluate which digital tools are best to use to support children to play, be creative, and learn about mathematical ideas. This has implications for teacher education as kindergarten preservice teachers (KPTs) may need support to develop their digital competencies. Yet, there is limited research on KPTs' evaluations of digital apps for young children, either before or after their participation in teacher education (Vee & Meaney, 2022). This may partly be because of the newness of touch-screen tablets as well as the ever-expanding range of digital apps (Blackwell et al., 2016). To better understand KPTs' decision making, I examine how they describe their choices in relationship to how children should learn mathematics and the potential role they consider digital apps have in facilitating this learning of mathematics.

KPTs' views about mathematics and the learning potential of apps may be affected by influences from outside of the kindergarten environment. For example, “mathematics in kindergarten is not inspired by school mathematics, although there are some overlaps” (Christiansen & Meaney, 2020, p. 72). The valuing of school mathematics in kindergartens could be connected to the readiness for school tradition, which focuses on the cognitive goals, considered necessary for success at school. Activities in this tradition are more often teacher led and controlled (Christiansen & Meaney, 2020). In contrast, Norwegian kindergartens have a strong focus on play and are considered as being firmly rooted in the social policy pedagogy tradition (Christiansen & Meaney, 2020; Lange & Meaney, 2018).

Therefore, in investigating KPT's choices about using digital tools to provide children with mathematical learning opportunities, a critical perspective is needed. According to Skovsmose and Borba (2004) critical mathematics education can have focus on issues related to mathematics education; such as background of the children, the communication pattern in the classroom, the organization of project work in mathematics education, the reliability of mathematics in practice, the distribution of resources and the access to computers and so on. Therefore, mathematics education needs to be concerned with the social and political aspects of learning of mathematics, such as how school influences might affect kindergarten traditions. The Norwegian kindergarten field has been under political pressure to provide more specific learning, described as a way to diminish social differences (see Lange & Meaney, 2018). This has pushed the kindergarten field towards the school readiness tradition. Although this push is evident in many recent policy documents that mention mathematics, in the current curriculum document, known as the Framework Plan, play retains a key role (Fosse et al., 2018).

The use of digital technology could increase the move towards a school-readiness approach, especially when apps, with a strong instructional focus, are sold as being educational (Christiansen, 2022). Previous research has shown positive learning effects with the use of digital apps, but these "depend on the teachers' awareness of why they use the manipulatives and on their ability to use them effectively" (Palmér, 2015, p. 366). In Palmer's (2015) research in Sweden, preschool teachers were more or less absent when children were using digital apps.

Taking a critical perspective, I investigate KPTs' descriptions of the learning potential of mathematical apps. As the KPTs are expected to implement the Framework Plan (Ministry of Education and Research, 2017) in their work, there is a need to understand how they consider implementing digital practices into children's interactions with mathematics. Therefore, my research question is: How can a critical perspective on KPTs' descriptions of the learning potential of mathematical digital game provide insights into the social and political aspects of the role of mathematics in kindergartens?

Theoretical background

Artifact centric activity theory (ACAT) (see Figure 1), developed by Ladel and Kortenkamp (2013), has been used in previous research to identify how KPTs evaluated the use of mathematical digital apps by children (Vee & Meaney, 2022). In the top right triangle in Figure 1, the focus is on the relationship between: the artefact (the app); the rules which govern the kinds of interactions that are possible; and the object, the mathematical content (Ladel & Kortenkamp, 2013). The mathematics learning made available to children is dependent on the design of the app. In the triangle on the left-hand side, the focus is on how the child (subject) would make sense of (internalize) the mathematics from what is made available for them to play with (externalize). The group, in the lower left triangle, is about how an individual interacts with an artefact as part of a society. This leads to expectations about how the artefact could or should be used in a social group. For example, the relationship between a teacher and child could affect the child's interactions with the artefact (Ladel & Kortenkamp, 2013).

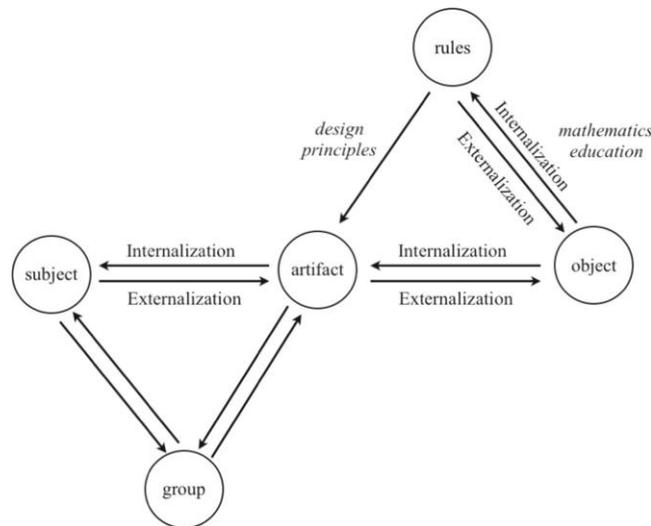


Figure 1: The ACAT framework from (Ladel & Kortenkamp, 2013)

In previous research (Vee & Meaney, 2022), ACAT was used to determine: how the KPTs see/understand what the apps can do (the artefact and the rules nodes); what mathematics should/could be learned (the object node) by young children (the subject node); and the contribution of interactions between the teachers and children (the subject and group nodes, depending on how the app might be used in the kindergarten). Understanding how the KPTs interpret what the children do with the apps and how these interactions might lead to children’s learning of mathematics can provide insights in the broader social and political context in which these evaluations take place.

Method

In this section, I describe the KPTs’ assignments and how they were analysed, according to the two triangles in the ACAT framework.

Data collection

The data were compulsory assignments, written by KPTs in a required first-year course, “Language, texts and mathematics”. 17 KPTs gave permissions for their assignments to be analysed, after they had completed all formal requirements of the course.

As part of the assignment, the KPTs had to observe children’s engagement with apps, which were chosen and used by the practicum kindergartens. As the teacher educator, I asked the KPTs to evaluate the apps according to the aims of the Framework Plan, particular in regard to play (Ministry of Education and Research, 2017). The KPTs were provided with the ACAT evaluation tool to support their evaluations.

Each assignment was read carefully. The KPTs’ points were then classified as being related to one or more nodes of the ACAT model (Ladel & Kortenkamp, 2013). Table 1 provides an overview of this classification. The first row describes each node. The second row describes the key aspects of the nodes, utilising Ladel and Kortenkamp’s descriptions. For example, when the KPTs wrote about children, it was classified as being connected to the Subject. When they wrote about the mathematical focus of the app, this comment was classified as being related to the Object. When they wrote about how aspects of apps, such as the built-in feedback, presented

and supported engagement with the mathematical content, these comments were classified as being about the Rules node. When they discussed about how children could play with apps by themselves or with others, including adults, I classified this as being related to the Group node.

Table 1: Classification of KPTs' reports into different ACAT nodes

The ACAT nodes	Subject: Children	Artifact: Apps	Object: Mathematics	Rules: How the app functions	Group: Individual/group interaction
Key aspects of each node in PTs' reports.	Explicit mention of children's skills, abilities or needs.	Explicit mention of aspects of the design of the apps.	Explicit mention of mathematics in the app.	Explicit mention of design aspects of the apps.	Explicit mention of whether the children can play individually or not.

Once the comments were classified according to the individual nodes, the commonly occurring combinations of comments connected to each triangle were viewed together. This provided insights into social and political aspects of the role of mathematics in kindergartens.

Results and discussion

The results of the analysis are discussed in relationship to ACAT's two triangles (subject-artefact-group and object-artefact-rules) (Ladel & Kortenkamp, 2013).

Artefact–Rules–Object triangle

On the whole, the KPTs choose apps they thought would suit the children in their kindergarten by presenting appropriate mathematics. Several KPTs wrote that using apps can promote language and mathematical development as well as supporting children to gain logical thinking and learn about the mathematics in a positive way. Nevertheless, KPT16 and 17 wrote that they were against the use of digital apps. They thought that there were other ways, such as board games, to learn mathematics, rather than with digital apps.

Most KPTs chose to use apps that focused on numbers, but also on the equal sign and addition strategies. Some chose apps about geometric shapes and measurements. Although they did not mention it explicitly, the KPTs may have focused on number and shapes because they explicitly are mentioned in the Framework Plan in "quantities, spaces and shapes" (Ministry of Education and Research, 2017). The focus on number matches previous research from Sweden in which preschool teachers also focussed on numbers (Johansson, 2015). There seems to be an acceptance that young children should be taught to count in early childhood institutions. Often the KPTs connected the mathematical focus of the apps to children's interests and learning needs, such as the need to practice numbers. For example, KPT5 wrote that children were very interested in numbers and counting and that was the reason why a number app was chosen. KPT3 also described how they used an app about numbers from 1 to 20, placing the numbers under pictures and matching the number to the correct picture. The KPT thought that this was good practice for children. The rules of the app supported the children's possibilities to learn by practicing. In previous research, in which KPTs had just played the apps by themselves, some KPTs had also emphasised the importance of practice (Vee & Meaney, 2022). KPT9 described a number app which was constructed so that the children could not fail. The children

would try and try, until they got the correct answer. KPT9 thought that this app might not give understanding because it did not provide feedback. For KPT9, it was important that the app provided an explanation and feedback in order for the children to learn.

In contrast to a focus on practicing, KPT4 considered that an app should be playful and explorative so that it would awaken the children's curiosity. Although KPT4 was in the minority in highlighting this aspect, many KPTs mentioned that the mathematical tasks in the apps should reflect everyday activities to provide good understanding. For example, KPT2 wrote that children should engage in problem-solving tasks, without necessarily realising that the tasks were mathematical. However, the majority of KPTs did not chose apps that focussed on problem-solving, even though in some earlier research kindergarten teachers had highlighted the importance of problem solving for young children's mathematics (Fosse et al., 2020).

Almost all the KPTs mentioned that it was important that the design of the app should include illustrations which could motivate and engage the children to do more. When the apps did not provide this kind of input, they evaluated the app negatively. For example, KPT4 wrote that an app should have more variety at the earlier levels and not advance so quickly.

In this triangle, it seemed that the KPTs considered the rules in the design of the artefact (the app) contributed to the children gaining mathematical understanding. Most of KPT focussed on number and counting as the mathematics that could be learnt through playing with apps. The KPTs also considered motivation and good illustrations as necessary for children to learn as well as explanation and repetition. This suggests that they considered that children should engage with mathematical idea through direct instruction and repetition of tasks in order to learn. This may indicate that KPTs were affected by the political pressure and media discussions about preparing children for school, even though play remains central in the kindergarten. As the provision of learning possibilities depends on teachers' awareness (Palmér, 2015), it is concerning to note that there was little focus on exploring and creativity.

Subject - Artefact - Group triangle

The subject in the ACAT analysis was the child or children who were engaged with the apps. The KPTs considered that the age of children was important in considering what they would learn from playing apps. KPT8 and 11 used the number apps "Tell i vei" (Count on the Way) and "Tella" (Counting), with young children. They described these as difficult for young children, but older children could learn from them because they could talk and ask about things. They described children as learning if they could talk and ask questions. They concluded that apps could not provide learning for very young children. Similarly, KPT8 described young children, between 1 and 2 years old, as being more occupied with sounds in the apps than doing the tasks. KPT8, 11, 13, 15, and 17 noted that young children (between the ages of 1 and 2 and a half) did not have the necessary fine motor skills to move the objects in the apps. KPT3 wrote that older children, from the age of 4, understood numbers and counting better, while the younger ones needed help from adults. This may be related to KPTs believing that children should learn from using tablets by themselves, through repetition and practice. As Palmer (2015) had found, preservice teachers tended to be somewhat absent when discussing how children used digital apps, indicating that children were expected to use them by themselves.

Many of the KPTs mentioned in their reports that the children had different knowledge and experiences about how to play with apps. KPTs 3, 14 and 17 reported that children had different understanding about how to use tablets, depending on their previous skills and experiences. As well, KPT7 described children as having different experiences with number understandings and so used different counting methods.

The Group node in the ACAT model relates to the expected kinds of interactions that children could have from engaging with apps either individually or in groups. KPT6 described how one tablet could be used with a group of 4 children, but that the adult should have control over the tablet, and supervise the children. This arrangement allowed them to have conversations with children. This is in alignment with the Framework Plan's requirement that "staff shall be actively involved with the children when using digital tools" (Ministry of Education and Research, 2017, p. 44). Similarly in KPT3's report, group situations were described as most valuable when an adult held the tablet in front of the children and the children tried to solve the different tasks with discussion and collaboration. KPT3 thought that when the children played on their own tablet, they become absorbed with the app and did not talk to each other.

The composition of the groups was also raised. KPTs 14 and 1 suggested that in a group situation it was good to have a mix of older and younger children for collaboration and to help each other. In several reports, the KPTs noted that the children helped each other in some of the difficult tasks. This suggests that these KPTs considered learning to occur as a result of social interactions. In these reports, discussion about the tasks in the app were necessary when the tasks were difficult. This is in contrast to the other KPTs who seemed to suggest that children learnt, from using the apps by themselves.

The design of digital apps provided the possibilities for learning through the task requirements and how children needed to respond. For example, KPT2 mentioned that some apps, in this case the Albert Junior app, the tasks supported mathematical conversations occurring between the KPTs and the children. KPT12 wrote that using the app could promote the children's linguistic and mathematical conversations.

This triangle focused on how children's interaction with the artefact, the apps, either individually or in groups provided learning opportunities. Most KPTs seemed to value group work for children, both with adults and with other children. However, they also seemed to accept that mathematics was something that needed to be taught, with children not having to engage themselves, except to answer the teacher's questions. Therefore, some apps were valued because they facilitated these kinds of mathematical conversations in group interactions.

This highlighted how the KPTs valued the social aspect of learning, but where the children being taught by the app and the teacher, rather than engaging creatively with the app or with others. Taking a critical aspect provided insights into how the KPTs focused on the background of children and what they were capable of doing, the kind of communication in kindergarten between children and the KPTs which was valued, and the organization and choice of apps which supported valued mathematical learning opportunities.

Conclusion

The research question was: How can a critical perspective on KPTs' descriptions of the learning potential of mathematical digital game inform about the social and political aspects of the role of mathematics in kindergartens? Using the ACAT to analysis the examples provided insights, into how different nodes in two triangles were connected. A critical perspective on KPTs' discussions on learning potential on mathematic in kindergarten with digital apps provided insights into the social and political milieu in which they were making these choices. From the analysis, it seemed that most of the KPTs considered that counting and number understandings were the important aspects of mathematics that the children should learn in kindergarten. This focus has been found in earlier research on mathematics for young children (Christiansen & Meaney, 2020), suggesting that it is a societal expectation. Although the Framework Plan (Ministry of Education and Research, 2017) suggested that digital tools should be used creatively, the ways that mathematics and mathematics learning were described indicated that it was difficult for KPTs to imagine how children could be creative when using apps.

In contrast, some KPTs indicated that they valued mathematics apps which had variation and could be related to everyday life, which is in alignment with how the Framework Plan promotes learning possibilities in kindergartens. Such an approach would support children to be motivated to learn mathematics. Nevertheless, many KPTs valued repetition and explanation in the apps, reinforcing a view that children needed to be taught mathematics. As a consequence, the KPTs considered that very young children who would struggle interacting with the apps by themselves could not learn from digital apps. Two KPTs explicitly stated that kindergarten children should not use digital apps, that kindergartens could make the same learning opportunities available through other means. These views seemed to be in alignment with media discussions which highlighted issues with children using screens (Christiansen, 2022).

Other KPTs indicated that they overcame societal concerns about using apps, by emphasising the importance of the teacher being in control of what happened on the app when they worked with a group of children. In this way, the children did not need to use the app themselves but instead looked at the app in order to answer the teacher's questions. This would limit the possibilities of children spending long hours by themselves on the tablet. Thus, a critical perspective on the KPTs' discussions provides insights into how the social and political milieu contributed to KPTs' choices of digital apps, connected to how they thought children learn mathematics and how the app could facilitate that kind of learning. These influences were both from the Framework Plan (Ministry of Education and Research, 2017) and from wider societal discussions about what mathematics for young children should be (Lange & Meaney, 2018) or about the value of tablets for young children (Christiansen, 2022).

References

- Blackwell, C. K., Lauricella, A. R., & Wartella, E. (2016). The influence of TPACK contextual factors on early childhood educators' tablet computer use. *Computers & Education*, 98, 57–69. <https://doi.org/https://doi.org/10.1016/j.compedu.2016.02.010>
- Christiansen, S., & Meaney, T. (2020). Cultural meetings? Curricula, digital apps and mathematics education. *Journal of Mathematics and Culture*, 14(2), 71–90.

- Christiansen, S. F. (2022). Multilingual children's mathematical engagement with apps: What can be learned from multilingual children's mathematical and playful participation when interacting with two different apps? *Transdisciplinary Journal of Cultural Participation*, 9(2), 1–12. <https://doi.org/https://doi.org/10.2478/tjcp-2022-0009>
- Fosse, T., Lange, T., Lossius, M. H., & Meaney, T. (2018). Mathematics as the Trojan horse in Norwegian early childhood policy? *Research in Mathematics Education*, 20(2), 166–182. <https://doi.org/https://doi.org/10.1080/14794802.2018.1473162>
- Fosse, T., Lange, T., & Meaney, T. (2020). Kindergarten teachers' stories about young children's problem posing and problem solving. In M. Carlsen, I. Erfjord, & P. S. Hundeland (Eds.), *Mathematics Education in the Early Years* (pp. 351–368). Springer. https://doi.org/https://doi.org/10.1007/978-3-030-34776-5_21
- Johansson, M. (2015). *Perceptions of mathematics in preschool: "Now we have a way of talking about the mathematics that we can work with"* [Doctoral thesis, Luleå University of Technology]. DiVa. <http://www.diva-portal.org/smash/record.jsf?pid=diva2%3A990408&dswid=-8602>
- Ladel, S., & Kortenkamp, U. (2013). An activity-theoretic approach to multi-touch tools in early mathematics learning. *International Journal for Technology in Mathematics Education*, 20(1), 3–8.
- Lange, T., & Meaney, T. (2018). Policy production through the media: the case of more mathematics in early childhood education. In M. Jurdak & R. Vithal (Eds.), *Sociopolitical Dimensions of Mathematics Education from the Margin to Mainstream* (ICME-13 Monographs, pp. 191–207). Springer. https://doi.org/10.1007/978-3-319-72610-6_11
- Ministry of Education and Research. (2017). *Framework plan for the content and tasks of kindergartens*. Norwegian Directorate for Education and Training.
- Palmér, H. (2015). Using tablet computers in preschool: How does the design of applications influence participation, interaction and dialogues? *International Journal of Early Years Education*, 23(4), 365–381. <https://doi.org/10.1080/09669760.2015.1074553>
- Skovsmose, O., & Borba, M. (2004). Research methodology and critical mathematics education. In P. Valero & R. Zevenbergen (Eds.), *Researching the Socio-political Dimensions of Mathematics Education: Issues of Power in Theory and Methodology* (pp. 207–226). Springer. https://doi.org/10.1007/1-4020-7914-1_17
- Vee, M. K., & Meaney, T. (2022). Kindergarten preservice teachers evaluating mathematical apps. In G. A. Nortvedt, N. F. Buchholtz, J. Fauskanger, F. Hreinsdóttir, M. Hähkiöniemi, B. E. Jessen, J. Kurvits, Y. Liljekvist, M. Misfeldt, M. Naalsund, H. K. Nilsen, G. Pálsdóttir, P. Portaankorva-Koivisto, J. Radišić, & A. Wernberg (Eds.), *Bringing Nordic mathematics education into the future: Proceedings of Norma 20, The Ninth Nordic Conference on Mathematics Education, Oslo 2021* (pp. 249–256). Swedish Society for Research in Mathematics Education.