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Developing Local Games for Enhancing Numeracy Skills in Primary Schools in Tanzania: A Participatory Approach

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Abstract

Digital games have emerged as a significant tool for enhancing learning and cognitive development in children. They serve as effective tools for skill enhancement due to their interactive and immersive nature, maintaining interest in learning and providing real-time feedback for immediate correction of mistakes. Furthermore, digital games foster critical thinking in children through decision-making and problem-solving in varied scenarios, while also creating a fun and less intimidating environment that reduces anxiety and promotes enjoyable learning. However, the success of game based learning initiatives in developing countries has been limited due to lack of sufficient involvement of local children in the development process, causing the disconnect between game developers and the target audience. These games also often fail to integrate local content with existing curricula and teaching methods. This research explores the development of local digital games aimed at enhancing numeracy skills among Tanzanian primary school children, employing a participatory approach. Addressing the shortcomings of existing educational games, it involved a participatory design approach with 42 pupils aged 6-8 and 14 teachers from six different schools across three regions in Tanzania. This participatory method led to the development of three games: 'Manati', 'Ruka Kamba', and 'Kombolela'. These games underwent rigorous testing to evaluate their pedagogical value, ease of use, and the level of fun and enjoyment they offer. The study found that involving children and teachers in the development process not only made the games easy to play, fun, and enjoyable but also pedagogically effective for the target audience. The findings emphasize the importance of user involvement in the whole process of game development, particularly in contexts where cultural sensitivity and curriculum alignment are important.

Keywords: *Participatory approach; digital local games; games for learning; games based learning*

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Introduction

Digital games have become a significant part of children's daily activities, taking their time in classrooms, at home, and during leisure (Duh *et al.*, 2010; Hermita *et al.*, 2021). Recent estimates suggest that by the age of 21, they spend approximately 10,000 hours engaged in digital gaming (Lamichhane & Read, 2020; Voulgari *et al.*, 2020). In the education context, digital games have emerged as a powerful tool for enhancing a variety of skills in children, largely due to their

interactive and immersive nature. They can maintain children's interest and focus on learning activities (Adedigba, 2023; Papastergiou, 2009), provide immediate feedback, helping them to correct their mistakes in real-time (Wouters *et al.*, 2013). As children interact with different game scenarios when playing games, they develop critical thinking skills by making choices, solving puzzles, or navigating challenges (Granic *et al.*, 2014). Beilock *et al.,* (2010) suggest that the fun and less intimidating environment provided by digital games can help alleviate anxiety, allowing children to learn a variety of skills in a more relaxed and enjoyable setting.

Given these benefits, the use of digital games to enhance various skills in developing countries is becoming more apparent partly due improvement of Information and Communication Technology (ICT) infrastructure and proliferation of mobile technology in developing countries. In Tanzania, the development and piloting of digital games have shown promising results in enhancing early childhood education. For instance, Ongoro and Mwangoka (2014) implemented a game-based learning system that improved preschoolers' abilities in alphabetical sound articulation, as piloted in twelve schools. Malamsha *et al.,* (2021) explored the development of a culturally sensitive, mobile-based game named HappyToto, aimed at educating children under five years and their parents or caretakers in Tanzania on sexual abuse prevention. The game significantly improved parents' confidence and ability to discuss CSAP topics, with notable increases in both confidence levels and ability scores, alongside children's enjoyment and interest in the game.

Similarly, the GraphoGame (GG) initiative, piloted in Bagamoyo, found that integrating GG into the learning process led to significant improvements in phonics-based literacy (Ojanen *et al.*, 2015). Furthermore, Lee and Choi (2020) conducted a study on a tablet-based math game, which involved 122 children from a rural primary school. This game notably enhanced numeracy skills, including quantity discrimination, addition, and subtraction. These initiatives reflect the increasing role of digital games in improving educational outcomes in developing countries.

Despite various initiatives, the success rate of game-based learning projects targeting children in developing countries has been limited. A primary reason being the misalignment with the cultural and linguistic diversity of developing countries leading to reduced effectiveness and engagement (Alaoui *et al.,* 2020; Kam *et al.,* 2009; Ongoro and Mwangoka, 2014). There is also a failure to localize content to align with local curricula and teaching methods reducing the relevance and educational value (Kam *et al.,* 2009; Nolan and McBride, 2014). Furthermore, there is an insufficient involvement of local children during the development stages, which is a challenge, considering the substantial cultural differences between developers in developed countries and children in developing countries (Hussain, 2010; Kam *et al.,* 2006). Typically, children from these countries are engaged only during the testing and evaluation phases, as seen in studies by Ferreira *et al.,* (2016), Ojanen *et al.,* (2015), and Sim *et al.,* (2015). Consequently, the unique needs of these children, which may differ significantly from those of their counterparts in developed countries or even from their own parents and teachers, are always not captured.

The involvement of children in the developing process of digital games in developing countries is a relatively new and unexplored field (Byrne and Sahay, 2007; Kam *et al.,* 2009; Lamichhane & Read, 2020; Wakil and Dalsgaard, 2013). In the present study, a participatory design approach was employed, involving pupils aged 13 to 15 from six primary schools, along with teachers from three different regions. This approach was integral to the design and development of games aimed at enhancing numeracy skills. The three games developed through this process – Ruka Kamba, Manati, and Kombolela – underwent thorough evaluation for pedagogical effectiveness, ease of use and playability, and enjoyment and fun. The findings of this study demonstrate that participatory design is an effective method in developing games that cater to the unique needs of marginalized user groups in developing countries.

Participatory approach in system development

As technological advancements continue, children are increasingly becoming prominent

users of information systems, thus establishing themselves as a crucial user group (Moser, 2013). They have unique preferences, curiosities, and needs that differ from those of their parents or teachers, necessitating a tailored approach to their involvement in the design process (Druin, 2002; Voulgari *et al.,* 2020). Children have different ways of expressing their thoughts (Melonio, 2016) offering invaluable insights into system usability, aesthetic appeal, and user engagement (Bell and Davis, 2016). However, despite the recognition of children as a special user group, there is a tendency among developers to rely on the feedback of parents and teachers about children's needs, rather than engaging with them directly (Druin, 2002; Hussain, 2010). Consequently, this approach often overlooks critical user perspectives, as teachers and parents may not fully understand the children's worldview, leading to a potential gap in user-centric design (Melonio, 2016).

Druin (2002) articulates four distinct roles that children can assume in the process of developing information systems: (1) as users engaging with systems whose development has concluded, (2) as testers providing feedback on prototypes during the development process, (3) as informants providing insights to designers at any stage of the development process, and (4) as partners collaborating as equals with adult team members in making group decisions. Druin (2002) strongly advocates for the integration of children as design partners, treating them as equal stakeholders throughout the entire development process. This approach allows children to participate in various phases, including idea generation, product development, and user testing, thereby enriching the design process with their unique perspectives (Bell and Davis, 2016).

In terms of application of participatory approach in systems development, Spinuzzi (2005) proposes three pivotal stages that developers can involve users in the development process: Initial Exploration of Work, Discovery Processes, and Prototyping. The Initial Exploration of Work involves designers participating themselves in users' current work practices and technologies, building a foundational understanding of user needs. In the Discovery Processes stage, designers and users engage interactively to align design with user values and organizational objectives. Lastly, the Prototyping phase is a collaborative effort in iteratively developing technology artifacts, focused on ensuring the design's seamless integration and functionality in the user's work environment. Therefore, Spinuzzi (2005) emphasizes the importance of user involvement throughout the development process to develop more user-centered and effective systems.

Recent studies have begun to recognize and incorporate the participation of children in the development of various systems, as evidenced by the work of researchers such as (Frauenberger *et al.,* 2011), (Voulgari *et al.,* 2020), (Melonio, 2016), (Porcino *et al.,* 2015), and (Sims, 2018). For example, Frauenberger *et al.,* (2011) found that children with autism spectrum conditions played a significant role in shaping a technologically enhanced learning environment through the ECHOES project. Similarly, Sims (2018) highlighted the valuable contributions of children as capable and inventive partners in the development of upper limb prostheses. Similarly, a child-centered approach to game development was effectively employed to engage and involve children aged 10–14 years in classroom settings, directly contributing to the game development process (Moser, 2012). This growing body of research underscores the importance and effectiveness of involving children as participants in the whole process of information systems and particular digital games.

Despite the successes highlighted in various studies, the involvement of children from developing countries in the design process remains limited (Byrne and Sahay, 2007; Kam *et al.,* 2006; Puri *et al.,* 2004), due to several challenges. One significant obstacle is the limited exposure of these children to advanced technology, which can hinder their ability to conceptualize future designs (Kam *et al.,* 2006; Wakil and Dalsgaard, 2013). Additionally, low literacy levels among many children in developing countries limit their ability to contribute to the game development process, especially in terms of reading and writing requirements (Lamichhane and Read, 2020; Oyugi *et al.,* 2008). Other challenges include

cultural and language barriers, incompatibilities of participatory design techniques with local values, geographical distances leading to high travel costs and communication difficulties (Kam *et al.,* 2009; Ojanen *et al.,* 2015).

These challenges make the involvement of children in the system development process unique and challenging. Pilot studies incorporating children at different stages of the design process in developing countries have yielded varied results. A notable study by Kam *et al.,* (2009) investigated 28 games across three communities in India and identified issues with digital games not aligning with the perceptions and understanding of games held by rural children. The authors concluded that there is a significant need to develop a deeper understanding of how to design games that resonate culturally and contextually with children living in rural villages. Hussain (2010) developed a framework highlighting psychological empowerment in participatory design with children in Cambodia with children of prosthetic legs. The study showed that children's involvement was crucial in understanding their needs in design processes. However, Hussain noted the importance of developers recognizing the unique challenges and conditions of conducting participatory design in developing countries compared to developed ones. These studies collectively show the need for culturally relevant, enjoyable, and effective digital games for learning through involving children during the whole process of game development.

The present study involved children from the beginning of the project, focusing on the redesign of local games for mobile devices aimed at improving their numeracy skills. Observing the success of participatory design involving children in developed countries, the study investigated the potential for pupils in developing countries to contribute similarly in the information system development process. Consequently, this study aims to demonstrate the effectiveness of participatory design with children as a method for developing information systems that are both relevant and acceptable by children in developing countries.

Materials and Methods

In this research, a participatory design methodology as suggested by (Spinuzzi, 2005) was adopted to develop digital games for enhancing numeracy skills among primary school pupils in Tanzania. This approach consists of three key stages: initial exploration of work, discovery processes, and prototyping. The subsequent sections detail the involvement of children in each stage of the game development process.

Initial Exploration of Work

This stage involves developers meeting with users to understand their work environment that includes learning about the technologies they use, as well as their work procedures, routines, teamwork, and other aspects of their work context (Spinuzzi, 2005). This project was centered on redesigning local games played by children, adapting them for a new platform accessible via mobile devices. To capture a broad perspective, schools from both rural and urban areas were included in the study. Data collection on the local games to be digitalized was conducted in six schools across the Dar es Salaam, Dodoma, and Morogoro regions, selecting two schools from each region on a convenience basis. In total, 14 teachers participated in the study, contributing their insights on how games can enhance teaching and learning.

To identify the local games played by pupils, Focus Group Discussions (FGDs) were conducted with groups of 6-8 pupils in each of the six schools, resulting in a total of 42 participating pupils across all regions. This approach aligns with Krueger's (1994) recommendation that groups of 5-7 participants are optimal for in-depth discussions. FGDs were chosen as the methodological approach because they are effective in gathering pupils' ideas for product development through conversational techniques (Iversen and Brodersen, 2008). Details of the number of teachers and pupils involved from the three selected regions is summarized in Table 1.

Table 1

Number of respondents participated in an understanding of local games

No	*Region*	*No of teachers*	*No of pupils FGDs*
	1 Dodoma	*5*	*14*
	2 Dar es Salaam	*5*	*16*
	3 Morogoro	*4*	*12*
	TATOL	***14***	***42***

In the FGDs, pupils were asked to describe the games they commonly played at home and during school break times. To ensure clear and informative responses, teachers assisted in selecting pupils who were articulate and could provide detailed explanations. There were instances where the game mechanics were not immediately clear to the developers from the pupils' verbal descriptions. To address this challenge, pupils were asked to physically demonstrate the games they played. These demonstrations were recorded by the developers for further analysis and understanding. An example of this can be seen in Figure 1, which shows a pupil demonstrating how the ruka kamba game is played.

Figure 1

A picture of pupil playing ruka Kamba

A total of 11 games were identified and found to have the potential to be redesigned into digital form. Table 2 shows a list of identified local games from various schools.

Table 2

A list of identified local games in three regions

No	*Swahili names*	*English name*
1	*"kukimbizana", "kidali", Kidali cha juu"*	*Last tag*
2	*"Mduara", "Ukuti" "Kikoo"*	*Dancing in a Circle*
3	*"Kula mbakishie baba"*	*Don't drop the stick*
4	*"Kombola" "kujifisha"*	*Hide-and-seek*
5	*"Kuruka kamba"*	*Jumping rope*
6	*"Marede"*	*Filling the bottle*
7	*"Danadana"*	*Football*
8	*"Kuendesha magari ya miti/ udongo"*	*Toy cars*
9	*"Kujipikilisha"*	*Cooking*
10	*"Kubembea"*	*Seesaw*
11	*"Manati"*	*Slingshot*

Discovery Processes

During the discovery processes stage, as outlined by Spinuzzi (2005), designers and users collaborate using various methods to understand work organization and envision future applications. In this specific study, the development process involved 15 pupils and 4 teachers from two schools in Dar es Salaam. This choice was made to simplify logistics, as involving participants from Dodoma and Morogoro was challenging due to distance and time constraints. The development team scheduled meetings every Friday to review progress and gather additional input from pupils and teachers.

The initial phase of development focused on identifying games suitable for digital adaptation on mobile devices, emphasizing the content and skills each game would target, as advised by (Plass *et al.*, 2015). This step involved determining the subject matter each game would teach, a critical factor influencing all major elements of game design (Moser, 2013; Plass *et al.*, 2015). It was decided that each game should focus on a single content and skill area. Through discussions with pupils and teachers, priority was given to games that would enhance number identification and counting skills.

Out of the 11 games identified, three games – kombolela, kuruka kamba, and manati – met these criteria and were selected for digital redesign. The game requirements were defined through user stories created collaboratively by teachers, pupils, and developers. Pupils described how the games were played, which

was then translated into user stories by the team. Teachers ensured that the game content was aligned with the Tanzanian curriculum and pedagogically effective. It was agreed that each game would feature three learning levels of increasing difficulty, with players required to complete five activities at each level before advancing. To progress to the next level, players needed to score more than 50% of the allocated marks. The activities within each level were set to be random.

Prototyping

The development process adopted a prototyping approach, with weekly sessions involving pupils and teachers to discuss progress, test the developed games, and provide feedback for further enhancements. This method was particularly beneficial as it provided a tangible means for children to express their ideas, overcoming communication challenges between children and adults (Druin, 2002). Adhering to the game design elements for learning outlined by Plass *et al.*, (2015), the development emphasized incorporating key components such as game mechanics, visual aesthetics, narrative, incentives, musical score, and the integration of content and skills. Once the requirement was known and prepared through user stories, the development of the first prototype was conducted.

Once a prototype was ready, pupils and teachers were invited to the lab for testing and to provide additional feedback for improvement. Each participant was given a tablet for approximately three hours to assess if the games aligned with the user stories. The team closely monitored for playability issues and assigned severity ratings to any critical incidents observed. After each session, two separate FGDs were conducted – one with pupils and another with teachers. This separation ensured that pupils could freely offer their valuable insights about the games. The FGDs with teachers were instrumental in ensuring that the games aligned with the Tanzanian curriculum's competencies and skills, and were pedagogically effective. Figure 2 illustrates pupils engaged in testing the games.

Figure 2

Pupils testing games at the development lab

The suggested improvements from the feedback sessions were carefully documented and then reviewed with both children and teachers. The development team assessed the required effort and time to implement these improvements. Following this, they integrated the changes, resulting in a new version of each game. This cycle of iterative development and testing was applied to all three games, with each iteration bringing the games closer to completion, based on the diminishing number of comments and suggestions from users.

Specifically, the ruka kamba game required three iterations, while kombolela needed four iterations before no further user feedback was provided. In contrast, the manati game, despite requiring more coding time, reached its final version after just two iterations. The finalized versions of the ruka kamba, manati, and kombolela games are displayed in Figures 3, 4, and 5, respectively. This process of iterative development, followed by regular testing sessions, was key to refining each game until a finished product was achieved.

Figure 3

A ruka kamba game

Figure 4

A manati game

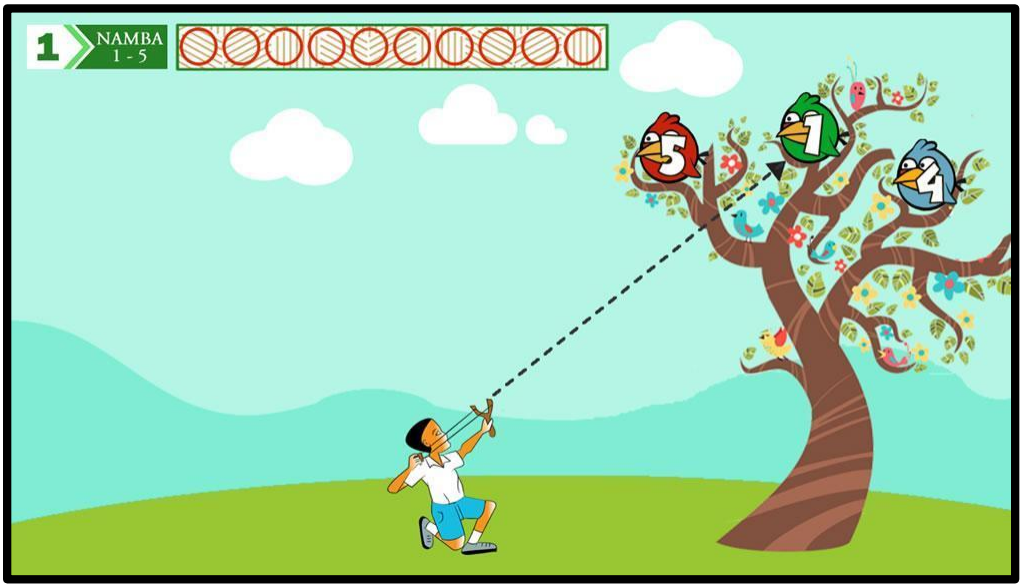
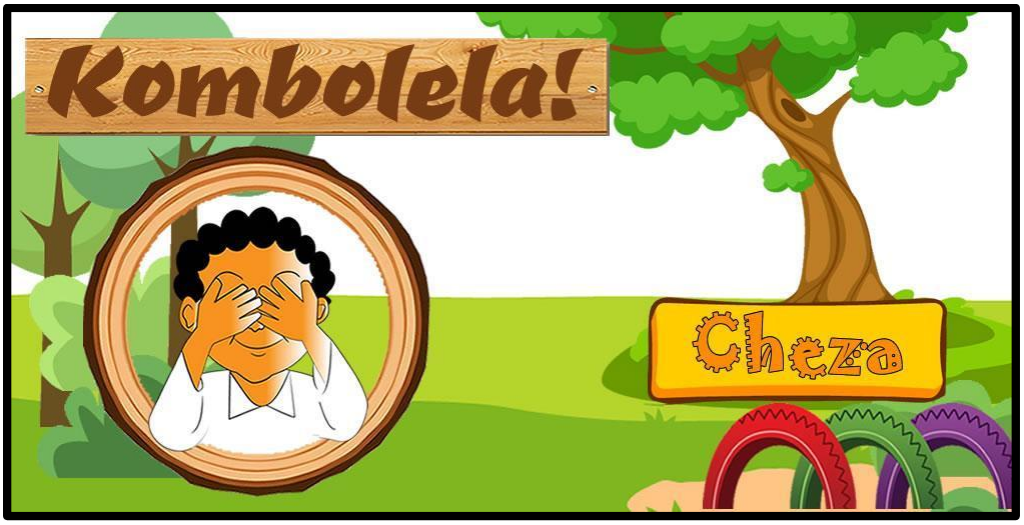


Figure 5

A kombolela game



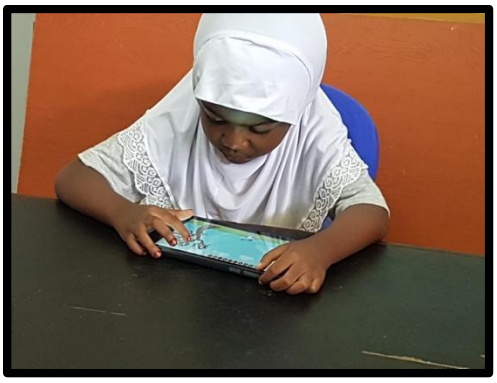
Results

Pedagogical Effectiveness

The effectiveness of whether the developed games effectively enhanced pupil learning based on the proposed knowledge skills: number identification or counting skills was evaluated through Pre-Test and Post-Test evaluation. The assessment process was structured so that each week, a group of 25 pupils from one school in a specific region received tablets to test the games. This process was then repeated with pupils from other regions: Dar es Salaam, Morogoro, and Dodoma, ensuring that a total of 75 pupils had the opportunity to test the games over a period of 3 weeks. Figure 6 shows a pupil playing a game in one of the schools in Dodoma.

Figure 6

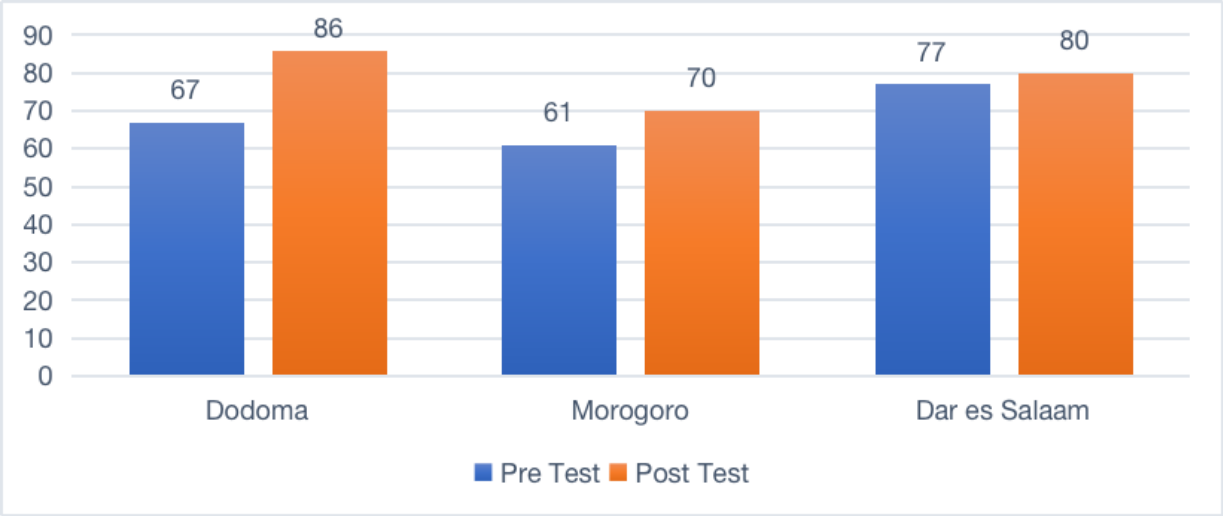
A Pupil playing a manati game during testing



To conduct this evaluation, a paper-based test comprising six questions was administered under the supervision of teachers before the pupils were given tablets to play the games for 5 hours. Upon completing all the activities, the pupils were given the same paper-based test again, and their results were compared. The comparison revealed a significant increase in scores: the average score in the pre-test was 53.89%, which rose to 91.55% in the post-test. This substantial improvement highlights the effectiveness of the developed games in enhancing numeracy skills. Figure 13 shows the results of the pre-test and post-test evaluations across the three schools involved.

Figure 7

Pre-test and post-test evaluation results for 3 schools.



Assessing Ease of Use

Research indicates that when digital games for learning are difficult to use, users tend to spend excessive time learning how to use it rather than actually utilizing the content itself (Ardito *et al.*, 2006). To gauge pupils' perceptions of the ease of use of the developed content, they were asked to rate the digital games on a 5-point Likert Scale, ranging from 1 (Very Difficult) to 5 (Very Easy). Out of the 75 pupils who responded to the questionnaire, a significant majority found the games very easy to play with 53% from Morogoro, 62% from Dodoma, and 75% from Dar es Salaam rating it as such. In terms of specific games, the majority of pupils ranked Kombolela (43%), Manati (76%) and Ruka Kamba (61%) in order as the easiest game to play.

Fun and Enjoyment

Children were also asked to determine their level of enjoyment and perception of fun regarding the three developed games, using a 5-point Likert Scale that ranged from 1 (Strongly Disagree) to 5 (Strongly Agree). The results indicated that a substantial majority of pupils found the developed games were enjoyable and fun, with 50% from Dodoma, 63% from Dar es Salaam, and 25% from Morogoro indicating they Strongly Agreed with this sentiment. On the other hand, a minority of pupils, comprising 11% each from Dodoma and Dar es Salaam, Strongly Disagreed, suggesting they did not find the digital games fun or enjoyable. For specific games, many children rated Kombolela (63%), Manati (56%), and Ruka Kamba (42%) in order as the most fun and enjoyable games.

Discussion

The growth of digital games for learning has increased significantly in the last few years and has shown to enhance students' learning motivation and performance across various educational subjects. However, developing these games for children in developing countries poses challenges, particularly when the children are not involved in the development process. This lack of involvement can lead to cultural and educational mismatches, and having games that are irrelevant and ineffective (Kam *et al.*, 2009; Voulgari *et al.*, 2020; Yanaze and Malheiro, 2022).

This study adopted a participatory design approach in developing digital games aiming at improving numeracy skills among Tanzanian children. Involving a significant number of participants, including 42 pupils and 14 teachers from three regions, both urban and rural, this

approach ensured the incorporation of a wide range of cultural and educational perspectives. The inclusion of such a diverse group of end-users in the design process was key to creating game designs that were not only culturally relevant but also aligned with the varied educational needs across different regions. This was supported by the insights and experiences of participants including Druin (2002) and Kam *et al.,* (2006), who have emphasized the importance of user involvement in educational technology design.

The findings from this work significantly highlight the effectiveness of participatory design in developing digital games that is not only engaging but also culturally relevant and tailored to learners' environments. This is consistent with Kam *et al.* (2006) findings, where games designed participatory for rural Indian children resulted in higher engagement and learning outcomes due to their cultural and contextual alignment. Similarly, Yanaze and Malheiro (2022) and Voulgari *et al.,* (2020) work emphasizes the necessity of incorporating local context in educational technology design in Africa, affirming the Tanzanian study's approach of digitalizing local games to ensure cultural relevance and acceptance.

Although participatory design approach was successfully applied in the development of digital games, they face challenges such as logistical constraints, technological barriers, and the need to align with educational curricula posed a great challenge. For instance, coordinating the involvement of pupils from varied locations: Morogoro and Dodoma presented logistical difficulties. Additionally, ensuring that the game content aligns with the existing primary education curriculum was challenging. These issues underscore the complexities of implementing participatory design in diverse geographical and infrastructural contexts, as well as the necessity for alignment with national educational standards (Kam *et al.,* 2006).

In conclusion, this study contributes valuable insights to the field of educational technology in developing countries, showcasing the effectiveness of participatory design in creating digital learning tools. It reinforces the importance of user involvement in the design process, particularly in contexts where cultural sensitivity and curriculum alignment are crucial (Kam *et al.,* 2006; Voulgari *et al.,* 2020). The project's success serves as a template for future initiatives aiming to integrate digital learning into educational systems in similar environments, emphasizing the potential of participatory design to create impactful and contextually relevant educational resources.

Conclusion

The study demonstrates the effectiveness and challenges of participatory design in developing digital games by involving local children and teachers, it ensures cultural relevance and educational value, enhancing numeracy skills. However, logistical and technological challenges, and the need for curriculum alignment pose significant challenges, particularly in coordinating diverse geographical participation. This underscores the complexity and potential of participatory design in developing contextually appropriate educational tools.

Despite the findings from this study, suggestions for future research are worth mentioning. First, future research should consider extending the participatory design approach to include many regions and could even include pupils and teachers from other countries. Such expansion would not only enhance the representativeness of the study but also offer valuable insights from different cultural and educational backgrounds. Moreover, diversifying the subject matter of the games beyond numeracy to include other key subject areas such as science and language arts could significantly broaden the scope providing a more varied learning experience for students.

Second, undertaking longitudinal studies to evaluate the effects of the developed game on student outcomes would be invaluable. Such studies would offer in-depth understanding of how these games influence academic performance and student engagement over an extended period. This approach would not only shed light on the sustained effectiveness of games for learning methods but also help in identifying long-term trends and impacts. Finally, future initiatives should explore incorporating cutting-edge features such as artificial intelligence (AI)

and machine learning to tailor and enhance the learning experience. Equally important is the need to ensure that these games are accessible to pupils in remote areas by developing versions of the games that require low bandwidth or can function offline.

References

Adedigba, O. (2023). Enhancing numeracy instruction through games in pre-primary classrooms. *Journal Of Teaching And Learning In Elementary Education*, *6*(1), 96. https://doi.org/10.33578/jtlee.v6i1.7984

Alaoui, Y., Belahbib, A., El Achaak, L., & Bouhorma, M. (2020). Unified Process to Design and Develop Serious Games for Schoolchildren. *Proceedings of the 3rd International Conference on Networking, Information Systems & Security*, 1–8. https://doi.org/10.1145/3386723.3387831

Beilock, S. L., Gunderson, E. A., Ramirez, G., & Levine, S. C. (2010). Female teachers' math anxiety affects girls' math achievement. *Proceedings of the National Academy of Sciences*, *107*(5), 1860–1863. https://doi.org/10.1073/pnas.0910967107

Bell, A., & Davis, K. (2016). Learning through Participatory Design: Designing Digital Badges for and with Teens. *Proceedings of the The 15th International Conference on Interaction Design and Children*, 218–229. https://doi.org/10.1145/2930674.2930705

Byrne, E., & Sahay, S. (2007). Participatory design for social development: A South African case study on community-based health information systems. *Information Technology for Development*, *13*(1), 71–94. https://doi.org/10.1002/itdj.20052

Druin, A. (2002). The role of children in the design of new technology. *Behaviour & Information Technology*, *21*(1), 1–25. https://doi.org/10.1080/01449290110108659

Duh, H. B.-L., Yew Yee, S. L. C., Gu, Y. X., & Chen, V. H.-H. (2010). A narrative-driven design approach for casual games with children. *Proceedings of the 5th ACM SIGGRAPH Symposium on Video Games*, 19–24. https://doi.org/10.1145/1836135.1836138

Frauenberger, C., Good, J., & Keay-Bright, W. (2011). Designing technology for children with special needs: Bridging perspectives through participatory design. *CoDesign*, *7*(1), 1–28. https://doi.org/10.1080/15710882.2011.587013

Granic, I., Lobel, A., & Engels, R. C. M. E. (2014). The benefits of playing video games. *American Psychologist*, *69*(1), 66–78. https://doi.org/10.1037/a0034857

Hermita, N., Alim, J. A., Putra, Z. H., Gusti, P. M., Wijaya, T. T., & Pereira, J. (2021). Designing interactive games for improving elementary school students' number sense. *Al-Jabar : Jurnal Pendidikan Matematika*, *12*(2), 413–426. https://doi.org/10.24042/ajpm.v12i2.9983

Hussain, S. (2010). Empowering marginalised children in developing countries through participatory design processes. *CoDesign*, *6*(2), 99–117. https://doi.org/10.1080/15710882.2010.499467

Iversen, O. S., & Brodersen, C. (2008). Building a BRIDGE between children and users: A socio-cultural approach to child–computer interaction. *Cognition, Technology & Work*, *10*(2), 83–93. https://doi.org/10.1007/s10111-007-0064-1

Kam, M., Mathur, A., Kumar, A., & Canny, J. (2009). Designing digital games for rural children: A study of traditional village games in India. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 31–40. https://doi.org/10.1145/1518701.1518707

Kam, M., Ramachandran, D., Raghavan, A., Chiu, J., Sahni, U., & Canny, J. (2006). Practical considerations for participatory design with rural school children in underdeveloped regions: Early reflections from the field. *Proceedings of*

the 2006 Conference on Interaction Design and Children, 25–32. https://doi.org/10.1145/1139073.1139085

Lamichhane, D. R., & Read, J. C. (2020). Play It My Way: Participatory Mobile Game Design with Children in Rural Nepal. In P.-L. P. Rau (Ed.), *Cross-Cultural Design. User Experience of Products, Services, and Intelligent Environments* (Vol. 12192, pp. 325–336). Springer International Publishing. https://doi.org/10.1007/978-3-030-49788-0_24

Malamsha, M. P., Sauli, E., & Luhanga, E. T. (2021). Development and Validation of a Mobile Game for Culturally Sensitive Child Sexual Abuse Prevention Education in Tanzania: Mixed Methods Study. *JMIR Serious Games*, *9*(4), e30350. https://doi.org/10.2196/30350

Melonio, A. (2016). *Participatory Game design and Children*. https://doi.org/10.13140/RG.2.1.1939.0320

Moser, C. (2013). Child-centered game development (CCGD): Developing games with children at school. *Personal and Ubiquitous Computing*, *17*(8), 1647–1661. https://doi.org/10.1007/s00779-012-0528-z

Nolan, J., & McBride, M. (2014). Beyond gamification: Reconceptualizing game-based learning in early childhood environments. *Information, Communication & Society*, *17*(5), 594–608. https://doi.org/10.1080/1369118X.2013.808365

Ojanen, E., Ronimus, M., Ahonen, T., Chansa-Kabali, T., February, P., Jere-Folotiya, J., Kauppinen, K.-P., Ketonen, R., Ngorosho, D., PitkÃ¤nen, M., Puhakka, S., Sampa, F., Walubita, G., Yalukanda, C., Pugh, K., Richardson, U., Serpell, R., & Lyytinen, H. (2015). GraphoGame â€“ a catalyst for multi-level promotion of literacy in diverse contexts. *Frontiers in Psychology*, *6*. https://doi.org/10.3389/fpsyg.2015.00671

Ongoro, C. A., & Mwangoka, J. (2014). Using Game-Based approach to enhance language learning for preschoolers in Tanzania. *Proceedings of the 2nd Pan African International Conference on Science, Computing and Telecommunications (PACT 2014)*, 121–126. https://doi.org/10.1109/SCAT.2014.7055145

Oyugi, C., Nocera, J. A., Dunckley, L., & Dray, S. M. (2008). The challenges for participatory design in the developing world. *Tenth Conference on Participatory Design*, 295–296.

Papastergiou, M. (2009). Exploring the potential of computer and video games for health and physical education: A literature review. *Computers & Education*, *53*(3), 603–622. https://doi.org/10.1016/j.compedu.2009.04.001

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

Porcino, T., Trevisan, D., Clua, E., Rodrigues, M., & Barbosa, D. (2015). A Participatory Approach for Game Design to Support the Learning and Communication of Autistic Children. In K. Chorianopoulos, M. Divitini, J. Baalsrud Hauge, L. Jaccheri, & R. Malaka (Eds.), *Entertainment Computing – ICEC 2015* (Vol. 9353, pp. 17–31). Springer International Publishing. https://doi.org/10.1007/978-3-319-24589-8_2

Sims, T. (2018). Participatory design of healthcare technology with children. *International Journal of Health Care Quality Assurance*, *31*(1), 20–27. https://doi.org/10.1108/IJHCQA-11-2016-0162

Spinuzzi, C. (2005). The Methodology of Participatory Design. *Technical Communication*, *52*(2), 163–174.

Voulgari, I., Vouvousira, S., & Fakou, A. (2020). A Game about our Neighbourhood: A Case Study of Participatory Game Design with Pre-school Children. *International Conference on the Foundations of Digital Games*, 1–5. https://doi.org/10.1145/3402942.34096

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Wakil, N., & Dalsgaard, P. (2013). A Scandinavian Approach to Designing with Children in a Developing Country—Exploring the Applicability of Participatory Methods. In P. Kotzé, G. Marsden, G. Lindgaard, J. Wesson, & M. Winckler (Eds.), *Human-Computer Interaction – INTERACT 2013* (Vol. 8117, pp. 754–761). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-40483-2_53

Wouters, P., Van Nimwegen, C., Van Oostendorp, H., & Van Der Spek, E. D. (2013). A meta-analysis of the cognitive and motivational effects of serious games. *Journal of Educational Psychology*, *105*(2), 249–265. https://doi.org/10.1037/a0031311

Yanaze, L. K. H., & Malheiro, C. A. L. (2022). GAMES EDUCACIONAIS ACESSÍVEIS: Estruturação e práticas investigativas. *TICs & EaD Em Foco*, *8*(2), 170–184. https://doi.org/10.18817/ticseademfoco.v8i2.634