

Children in Digital Movement: Facilitating Exergame-based Learning

Lars Elbæk and Nanna Jacobsen

University of Southern Denmark, Department of Sports and Biomechanics, Odense, Denmark

lelbaek@health.sdu.dk

nanna.heiner@gmail.com

Abstract: Exergame-based Learning (EBL) offers a way to reconcile concerns about children's increasing screen time with the need to promote physical activity, social participation, and academic learning in schools. This paper explores how EBL can be facilitated in a Danish preschool context using the Multiball system. Grounded in embodied cognition and embodied learning, we conceptualise EBL as learning through bodily participation in technologically mediated learning, where movement, perception, and thinking are intertwined (Dourish, 2001; Malinin, 2019; Skovbjerg & Jensen, 2024). Drawing on Reidsma et al.'s (2022) framework for facilitator roles in movement-based design, we view facilitation as situated mediation through framing, orchestration, and reflection rather than mere technical operation. Methodologically, the study adopts a qualitative single-case design with embodied fieldwork in one preschool class (17 children, aged 5–6 years) over four months. Weekly Multiball sessions integrated exergames with analogue materials and targeted physical, cognitive, and socio-emotional aims. Data consisted of video-recorded observations, participatory field notes, and a follow-up semi-structured teacher interview, analysed through reflexive thematic analysis (Braun & Clarke, 2019). Findings show that children's engagement and learning opportunities emerged through facilitation rather than technology alone. Effective EBL depended on the facilitator's ability to shift between instructor/game master, coach/mediator, role model, and initiator/animator roles, regulating intensity, clarifying goals, and connecting gameplay to academic and socio-emotional development (Reidsma et al., 2022; Baalsrud et al., 2021). The study concludes that EBL holds promise for holistic learning in pre-school, but only when supported by robust pedagogical framing, classroom management, and facilitator competence, rather than by exergame systems alone.

Keywords: Embodied learning, Holistic development, Exergames, Education, Embodied cognition

1. Introduction

Digital media increasingly shape children's preschools, while concerns about reduced physical activity, diminished active play, and weakened well-being continue to grow (Dindler et al., 2024; Eccles and Roeser, 2015). At the same time, digital technologies have become embedded in contemporary educational settings and are no longer peripheral to classroom practice (Bottino, 2016; Granic et al., 2020). This creates a productive tension: although screen time is often associated with distraction and sedentary habits, digital tools may also support active, collaborative, and meaningful learning when they are thoughtfully integrated into pedagogy (Syaukani et al., 2023; Dindler et al., 2020).

This paper is grounded in a holistic understanding of human development, defined here as the integration of physical, cognitive, and social-emotional capacities (Herbst, 2024). Such a perspective aligns with embodied cognition and embodied learning, which treat movement, perception, and thinking as inseparable dimensions of learning (Dourish, 2001; Malinin, 2019). In EBL contexts, this involves not only academic engagement, but also the coordination of bodily activity, attention, affect, and social participation. From this view, learning in school should cultivate academic achievements, participation, belonging, curiosity, and bodily engagement (Cohen, 2006; Eccles & Roeser, 2015).

An approach for supporting this broader educational aim is Exergame-Based Learning (EBL), where digital play and physical movement are combined in learning activities. Exergames have been described as digital games that require bodily movement and active cognitive engagement (Mueller et al., 2017; Oh and Yang, 2010). Research suggests that exer-games can promote physical activity, motor competence, motivation, engagement, and cognitive and socio-emotional outcomes (Staiano and Calvert, 2011; Chow and Mann, 2023; Zosh et al., 2022). Movement-based technologies such as interactive floors, LÜ, and Multiball further extend these possibilities by linking gameplay to embodied, collaborative, and curriculum-related learning (Grønbaek et al., 2007; Goncalves et al., 2024; LYMB.IO, n.d.).

However, the literature also shows that implementing exergames in school contexts remains challenging. Positive learning effects do not automatically translate into meaningful classroom practice, and teachers often report uncertainty about lesson design, technological use, pedagogical alignment, differentiation, and classroom management (Laine et al., 2020; Kosmas & Zaphiris, 2023; Krause & Jenny, 2023; Meckbach et al., 2013). Similarly, Goncalves et al (2024) and Reidsma et al (2022) argues that meaningful participation depends less on the technology itself and more on how activities are structured, guided, and adapted in practice. This points to a gap where existing research largely focuses on the effects or implementation of exergames, and less attention

has been given to the pedagogical work required to facilitate holistic and meaningful learning in practice in the preschool.

This reveals a gap in literature: while previous research has largely examined the effects or implementation of exergames, less attention has been given to the pedagogical work through which teachers facilitate holistic and meaningful learning in the preschool.

In this study, EBL is conceptualised as a situated pedagogical practice in which technology, movement, social interaction, and teacher facilitation interact to shape learning experiences. Drawing on perspectives of embodied learning, meaningful participation is understood as emerging through the ways teachers organize, guide, and adapt activities to connect bodily engagement, attention, social participation, and learning (Goncalves et al, 2024). This perspective positions facilitation as central to understanding how EBL functions as a holistic learning format within educational practice.

To address this gap the study builds on facilitation research in movement-based design, particularly the framework developed by Reidsma et al (2022), and explores teachers' experiences of implementing exergames in preschool settings. The study is guided by the following research question:

How do teachers facilitate Exergame-Based Learning to support holistic learning and meaningful participation in preschool contexts?

2. Theoretical Foundation

Exergame-Based Learning is grounded in embodied cognition (EC) and embodied Learning (EL), meaning that knowledge is generated through the body's interaction with the environment rather than through abstract mental processes alone (Malinin, 2019). Embodied Learning extends this view into education by emphasising that movement, sensation, and action are integral to children's Learning and meaning-making. This is especially relevant in early childhood and preschool, where Learning is often social, playful, and physically enacted (Skovbjerg & Jensen, 2024; Hammershøj, 2022). In this sense, EBL is not "learning with technology," but learning through active bodily participation in technologically mediated play.

Reidsma et al. (2022) conceptualise facilitation in movement-based design as the situated mediation of activity through framing, orchestration, and reflection. Applied to EBL, this means that the facilitator does more than explain rules or manage technology; the facilitator shapes the educational quality of the activity by framing its purpose, organising participation, and supporting meaning-making during and after the activities. With Multiball (MB) the same exergame can therefore lead to different outcomes depending on the structure. Facilitation is thus the bridge between the exergame environment and holistic Learning, allowing physical, cognitive, and social-emotional dimensions to be integrated in purposeful ways (Goncalves et al, 2024; Cohen, 2006).

The framework of Reidsma et al. (2022) describes types of facilitation approaches as well as several facilitator roles that shift dynamically during movement-based activities. Being instructor/games master, the facilitator structures the activity from an external position by setting up the game, introducing the rules, and clarifying the purpose of the session. The coach/mediator remains partly involved during play, guiding participants toward intended outcomes through selective support, adjustment, and encouragement. The role model/undercover facilitator participates alongside the learners, inspiring movement, attitudes, or forms of collaboration to support inclusion and engagement. Finally, the initiator/animator becomes fully immersed in the activity, sustaining energy, experimentation, and responsiveness to the group's dynamics. These roles are flexible positions that reflect different ways of mediating embodied Learning.

Taken together, these facilitator roles are useful for analysing EBL in preschool settings. Aligning with Chan et al. (2024), Learning is shaped through the facilitator's shifting actions, the design of the environment, and the participants' embodied participation, as opportunities for multiple involvements motivate and encourage gameplay. In EBL, pedagogical success emerges through the interplay between game design, facilitation, and children's embodied participation. This makes facilitation a central analytic lens for understanding how exergames may support holistic Learning in practice.

3. Study Design and Method

This study used a qualitative single-case design informed by embodied fieldwork, with embodied cognition and embodied learning as sensitising concepts (Malinin, 2019; Hodge and Sharpe, 2016; Yin, 2018). A case-study approach was appropriate to develop a contextualised understanding of how exergame-based learning is

facilitated and experienced in a naturalistic school setting. The case consisted of one Danish preschool class, and the intervention took place in the school's regular learning environment over four months.

The class comprised 17 children (7 girls, 10 boys, aged 5–6 years), one early childhood educator, and one main teacher. It functioned as a regular Danish preschool class, with no pupils identified as having disabilities or special educational needs. The school was selected due to its interest in innovative teaching and access to the Multiball (MB). The teacher knew of MB but had no prior experience using it. Written informed consent was obtained from guardians.

The intervention ran once a week from February to June 2025 (excluding holidays). Sessions were conducted in the school gym, where MB was mounted on the wall, and were video recorded from a fixed camera position. Each of the ten sessions (approx. 40 minutes) started with a pre-brief and mood-setter and ended with debrief and calming activities. Sessions combined MB exergames with analogue materials (e.g., beanbags, letter tiles, rope ladders, hula-hoops) to embody tasks and scaffold learning aims.

Table 1 summarises the ten sessions organised around three learning foci: physical (Classes 1–3), cognitive (Classes 4–7), and socio-emotional (Classes 8–10). MB games were selected according to learning objectives and children's responses.

Table 1: Overview of the project period. 1-2 focused on physical activities, 3-5 on cognitive activities, and 6-8 on socio-emotional activities. 0 and 9 were not directly related to the intervention activities

Session	Activities	EBL-activities	Responsible
Class 0a 17 February 2025	Aim: Getting familiar with the class outside project-plan hours	Playing for fun, observing.	Researcher
Physical aim: What can bodies do alone and together?			
Class 1 19 February 2025	Welcome, Moodsetter, EBL 1 + 2, Yoga-debrief	EBL 1 MonsterMatch: Two rows; children take turns and run behind the line. EBL 2 Splash: Throw beanbags in different ways.	Researcher, with assistance from the teacher
Class 2 26 February 2025	Welcome, Moodsetter, EBL 3 + 4, Yoga-debrief	EBL 3 Splash: Different ways to throw the beanbag EBL 4 Ballon Mania: Sliding on cloths towards the screen while targeting a specific color.	Researcher, with assistance from the teacher
Cognition aim: Can we learn with moving bodies?			
Class 3 10 March 2025	Welcome, Moodsetter, EBL 5, Yoga-debrief	EBL 5 DrawIO: Two rows; children take turns and run behind the line.	Researcher, with assistance from the teacher
Class 4 17 of March 2025	Welcome, Moodsetter, EBL 6 + 7 Yoga-debrief	EBL 6 Ballon Maina: Identifying the correct color. EBL 7 Connect 4: Counting syllables.	Researcher, with assistance from the teacher
Class 5 31 March 2025	Welcome, Moodsetter, EBL 8, Yoga-debrief	EBL 8 Math Game: Calculation game played in teams.	Researcher
Affective aim: How do children experience and enact collaboration?			
Class 6 28 of April 2025	Welcome, Moodsetter, EBL 9, Yoga-debrief	EBL 9 Egg Hunt: Throwing and catching different balls without dropping them.	Reseracher, with assistance from the teacher
Class 7 5 May 2025	Welcome, Moodsetter, EBL 10 + 11, Yoga-debrief	EBL 10 Memory: Spelling the name of the revield animal. EBL 11 Connect 4: Role-playing to place a brick on the castle.	Researcher

Session	Activities	EBL-activities	Responsible
Class 8 12 May 2025	Welcome, Moodsetter, EBL 12, Yoga-debrief	EBL 12 Countries: Talking about countries around the world.	Researcher, with assistance from the teacher
Class 9 14 May 2025	Aim: Goodbye, talking about the future of playful learning	Playing for fun, observing.	Researcher

The Multiball served as the central technological platform, with games chosen in collaboration with the teacher to match age level and objectives. Analogue materials were used to increase success experiences (e.g., beanbags instead of balls) and link movement to language and numeracy.

Observational data were collected in all sessions through fixed-camera recordings and participatory observation (Spradley, 1980). Video was revisited to identify episodes where facilitation shaped learning opportunities, participation, or affective engagement. Attention was guided by Reidsma et al.'s (2022) facilitator roles, focusing on shifts between instructing, coaching, modelling, and animating.

A follow-up semi-structured telephone interview with the teacher in September 2025 (approx. 45 minutes) explored children's physical, cognitive, and socio-emotional engagement, as well as practical conditions for using EBL (Kvale & Brinkmann, 2015). It also served to validate interpretations from the observations.

All interview and observational data were transcribed verbatim. Analysis followed reflexive thematic analysis (Braun & Clarke, 2019), focusing on meaning patterns related to facilitation and learning in the MB setting. Through repeated familiarisation, coding, and iterative theme development, we examined how facilitator roles, bodily movement, task framing, and social interaction shaped emerging learning opportunities.

4. Results

The results illustrate how exergame-based learning (EBL) can be facilitated and enacted in preschool settings. To address how EBL can be facilitated, we analysed children's behaviours in response to facilitation led by the researcher, the teacher, and both in combination. We also examined what teacher perspectives EBL raises in relation to holistic learning. The analysis highlights (1) children's facilitated acquisition using EBL, (2) the expansion of holistic learning to include socio-emotional competencies, and (3) facilitation as a central requirement for EBL teaching practice and classroom management.

4.1 Children's Facilitated Acquisition Using EBL

Our findings indicate that learning in EBL environments emerges through facilitation rather than technology alone. Exergames provide immersive and motivating conditions for learning by doing, but facilitation is essential for aligning embodied action and collaboration with learning goals. The following observations show how EBL framed participation, guided attention, and enabled learning outcomes through movement and play.

There are tiles with letters all over the floor. Two girls are jumping from tile to tile. One of them suggests they must spell their names. They keep taking turns spelling their name. They say the letter, search for it, and run to it while saying the letter out loud. They also want to spell the name of the teacher as she walks in. (Observation 5th May 2025)

The children sit in a long row, passing one ball from one end to the other. While waiting, some children start to massage each other, while others play with each other's hair. When one of the bigger boys passes the ball to a small girl in front of him, he slows down his movements, takes a breath, and stays calm until she takes the ball. (Observation 20th February 2025)

Moving to the sound of letters or engaging in coordinated activities shows clear potential for both academic learning and socio-emotional development, as they practise verbal and physical interaction. The teacher highlights that EBL is particularly advantageous for pupils with different learning styles, since it offers multiple ways of engaging with content. At the same time, she expresses concerns about using EBL with larger groups, suggesting smaller groups are more manageable. She also points to limited knowledge about which games to select in specific situations and what to do if the system fails as primary barriers to broader use.

Teacher: "Because we are alone with huge groups of children, it is a challenge. And I know very little about what games there are and how to make the MB work. Maybe I'll be more curious if someone shows me."

These considerations highlight EBL's practical limitations and the need for better practical clearance when planning to use EBL in teaching.

4.2 Regulating Energy and Affective Intensity

The analysis highlights the importance of regulating energy and affective intensity within the learning situation. Observations show how the combination of task information, high stimuli, and physical activity significantly shapes participation.

I walk around and place hula hoops on the floor as the children enter the gym. I don't say anything as they walk over and start tapping the Multiball. The room becomes more energetic as more children arrive. The Multiball attracts the children who intuitively join in the activities without saying good morning or interacting with other peers. (Observation 31st March 2025)

Here, the researcher acts as an observer, without involvement, allowing participants to engage intuitively in open play with the MB. This leads to active but uncoordinated participation, as children act individually rather than collectively. When the researcher shifts to an instructor role, the already elevated intensity makes it difficult to gain structure and guide interaction.

The pupils keep trying to get the displayed blocks to fall into place in the MB game. I tell them to keep their hand off the screen before hitting the wall again. "What about the feet?" Simon says and takes off his shoes and throws them against the wall. "I don't understand! Sometimes it will, and sometimes it won't." Frustrated, he walks away. (Observation 31st March 2025)

Afterwards, a role-model approach redirects attention toward an embodied activity:

I call for everyone to gather around the hula-hoop. "Do you all have the thumb on the hula-hoop? First the little finger. Now, the pointy." The fast-paced, straightforward explanation and demonstrated exercises get them to concentrate and follow along. (Observation 31st March 2025)

The observation shows how instructions alone are insufficient. The facilitator must balance guidance and role-model approaches to demonstrate and explain expectations. In prolonged multisensory environments, instructions can strain attention, leading children to drift toward the most stimulating activity, as seen when focus returns to MB. The role-model approach helps redirect attention toward grounded tasks without combined screen, movement, and cognitive overload. As the teacher notes, this helps the children manage simultaneous stimuli.

Teacher: "It's a bit like multitasking (...) It takes focus from what we're doing (...) You can't do two things at the same time."

As a mediator of MB activities, the facilitator's role as initiator or animator becomes central, requiring continuous adjustment of tempo, intensity, and organisation to sustain a productive learning environment.



Figure 1: Facilitator overseeing and facilitating gameplay on the MultiBall device

4.3 Classroom Management and Teaching Frames in EBL Facilitation

Our analysis shows EBL facilitation shapes teaching structure and goals, giving meaning to content (Reidsma et al., 2022). The observation indicates that controlled facilitation with clear verbal and physical guidance supports

active participation. Simple instructions, combined with embodied demonstration, position the facilitator as instructor and mediator, fostering attention and engagement.

The pupils are lined up in two rows behind two hula hoops. Close to the MB is a rope ladder with numbers in the spaces between its lines. I change the numbers. "You start in the hula hoop. Then I tell you what number to go for". (Observation, 18th March, 2025)

The game requires focus, so we aim for a controlled class with strong attention and engagement. Acting as role models, we demonstrate actions while explaining, reducing confusion and misunderstandings. However, combining technology and analogue tools introduces multiple stimuli and risks overreliance on technology. This can conflict with intended scaffolding and structure, as technical issues or excessive inputs may overwhelm children and disrupt engagement, as the following observation illustrates.

The MB does not always respond as intended. The children start to get tired and silly. Cody kicks the ball away and runs around the gym. I gather the class together as chaos arises. The teacher lines them up again. (Observation, 18th March, 2025)

Clear instructions, such as returning to line, help redirect attention and ease task demands. A shift from pupil-led activities to instructor-led formats becomes necessary to restore focus. While pupil-led work engages children in exploring and co-creating knowledge, controlled facilitation limits demand to listening and following instructions. As the session ends, the facilitator shifts into an animator role, concluding the activity in a structured, grounded, and embodied way that supports closure and sustained engagement.

I tell the children to sit beside me around the hula hoops on the floor. We do yoga movements to calm down. As they easily become distracted, I encourage them to try different stretches that require focus. (Observation, 18th March, 2025)

The observations show enriching facilitation relies on the teacher's ability to shift roles in response to changes in pace, energy, and group dynamics. Knowledge of the target group is critical for an optimal learning environment, as teachers must adjust activities to maintain children's energy, focus, and motivation.

Teacher: "Because playing with MB is different, it creates curiosity. But it might only do that for a short period of time. Then we need a different pace."

The teacher also emphasises the importance of group compositions and social dynamics.

Teacher: "It would be a huge challenge for me if the class composition were less respectful. It would cause so much chaos, especially if I were alone and had to do all these activities at the same time. especially help the children who react to changes in their surroundings. It would create chaos."

The results highlight the importance of classroom management that must continuously be adapted to the specific context and navigated under certain conditions to claim that EBL benefits holistic learning. Overall, verbal instructions and embodied guidance enable focused participation and structure. Excessive openness and embodied individuality invite exploratory engagement but risk becoming overwhelming. The flux between facilitation roles is a key aspect for maintaining participation and focus.

5. Implications for Facilitation

Overall, the facilitator plays a central role in structuring participation in EBL. Open facilitation often drew children toward the immediate stimulation of the exergame, fragmenting attention and making later attempts to restore structure less effective, highlighting the importance of timing and regulation. A role-model approach with clear embodied guidance supported collective participation, although children remained sensitive to competing stimuli (Reidsma et al., 2022). The findings further suggest that combining too many activities increases cognitive load, while simpler and more focused activities enhance attention and engagement.

Although pupil-led participation allowed children to explore tasks in their own ways, it often privileged more dominant children and risked excluding quieter peers. We therefore argue that guided shared participation may be the most productive facilitation approach in EBL, balancing children's freedom to participate creatively with pedagogical structure and inclusion. Finally, frequent shifts between activities and facilitation styles appeared to disrupt immersion and focus. More sustained facilitation within fewer activities may therefore support deeper and more meaningful participation in EBL.

6. Discussion

The findings reinforce that facilitation is a constitutive condition for Exergame-Based Learning (EBL), not an optional add-on to otherwise self-sufficient technology. Learning did not arise from the Multiball (MB) system alone but from how facilitators framed activities, orchestrated participation, and scaffolded reflection in situ, in line with Reidsma et al.'s (2022) account of facilitation as situated mediation in movement-based design. Shifts between instructor, coach, role model, and initiator/animator roles were crucial for aligning bodily action, attention, and social interaction with intended learning goals (Molin, 2017; Reidsma et al., 2022). From an embodied learning perspective, this supports the view that cognition is enacted through bodily and social participation, and that it is facilitation which determines which actions “count” as learning and how playful episodes are connected to curricular and socio-emotional aims (Dourish, 2001; Malinin, 2019; Skovbjerg & Jensen, 2024). Accordingly, development for EBL should prioritise flexible facilitation skills - reading group dynamics, modulating intensity, and moving between more and less directive roles - rather than focusing mainly on technical proficiency (Meckbach et al., 2013; Goncalves et al., 2024; Rasmussen et al., 2023).

The study speaks to a broader tension between concerns about digital childhood and aspirations for holistic education. Children's lives are increasingly saturated with digital media, and high screen time is associated with sedentary behaviour and risks to health and well-being (Herbst, 2024). Yet digital technologies are also deeply embedded in schools and can support collaboration and problem-solving when used thoughtfully (Bottino, 2016; Dindler et al, 2020; Kay, Bradley and Craig, 2024). EBL can be seen as a bridging practice within this landscape: by tying digital engagement directly to bodily action, social collaboration, and playful exploration, it addresses policy calls for educational practices that integrate physical, cognitive, and socio-emotional development (Herbst, 2024; Eccles and Roeser, 2015; Cohen, 2006; Hirsh-Pasek et al, 2010). However, our findings also show that EBL is not a technological fix. When facilitation was minimal or overly open, children gravitated toward the most stimulating aspects of the technology, and attention fragmented, effectively reproducing patterns associated with unsupervised screen use (Donohue & Schomburg, 2017). EBL thus represents a societal opportunity that is conditional on strong pedagogical framing, classroom management, and institutional support—such as time for preparation, technical reliability, and sustained professional learning rather than a simple solution to the challenges of using digital learning tools in childhood.

The EBL environment serves as an arena for exploration and embodied participation. It mediates emotional expression, inclusion, and attention, requiring the teacher/facilitator to navigate different moods, practices, and media stimuli. Aligned with Skovbjerg (2021), EBL becomes an affective structure in which children collectively learn to negotiate rules, roles, and relationships, engage in social dynamics, and regulate emotional expressions to enhance holistic learning. We argue that pedagogically sensitive management of the classroom mediates such learning.

Although teacher facilitation was the primary focus of this study, the teacher interview and classroom observations provide preliminary insights into the learning outcome of EBL. Furthermore, the study's small sample size and single-class design limit the transferability of the findings (Creswell, 2018). Furthermore, the analysis was shaped by the second author's familiarity with the school context and positive expectations regarding movement-based technologies, creating a potential risk of bias. To address this, the study incorporated ongoing reflexive practices, including field notes, iterative video analysis, documentation of assumptions, and critical dialogue with the first author. This process challenged initial interpretations and fostered a more nuanced understanding of the opportunities and challenges of EBL. Nevertheless, the findings remain constrained by the single-site design and primary reliance on one researcher's analysis (Stake, 2000; Yin, 2014).

In sum, EBL facilitation depends on the ability to regulate intensity, timing, and environmental structure. Shifts between facilitation roles are therefore not merely aesthetic but fundamental for aligning attention and enabling meaningful participation.

Ethics Declaration: This study involved schoolchildren. Ethical clearance followed University of Southern Denmark's Ethics Committee guidelines. All participants handed in informed consent prior to participation.

AI Declaration: CoPilot has been used for smaller adjustments during the writing of this article. AI has helped merge text piece, spell- and grammar checking as well served as an inspiration tool.

References

- Baalsrud Hauge, J., Söbke, H., Bröker, T., Lim, T., Luccini, A. M., Kornevs, M., & Meijer, S. (2021). Current competencies of game facilitators and their potential optimization in higher education: Multimethod study. *JMIR Serious Games*, 9(2), e25481. <https://doi.org/10.2196/25481>
- Bottino, R. (2016). Societal challenges and new technologies: Education in a changing world. *International Journal of Cyber Ethics in Education (IJCEE)*, 4(1), 46–55. <https://doi.org/10.4018/IJCEE.2016010104>
- Braun, V., & Clarke, V. (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>
- Chan, C. K., Burton, K., & Flower, R. L. (2024). Facilitators and barriers of technology adoption and social connectedness among rural older adults: A qualitative study. *Health Psychology and Behavioral Medicine*, 12(1), 2398167. <https://doi.org/10.1080/21642850.2024.2398167>
- Chow, D. H. K., & Mann, S. K. F. (2023). Exergaming and education: A relational model for games selection and evaluation. *Frontiers in Psychology*, 14, 1197403. <https://doi.org/10.3389/fpsyg.2023.1197403>
- Cohen, J. (2006). Social, emotional, ethical, and academic education: Creating a climate for learning, participation in democracy, and well-being. *Harvard Educational Review*, 76(2), 201–237. <https://doi.org/10.17763/haer.76.2.j44854x1524644vn>
- Dindler, C., Smith, R., & Iversen, O. S. (2020). Computational empowerment: Participatory design in education. *CoDesign*, 16(1), 66–80. <https://doi.org/10.1080/15710882.2020.1722173>
- Donohue, C., & Schomburg, R. (2017). Technology and interactive media in early childhood programs: What we've learned from five years of research, policy, and practice. *YC Young Children*, 72(4), 72–78. <https://www.naeyc.org/resources/pubs/yc/fall2017/technology-and-interactive-media>
- Dourish, P. (2001). *Where the action is: The foundations of embodied interaction*. MIT Press. <https://mitpress.mit.edu/9780262541787/where-the-action-is/>
- Eccles, J. S., & Roeser, R. W. (2015). *School and community influences on human development*. Psychology Press. <https://www.routledge.com/School-and-Community-Influences-on-Human-Development/Eccles-Roeser/p/book/9781138891241>
- Goncalves, A., Lespiau, F., Briet, G., Vaillant-Coindard, E., Palermo, A., Decobert, B. E., et al. (2024). Exploring the use of a learning-based exergame to enhance physical literacy, soft skills, and academic learning in school-age children. *JMIR Serious Games*, 12, e53072. <https://doi.org/10.2196/53072>
- Granic, I., Morita, H., & Scholten, H. (2020). Beyond screen time: Identity development in the digital age. *Psychological Inquiry*, 31(3), 195–223. <https://doi.org/10.1080/1047840X.2020.1820214>
- Grønbaek, K., Iversen, O. S., Kortbek, K. J., Nielsen, K. R., & Aagaard, L. (2007, September). Interactive floor support for kinesthetic interaction in children learning environments. In *IFIP Conference on Human-Computer Interaction* (pp. 361–375). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-540-74800-7_29
- Hammershøj, L. G. (2022). Play attitude and moods of play: A design-based inquiry into the affective nature and importance of play. *International Journal of Play*, 11(3), 327–345. <https://doi.org/10.1080/21594937.2022.2124256>
- Herbst, M. (2024). *The State of the World's Children 2024: The future of childhood in a changing world*. UNICEF. <https://www.unicef.org/reports/state-of-worlds-children/2024>
- Hirsh-Pasek, K., et al. (2010). A mandate for playful learning in preschool: Presenting the evidence. *Oxford Academic*. <https://doi.org/10.1093/oxfordhb/9780195393002.013.0019>
- Hodge, K., & Sharpe, L. (2016). Case studies. In *Routledge handbook of qualitative research in sport and exercise*. Routledge. <https://www.routledge.com/Routledge-Handbook-of-Qualitative-Research-in-Sport-and-Exercise/Sparkes-Smith/p/book/9780415671965>
- Kay, R., Bradley, K., & Craig, C. D. (2024). Technology use in the early years: A review of the literature. *ICERI2024 Proceedings*, 3540–3549.
- Kosmas, P., & Zaphiris, P. (2023). Improving students' learning performance through technology-enhanced embodied learning: A four-year investigation in classrooms. *Education and Information Technologies*, 28(9), 11051–11074. <https://doi.org/10.1007/s10639-022-11505-6>
- Krause, J. M., & Jenny, S. E. (2023). Physical educators' exergaming integration experiences, attitudes, and self-efficacy beliefs. *Physical Educator*, 80(1), 91–107. <https://library.iated.org/view/KAY2024TEC>
- Kvale, S., & Brinkmann, S. (2015). *InterViews: Learning the craft of qualitative research interviewing*. Sage. <https://us.sagepub.com/en-us/nam/interviews/book239402>
- 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>
- LYMB.IO. (n.d.). *Multiball*. <https://multi-ball.com/>
- Malinin, L. H. (2019). How radical is embodied creativity? *Frontiers in Psychology*, 10, 2372. <https://doi.org/10.3389/fpsyg.2019.02372>
- Meckbach, J., Gibbs, B., Almqvist, J., Öhman, M., & Quennerstedt, M. (2013). Exergames as a teaching tool in physical education? *Sport Science Review*, 22(5–6), 369–385. <https://doi.org/10.2478/ssr-2013-0017>
- Molin, G. (2017). The role of the teacher in game-based learning: A review and outlook. In *Serious games and edutainment applications: Volume II* (pp. 649–674). https://doi.org/10.1007/978-3-319-51645-5_29

- Mueller, F. F., Gibbs, M. R., Vetere, F., & Edge, D. (2017). Designing for bodily interplay in social exertion games. *ACM Transactions on Computer-Human Interaction (TOCHI)*, 24(3), 1–41. <https://doi.org/10.1145/3072614>
- Oh, Y., & Yang, S. (2010). *Defining exergames & exergaming*. ResearchGate. https://www.researchgate.net/publication/230682103_Defining_Exergames_and_Exergaming
- Rasmussen, L. S., Wolfgang, P., Kaos, M., & Elbæk, L. (2023). Confidence in movement-based game design facilitation: Learning from a novice design facilitator. In *17th European Conference on Games Based Learning, ECGBL 2023* (pp. 539–548). <https://doi.org/10.34190/ecgbl.17.1.1672>
- Reidsma, D., van Delden, R., Weijdom, J., Engelhardt Hansen, R., Lekbo, S., Andersen, R., Schjødt Rasmussen, L., & Elbæk, L. (2022). Considerations for (teaching) facilitator roles for movement-based design. In *Extended Abstracts of the Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '22 EA)*. ACM. <https://doi.org/10.1145/3505270.3558348>
- Skovbjerg, H. M. (2021). *On play*. Samfundslitteratur. <https://samfundslitteratur.dk/bog/on-play>
- Skovbjerg, H. M., & Jensen, J. B. (2024). Could a playful approach to teaching be a path to resonant connections? Experiences from teacher education in Denmark. *Frontiers in Education*, 9, 1237116. <https://doi.org/10.3389/educ.2024.1237116>
- Spradley, J. (1980). *Participant observation*. Holt, Rinehart and Winston. <https://books.google.com/books?id=7DiBAAAAMAAJ>
- Staiano, A. E., & Calvert, S. L. (2011). Exergames for physical education courses: Physical, social, and cognitive benefits. *Child Development Perspectives*, 5(2), 93–98. <https://doi.org/10.1111/j.1750-8606.2011.00180.x>
- Syaukani, A. A., Hashim, A. H. M., & Subekti, N. (2023). *Conceptual framework of applied holistic education*. TMFV.
- Yin, R. K. (2018). *Case study research and applications: Design and methods* (6th ed.). Sage. <https://us.sagepub.com/en-us/nam/case-study-research-and-applications/book250150>
- Zosh, J. M., Hassinger-Das, B., & Laurie, M. (2022). *Learning through play and the development of holistic skills across childhood*. LEGO Foundation. <https://learningthroughplay.com/resource/learning-through-play-and-the-development-of-holistic-skills-across-childhood>