International Journal of Psychological Studies; Vol. 16, No. 1; 2024
ISSN 1918-7211 E-ISSN 1918-722X
Published by Canadian Center of Science and Education

5-Year-Old Children Performing Piaget's Liquid Conservation Tasks Demonstrated in Physical and Digital Environment

Christos Sakkas[1] & Stavroula Samartzi[1]

[1] Department of Psychology, Panteion University, Athens, Greece

Correspondence: Christos Sakkas, Department of Psychology, Panteion University, Greece. E-mail: chsakkas@hotmail.com

Received: February 14, 2024 Accepted: February 28, 2024 Online Published: February 29, 2024

doi:10.5539/ijps.v16n1p61 URL: https://doi.org/10.5539/ijps.v16n1p61

Abstract

This study investigates the understanding of Piaget's concept of liquid conservation in 5-year-old children, comparing physical and digital environments of executing conservation tasks. Involving 86 participants (equal gender representation), it employs an Android tablet to demonstrate the pouring of water between glasses with animated images in a digital environment condition and real glasses (one short-wide and one long-narrow) filled with water for the physical environment condition. Each child completed four distinct conservation tasks, each one 3 times, designed to parallel each other in both environments. Two of the tasks concerned the general concept of conservation, and the other two were either about identity or compensation or reversibility concepts. The study aims to determine whether digital environments can be as effective as physical ones in teaching fundamental conservation concepts, exploring the impact of emerging digital learning tools versus traditional methods. Another objective of this study is to find associations between the general concept of conservation and the three other concepts: identity, compensation, and reversibility. This research contributes to the understanding of cognitive development in children and the efficacy of digital versus physical learning aids by verifying that children perceive physical and virtual learning with the same effectiveness.

Keywords: cognitive development, digital environment, liquid conservation, Piaget, psychology

1. Introduction

The advent of digital technology has transformed our manner to perceive and interact with the world, a change that is profoundly evident in the field of child development. With the increasing ubiquity of digital devices in children's lives, it becomes imperative to understand how interactions with virtual environments influence cognitive development (Sung et al., 2016; Zhang & Nouri, 2018). This study delves into the cognitive processes of children aged approximately 5 years old and specifically in their understanding of liquid conservation, a concept pivotal in Piaget's theory of cognitive development (Babakr et al., 2019; Piaget 1951,1954; Piaget & Inhelder 1974). Conservation tasks, which assess a child's ability to recognize that certain properties of objects remain constant despite changes in their form or arrangement, have long been a cornerstone in evaluating cognitive growth.

In this research, we explore a novel dimension of this theory by juxtaposing children's interaction with a liquid conservation task in two distinct environments: the digital and the physical. Do children perceive and process information differently when presented in a digital format compared to a physical one? This question lies at the heart of our study. The comparison of digital and physical environments in understanding liquid conservation provides a unique lens through which we can examine the impact of digital environments on cognitive development. This study, therefore, seeks to bridge the gap between traditional developmental theories and the contemporary digital context in which today's children are immersed. Recent studies have shed light on the evolving landscape of digital learning tools in early childhood education (Behnamnia et al., 2020). Researchers have studied the impact of these tools on learning outcomes, exploring how they contribute to cognitive development, literacy, and other essential skills (Palaiologou, 2016). Concurrently, concerns have arisen regarding the effects of prolonged screen time on children's attention span, social interaction, and overall well-being, prompting deeper investigations. Central to these inquiries is the quality of content and design, with a focus on assessing the effectiveness of interactive games, educational apps, and multimedia resources in engaging young learners (Murcia et al., 2018). Equally important is the role of educators in integrating digital tools into curricula, necessitating attention to teacher training and ongoing support mechanisms. So the comparison performed in this research is not only a matter of academic interest but has practical implications in areas ranging from educational technology to parenting strategies in the digital era.

Piaget's conservation theory is a fundamental concept in developmental psychology, and it is also central to Piaget's stages of cognitive development. This theory suggests that children reach the ability to grasp conservation at the concrete operational stage (Elkind, 1967; Piaget, 1951,1954). Key experiments involving the conservation of number, length, mass, and liquid volume were used to demonstrate this theory, revealing how younger children often struggle with understanding that the transformation of an object's shape or arrangement does not necessarily mean a change in its quantitative properties. This foundational theory has significantly influenced the understanding of children's cognitive development. Experiments were conducted where, for instance, liquid would be poured from a short, wide glass into a tall, thin glass, and children would be asked if the amount of liquid changed. Younger children typically responded that the quantity had changed, demonstrating a lack of conservation understanding. This concept is crucial in the study of cognitive development, indicating a shift from preoperational to concrete operational stages in a child's thinking, where they begin to understand the world more logically.

Whereas some studies often replicated Piaget's original experiments, others expanded on them, and they added additional features and parameters (e.g., Gelman 1969; Kwong See et al., 2012; Light et al., 1979; McGarrigle & Donaldson, 1974). Other studies have explored factors influencing conservation understanding, including age, cultural background, and education (e.g., Goldschmid et al., 1973; Kim, 1987; Nambeye, 2020). Also, contemporary studies have started using conservation experiments with the embodied cognition approach that considers perception, action, and cognition as tightly linked (Lozada & Carro, 2016). Nevertheless, Piaget's work on child development, particularly concerning his methodology and assumptions about children's cognitive abilities did not evade criticism (Lourenço & Machado, 1996). Although Piaget's theory about stages of cognitive development have been foundational in psychology and education, it is not without its challenges. Researchers critiquing Piaget have pointed out several key issues such as underestimation of children's abilities (Gruen, 1965), methodological concerns (Light et al., 1979), and issues with repeating the question in conservation tasks (McGarrigle & Donaldson, 1974).

None of the aforementioned studies and existing research compares the execution of Piaget's conservation tasks in a physical environment with the execution in a digital environment. Thus, the rationale for comparing digital and physical environments in the context of conservation tasks lies in understanding how different environments influence a child's cognitive development and learning processes. This comparison can reveal insights into how children perceive, interact with, and learn from digital versus physical stimuli, thereby informing educational strategies and developmental theories in the contemporary, technology-oriented world. Also, several key points justifying the need of such comparison can be identified:

(1) Perceptual Differences: Digital and physical environments offer different sensory experiences. Understanding how these differences affect a child's perception, especially in tasks like conservation, which rely on visual and spatial judgments, is important.

(2) Developmental Stages: They provide insight into whether developmental stages identified by Piaget, such as the concrete operational stage, manifest differently when children interact with digital versus physical environments.

(3) Cognitive Development Understanding: It helps in understanding whether the abstract thinking and reasoning skills required in conservation tasks are developed differently in digital versus physical settings.

(4) Technological Integration: With children increasingly exposed to digital environments, it is crucial to understand how these virtual experiences influence their capacity to incorporate technological knowledge into their existing representational system.

(5) Educational Practices Incorporating Digital Learning: As education increasingly incorporates digital tools, understanding how children adapt to and learn from virtual environments is key to designing effective educational content.

(6) Future Research Direction: Such comparisons could open avenues for further research in cognitive psychology and educational technology, considering the evolving nature of digital media.

Hence the main objective of this study, which is to explore whether a digital environment yields better results than a physical environment in conservation tasks, is pivotal because it examines how and if a child's cognitive understanding is enhanced by digital methods. The second objective of this research is to correlate the answers of the general concept of conservation with three more specific concepts, identity, compensation, and reversibility (Acredolo & Acredolo 1979; Brainerd, 1972; Siegler, 1981). These concepts are considered by Piaget to be easier to understand by children in comparison to the concept of conservation that is based on reasoning because they are based on perception. For this reason, they are normally acquired before the conservation concept (Hooper, 1969).

In the following sections, the methodology of the study and the results will be presented. Then the results and their implications in the broader context of child development and cognitive technology will be discussed.

2. Method

2.1 Participants

The participants were 86 children, with equal gender representation, from public and private institutions. Participants were approximately 5 years old, an age group that falls within Piaget's preoperational stage of cognitive development, where children begin to engage in symbolic play but still struggle with logic and conservation concepts. There were no apparent disparities in the children's developmental stage or socioeconomic status, and everyone was in good health. The execution of the study was conducted with full consent and awareness of both the guardians and the administrative bodies of the institutions. Additionally, the children themselves gave verbal assent to participate in this research. All 86 of the participants answered questions about the general concept of conservation. 20 of the participants answered questions about the concept of identity. Thirty-six of the participants answered questions about the concept of compensation, and 30 of the participants answered questions about the concept of reversibility.

2.2 Research Design

The experimental design for this study was structured to compare children's understanding of conservation across physical (real glasses and water) and digital (tablet-based) environments using a series of water-pouring tasks. Each participant completed four distinct conservation tasks, each one repeated three times. Two of the tasks concerned the general concept of conservation, one in a physical environment and the other in a digital environment. The other two were either about identity or compensation or reversibility concepts, again one in each environment.

The first task in both environments involved simply transferring water from one glass to another, testing the basic concept of liquid conservation. The other task in both environments was one of the following three. For testing the identity concept, the idea that the new glass was taller and thinner was introduced, prompting children to consider changes in shape and volume perception. For testing the compensation concept, explicit information that no additional liquid was added during the transfer was included, emphasizing the conservation of quantity despite visual differences. For testing the concept of reversibility, pouring the water back into the original glass was added to the demonstration process, allowing children to directly observe the reversibility of the action.

More specifically, two sets of experimental tools were utilized:

(1) Digital Environment Tool: An Android tablet device was used for digital tasks. This device displayed images, static and animated, of water being poured between glasses (Figure 1). The tablet's interactive interface and vivid graphics provided a realistic virtual experience, enabling children to engage with the conservation tasks in a digital format (Sakkas & Samartzi, 2023).

(2) Physical Environment Tools: For the physical tasks, real glasses were used. These included a set of two different glasses—one short and wide, and the other tall and thin—to demonstrate the conservation of liquid. The glasses were transparent, allowing children to clearly observe the water level during and after pouring. Real water was used to visually demonstrate the conservation principle in a tangible way.

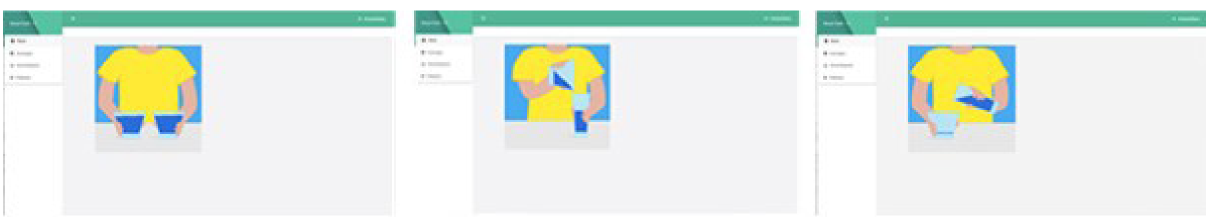

Figure 1. Example of the Android tablet screen display

In each task of the study, there were two distinct phases: the demonstration phase and the question phase. This design ensured that each child had the same experience and basis for understanding before answering the questions.

(1) Demonstration Phase

1) In both the digital and physical environments, the experimenter first demonstrated the action of pouring water from one glass to another. The vocal instructions from the experimenter were the same, regardless of the environment, and they described the actions that were demonstrated.

2) For the digital tasks, this was done using images and animations on the tablet, simulating the pouring of water.

3) For the physical tasks, the experimenter physically poured water from one real glass to another in front of the children.

(2) Question Phase

1) Following the demonstration, children were asked whether the amount of water in the glasses remained the same or changed after the transfer.

2) Except from motivational phrases when the children became idle, such as “What do you think—you haven’t told me yet,” “Try to find the answer—you can do it,” “We agreed to help me understand—let’s continue,” no additional information or help was provided to the children.

2.3 Procedure

The child participant sat at a table across from the experimenter, and the two of them were the only people present in the room. For the physical environment tasks, the experimenter used real glasses filled with water, pouring it from one to the other. For the digital environment tasks, the experimenter used a tablet device to present on the screen the appropriate static and animated images. The experimenter followed exactly the research design and used the same language, instructions, and expressions in both physical and digital environment tasks. Each child completed all tasks in between 10 and 15 minutes in total. The children received no feedback on their answers during or after the experiment. Finally, each child was assigned a random ID number to conceal their identity; all children participated anonymously in the research.

3. Results

Researchers analyzed the data using IBM SPSS Statistics (Version 26). Table 1 demonstrates the results of the liquid conservation tasks that were performed in the experiment. In each cell appears the absolute number of answers followed by the percentage of total participants in each task. The data are split by environment: physical when the tasks were demonstrated by real glasses and digital when the tasks were demonstrated by images in the tablet screen. An answer was considered correct when the child told the experimenter that the amount of liquid after the demonstration was equal, whereas an answer was considered wrong when the child told the experimenter that the amount of liquid was different (either more or less). Also, to perform the statistical analysis, the answers of each participant for each task’s three repetitions were aggregated in a single answer following the rule that if at least two out of three answers were correct, the participant answered correctly.

Table 1. Liquid Conservation Tasks Results

Environment	Answers	General (n=86)	Identity (n=20)	Compensation (n=36)	Reversibility (n=30)
Physical	Correct	11 (12.8%)	1 (5.0%)	3 (8.3%)	20 (66.7%)
	Wrong	75 (87.2%)	19 (95.0%)	33 (91.7%)	10 (33.3%)
Digital	Correct	15 (17.4%)	1 (5.0%)	3 (8.3%)	21 (70.0%)
	Wrong	71 (82.6%)	19 (95.0%)	33 (91.7%)	9 (30.0%)

To better visualize these results, researchers plotted the number of correct and wrong answers for each concept of conservation in bar charts, one for physical tasks and one for digital tasks (Figure 2 and Figure 3, respectively). Blue indicates correct answers, and red indicates wrong answers. The majority of the answers in the general concept of conservation, the identity, and the compensation tasks is wrong, whereas in the reversibility tasks, the majority of the answers is correct. The answers for each concept are consistent and follow the same distribution regardless of the environment of execution of the tasks, physical or digital.

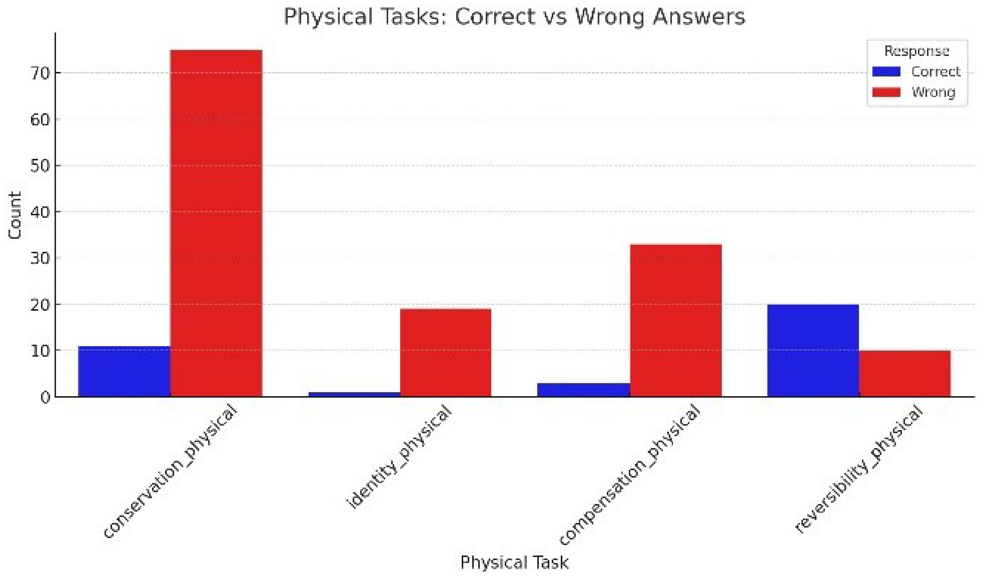

Figure 2. Answers for Physical Environment

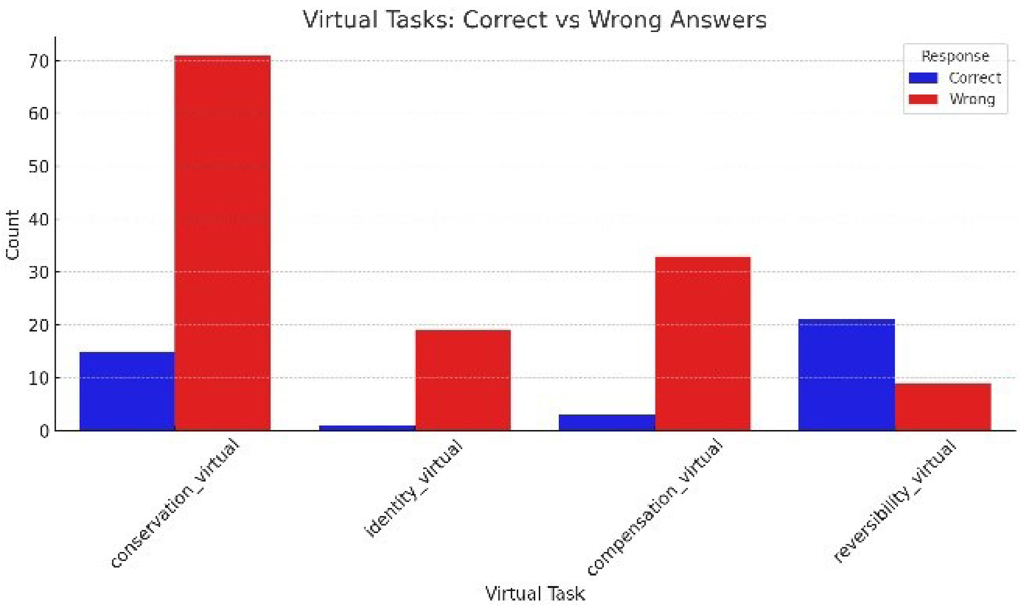

Figure 3. Answers for Digital Environment

To analyze the results, researchers performed the chi square test of independence to check for possible associations between physical and digital environment conditions in each concept of conservation separately. Because the tables for the analysis were 2x2, researchers used the continuity correction adjustment.

(1) For the general concept of conservation: Out of 11 children who answered correctly in the physical environment condition, six answered correctly in the digital environment condition, and five answered wrong. Out of 75 children who answered wrong in physical environment condition, 66 answered wrong in the digital environment condition, and nine answered correctly. Researchers found significant association between the physical and digital environment in the general concept of conservation: x^2(df=1, N=86)=9.285, p=0.002.

(2) For the concept of identity: Out of one child who answered correctly in the physical environment condition, one also answered correctly in the digital environment condition, and zero answered wrong. Out of 19 children who answered wrong in the physical environment condition, 19 answered wrong in the digital environment condition, and zero answered correctly. Researchers found significant association between the physical and

digital environment in the concept of identity: x^2(df=1, N=20)=4.488, p=0.034.

(3) For the concept of compensation: Out of three children who answered correctly in the physical environment condition, zero answered correctly in the digital environment condition, and all three answered wrong. Out of 33 children who answered wrong in the physical environment condition, 30 answered wrong in the digital environment condition, and three answered correctly. Researchers found no significant association between the physical and digital environment in the concept of compensation: x^2(df=1, N=36)=0.000, p=1.000.

(4) For the concept of reversibility: Out of 20 children who answered correctly in the physical environment condition, 16 answered correctly in the digital environment condition, and four answered wrong. Out of 10 children who answered wrong in the physical environment condition, five answered wrong in the digital environment condition and five answered correctly. Researchers found no significant association between the physical and digital environment in the concept of reversibility: x^2(df=1, N=30)=1.607, p=0.205.

Further analysis targeted the relationship between the three specific concepts of conservation and the general concept of conservation in each environment condition. Again, researchers used the chi square test of independence with the continuity correction adjustment to determine statistical associations.

For tasks performed in the physical environment:

(1) Out of one child who answered correctly about the general concept of conservation, one also answered correctly about the identity concept, and zero answered wrong. Out of 19 children who answered wrong about the general concept of conservation, 19 also answered wrong about the identity concept, and zero answered correctly. Researchers found significant association between the two concepts: x^2(df=1, N=20)=0.488, p=0.034.

(2) Out of two children who answered correctly about the general concept of conservation, two also answered correctly about the compensation concept, and zero answered wrong. Out of 34 children who answered wrong about the general concept of conservation, 33 also answered wrong about the compensation concept, and one answered correctly. Researchers found significant association between the two concepts: x^2(df=1, N=36)=12.321, p=0.0004.

(3) Out of eight children who answered correctly about the general concept of conservation, six also answered correctly about the reversibility concept, and two answered wrong. Out of 22 children who answered wrong about the general concept of conservation, eight also answered wrong about the reversibility concept, and 14 answered correctly. Researchers found no significant association between the two concepts: x^2(df=1, N=30)=0.021, p=0.884.

For tasks performed in the digital environment:

(1) Out of one child who answered correctly about the general concept of conservation, one also answered correctly about the identity concept, and zero answered wrong. Out of 19 children who answered wrong about the general concept of conservation, 19 also answered wrong about the identity concept, and zero answered correctly. Researchers found significant association between the two concepts: x^2(df=1, N=20)=4.488, p=0.034.

(2) Out of five children who answered correctly about the general concept of conservation, three also answered correctly about the compensation concept, and two answered wrong. Out of 31 children who answered wrong about the general concept of conservation, 31 also answered wrong about the compensation concept, and zero answered correctly. Researchers found significant association between the two concepts: x^2(df=1, N=36)=13.196, p=0.0002.

(3) Out of nine children who answered correctly about the general concept of conservation, seven also answered correctly about the reversibility concept, and two answered wrong. Out of 21 children who answered wrong about the general concept of conservation, seven also answered wrong about the reversibility concept, and 14 answered correctly. Researchers found no significant association between the two concepts: x^2(df=1, N=30)=0.030, p=0.862.

4. Discussion

The results of this research point out that liquid conservation tasks of conservation and identity concepts on 5-year-old children yield different results depending on the environment of execution. In contrast, for liquid conservation tasks of compensation and reversibility concepts, the results are expected to be similar regardless of the environment of execution, whether it is physical or digital.

In addition, the number of correct and wrong answers were approximately the same within each concept of conservation, in both environments. For the general concept of conservation, the identity concept, and the compensation concept, the majority of the answers was wrong, averaging approximately 87% of the total, whereas for the reversibility concept, the majority of the answers was correct, at approximately 68%. Research on Piaget's conservation concepts suggests that although traditionally it has been believed that children under 6 years of age could not understand these concepts, more recent studies indicate that younger children may indeed be capable of grasping them (Rothenberg 1969; Sakkas & Samartzi, 2023). For instance, several studies (Watanabe, 2017a, 2017b, 2019, 2022) found that children as young as 3 years old might be able to acquire Piaget's conservation concepts when these tasks are integrated into play. These studies also observed that a 4-year-old was able to robustly acquire the conservation concept for numbers and length, indicating a potential acceleration in cognitive development compared to the age previously presumed by Piaget. This shift in understanding aligns with the broader observation that younger children today may have higher intelligence than those in previous generations (Flynn, 2012; Pietschnig & Voracek, 2015). As Piagetian tasks generally assess logical thinking, an increase in intelligence quotient (IQ) could positively affect the ability to correctly solve these tasks. It is interesting to notice that out of the three specific concepts of conservation investigated in the present study, only reversibility presented a positive percentage of correct questions, thus suggesting that it is more easily acquired by this marginal age group for Piaget's conservation understanding.

The similar performance of children in both digital (using a tablet) and physical (using real glasses) settings for liquid conservation tasks can be understood through several perspectives. Research on the use of tablets and their effects on learning and development in young children suggest that digital technology, when meaningfully integrated, can positively affect areas like math, science, problem-solving, and self-efficacy (Peirce, 2013). This indicates that tablet-based learning can effectively engage children in similar ways to physical tasks, aiding in their cognitive development (Semmelmann et al., 2016). Moreover, researchers can use tablets effectively in developmental cognitive research with children (Frank et al., 2016). Researchers compared the reliability, performance, and sensitivity of response times in tablet-based tasks to other methods and found tablets to be equally or more favorable. This supports the idea that tablet-based tasks can be as effective as physical ones in assessing cognitive abilities in children. Therefore, these studies collectively suggest that when tablet-based learning is designed appropriately, it can be as effective as traditional physical learning methods, including tasks that assess cognitive development like liquid conservation. The key factor appears are the quality of interaction and engagement that the learning tool (whether digital or physical) facilitates rather than the medium itself. Nonetheless, the design of digital learning tools plays a pivotal role in curriculum development, particularly in early childhood education. Effective integration of digital tools requires careful alignment with curriculum objectives, pedagogical principles, and developmental milestones (Laurillard, 2010). Design considerations encompass user interface, interactivity, content relevance, and accessibility, ensuring that tools are engaging, age-appropriate, and conducive to learning. Digital learning tools can serve as dynamic resources that enrich educational experiences and support holistic development in early childhood settings.

Adding to the existing literature, the results of this study were that physical and digital environments' associations were statistically significant in two out of the four concepts: in the general concept of conservation and the identity concept. In the compensation and reversibility concepts, no statistical significance was observed. Interesting results were also produced regarding the association of the general concept of conservation with the three specific concepts: identity, compensation and reversibility. Researchers observed statistical significance in identity and compensation concepts when they were associated with the general concept of conservation. The reversibility concept presented no statistical significance when associated with the general concept of conservation in both environments. The absence of statistical significance and the high number of correct answers in reversibility concept compared to the others further reinforces the results and views of previous studies, which suggests reversibility may be acquired developmentally prior to conservation and possibly is not closely related (Brainerd, 1972; Bruner et al., 1966; Murray & Johnson 1969).

Finally, as noted, the age group of this study is on the margin of the preoperational stage of Piaget's theory because the researchers were trying to find the limit of understanding of conservation concepts of children. Future research should focus on older aged children because they will provide more balanced answers in terms of correct and wrong, thus enabling the identification of stronger associations among all concepts of conservation. Another interesting research direction would be the investigation of embodied cognition, which can be implemented by having the children, instead of being only observers of the liquid conservation demonstration, to interact and participate in the experimental process in various ways (Lozada & Carro, 2016), like handling the glasses themselves and pouring the water from one to another in the physical environment and pressing buttons to manipulate the animation on the tablet device in the digital environment.

Acknowledgments

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors. Funding for this research was covered by the authors of the article.

References

Acredolo, C., & Acredolo, L. P. (1979). Identity, Compensation, and Conservation. *Child Development, 50*(2), 524-35. https://doi.org/10.2307/1129432

Babakr, Z. H., Mohamedamin, P., & Kakamad, K. (2019). Piaget's Cognitive Developmental Theory: Critical Review. *Education Quarterly Reviews, 2*(3), 517-524. https://doi.org/10.31014/aior.1993.02.03.84

Behnamnia, N., Kamsin, A., Ismail, M. A. B., & Hayati, A. (2020). The effective components of creativity in digital game-based learning among young children: A case study. *Children and Youth Services Review, 116*, 105227. https://doi.org/10.1016/j.childyouth.2020.105227

Brainerd, C. J. (1972). Reinforcement and reversibility in quantity conservation acquisition. *Psychonomic Science, 27*(2), 114-116. https://doi.org/10.3758/BF03328907

Bruner J. S., Olver R. R., Greenfield P. M., Hornsby J. R., & Harvard University Center for Cognitive Studies. (1966). *Studies in cognitive growth: a collaboration at the center for cognitive studies*. John Wiley.

Elkind, D. (1967). Piaget's conservation problems. *Child Development, 38*(1), 15-27. https://doi.org/10.2307/1127125

Flynn, J. R. (2012). *Are we getting smarter? Rising IQ in the twenty-first century*. Cambridge University Press. https://doi.org/10.1017/CBO9781139235679

Frank, M. C., Sugarman, E., Horowitz, A. C., Lewis, M. L., & Yurovsky, D. (2016). Using tablets to collect data from young children. *Journal of Cognition and Development, 17*(1), 1-17. https://doi.org/10.1080/15248372.2015.1061528

Gelman, R. (1969). Conservation acquisition: a problem of learning to attend to relevant attributes. *Journal of Experiment Child Psychology, 7*, 167-187. https://doi.org/10.1016/0022-0965(69)90041-1

Goldschmid, M. L., Bentler, P. M., Debus, R. L., Rawlinson, R., Kohnstamm, D., Modgil, S., Nicholls, J. G., Reykowski, J., Strupczewska, B., & Warren, N. (1973). A cross-cultural investigation of conservation. *Journal of Cross-Cultural Psychology, 4*(1), 75-88. https://doi.org/10.1177/002202217300400106

Gruen, G. E. (1965). Experiences affecting the development of number conservation in children. *Child Development, 36*(4), 963-979. https://doi.org/10.2307/1126937

Hooper, F. H. (1969). Piaget's conservation tasks: The logical and development priority of identity conservation. *Journal of Experimental Child Psychology, 8*(2), 234-249. https://doi.org/10.1016/0022-0965(69)90098-8

Kim, M. (1987). *Cognitive development of Korean kindergarten children and its relationship to age, gender, social class, and maternal attitude*. [Doctoral dissertation, Oregon State University]. https://ir.library.oregonstate.edu/concern/graduate_thesis_or_dissertations/kw52jc979

Kwong See, S. T., Rasmussen, C., & Pertman, S. Q. (2012). Measuring children's age stereotyping using a modified Piagetian conservation task. *Educational Gerontology, 38*(3), 149-165. https://doi.org/10.1080/03601277.2010.515891

Laurillard, D. (2010). An approach to curriculum design. *Institute of Education, London, 14*, 16.

Light, P. H., Buckingham, N., & Robbins, A. H. (1979). The conservation task as an interactional setting. *British Journal of Educational Psychology, 49*(3), 304-310. https://doi.org/10.1111/j.2044-8279.1979.tb02430.x

Lourenço, O., & Machado, A. (1996). In defense of Piaget's theory: A reply to 10 common criticisms. *Psychological Review, 103*(1), 143. https://doi.org/10.1037/0033-295X.103.1.143

Lozada, M., & Carro, N. (2016). Embodied action improves cognition in children: Evidence from a study based on Piagetian conservation tasks. *Frontiers in Psychology, 7*, 393. https://doi.org/10.3389/fpsyg.2016.00393

McGarrigle, J., & Donaldson, M. (1974). Conservation accidents. *Cognition, 3*, 341-350. https://doi.org/10.1016/0010-0277(74)90003-1

Murcia, K., Campbell, C., & Aranda, G. (2018). Trends in Early Childhood Education Practice and Professional Learning with Digital Technologies. *Pedagogika, 68*(3), 249-264. https://doi.org/10.14712/23362189.2018.858

Murray, F. B., & Johnson, P. E. (1969). Reversibility in no conservation of weight. *Psychonomic Science, 16*(6), 285-287. https://doi.org/10.3758/BF03332691

Nambeye, T. (2020). *The influence of Jean Piaget's conservation tasks on the academic performance of pupils in the concrete operational stage of Kitwe District*. [Doctoral dissertation, University of Zambia]. http://dspace.unza.zm/bitstream/handle/123456789/7074/FINAL%20DESSERTATION%20DR%20KABAGHE%20JANUARY.pdf

Palaiologou, I. (2016). Children under five and digital technologies: Implications for early years pedagogy. *European Early Childhood Education Research Journal, 24*(1), 5-24. https://doi.org/10.1080/1350293X.2014.929876

Piaget, J. (1951). *Play, dreams and imitation in childhood*. Routledge & Kegan Paul.

Piaget, J. (1954). *The construction of reality in the child*. Basic Books. https://doi.org/10.1037/11168-000

Piaget, J., & Inhelder, B. (1974). *The child's construction of quantities: Conservation and atomism*. Routledge & Kegan Paul. https://doi.org/10.4324/9781315006253

Peirce, N. (2013). *Digital game-based learning for early childhood. A state of the art report*. http://dx.doi.org/10.13140/RG.2.2.25305.42087

Pietschnig, J., & Voracek, M. (2015). One century of global IQ gains: A formal meta-analysis of the Flynn effect (1909–2013). *Perspectives on Psychological Science, 10*(3), 282-306. https://doi.org/10.1177/1745691615577701

Rothenberg, B. B. (1969). Conservation of Number among Four- and Five-Year-Old Children: Some Methodological Considerations. *Child Development, 40*(2), 383-406. https://doi.org/10.2307/1127410

Sakkas, C., & Samartzi, S. (2023). Human-human versus human-robot interaction in Piaget's liquid and mass conservation performed by 5–6-year-old children. *International Journal of Psychological Studies, 15*(1), 1-60. https://doi.org/10.5539/ijps.v15n1p60

Semmelmann K., Nordt M., Sommer K., Röhnke R., Mount L., Prüfer H., Terwiel S., Meissner T.W., Koldewyn K., & Weigelt S. (2016). U Can Touch This: How Tablets Can Be Used to Study Cognitive Development. *Frontiers in Psychology, 7*, 1021. https://doi.org/10.3389/fpsyg.2016.01021

Siegler, R. S. (1981). Developmental sequences within and between concepts. *Monographs of the Society for Research in Child Development, 46*, 1-84. https://doi.org/10.2307/1165995

Sung, Y. T., Chang, K. E., & Liu, T. C. (2016). The effects of integrating mobile devices with teaching and learning on students' learning performance: A meta-analysis and research synthesis. *Computers & Education, 94*, 252-275. https://doi.org/10.1016/j.compedu.2015.11.008

Watanabe, N. (2017a). Accelerated cognitive development-Piaget's conservation concept. *Journal of Educational and Developmental Psychology, 7*(2), 68-74. https://doi.org/10.5539/jedp.v7n2p68

Watanabe, N. (2017b). Acquiring Piaget's conservation concept of numbers, lengths, and liquids as ordinary play. *Journal of Educational and Developmental Psychology, 7*(1), 210-217. https://doi.org/10.5539/jedp.v7n1p210

Watanabe, N. (2019). Attachment play related to Piaget's conservation task with parent. *International Journal of Psychological Studies, 11*(2), 24-31. https://doi.org/10.5539/ijps.v11n2p24

Watanabe, N. (2022). Conservation developmental process in early childhood: Impact of intrinsic motivation and practice effects. *Current Psychology, 41*(10), 7041-7048. https://doi.org/10.1007/s12144-020-01217-x

Zhang, L., & Nouri, J. (2018). *A systematic review of learning and teaching with tablets*. International Association for Development of the Information Society.