Sense-Making of Digital Game Technologies (DGT): Positive Instances of Children-Led Engagement With Chess

Malola Prasath Thittanimuttam Sundaramadhavan[1,2], Luis Blasco De la Cruz[3], Astrid Barbier[3], Sharon Whatley[4], Muthu Kumar Narayan[6], Delgerzaya Bayaraa[7], Tamer Karaketin[7], Mustaffa Megrahi[5] and Humberto Enrique Gutiérrez Rivas[8,9]

[1]Foundation for Learning Research in Chess, Chennai, India
[2]ENHANCE Institute of Chess Excellence
[3]Madrid Chess Academy, Spain
[4]Gibraltar Chess Academy, UK
[5]AtlantisTraining and Consultancy, Cardiff, UK
[6]Intellect Arena, Chennai, India
[7]Ut Tsai School, Mongolia
[8]Universidad de Carabobo UC,
[9]Universidad Nacional Abierta, UNCA, Venezuela

FLRinChess@gmail.com
luisblasco@madridchessacademy.com
Barbier.Astrid@gmail.com
Sharon.whatley@icloud.com
Nmuthu26@yahoo.com
Delgerzaya.b@gmail.com
Tamerkaraketin @gmail.com
Mmegrahi@yahoo.com
Navegante77@gmail.com

Abstract: The Game of Chess, a drosophila of reasoning, is a unique opportunity for nurturing children into systemic thinking approaches that naturally embrace the higher-order thinking skills required for STEM aspiration. In this paper, we conceptualise chess from a digital game technology perspective to nurture a rich system thinking experience and illustrate the various attempts to introduce a digitally immersive classroom experience for children using a generation of digital chess infrastructure. We continue to illustrate a few positive hands-on experiences of deploying generations of digital chess infrastructure for group learning in the classroom environment for nurturing both the learning and the social imagination of children working together to expand their quest for chess. We examined what brought the attention, advocacy, and achievement to build an agency for chess. With no prior value claim existing for the advocacy of technology deployment with chess in classrooms, the present framework shows how the attention to chess is progressively enriched. Further, the positive instances of children-led engagements demonstrate the goal of steadily integrating digitally immersive chess experiences into classroom learning environments. We make sense of the social imagination of classrooms and make in-vivo observation on children-led empowerment, shared aspiration, competency building and the evolution of contemporary practices in chess leading to the agency for chess. We conclude that a transformative opportunity exists through deploying a digitally immersive chess environment within the classroom for nurturing systemic thinking in children with chess.

Keywords: Chess, Chess in school, System thinking, Digital game technologies, Social imagination, Bridging.

1. Introduction

Chess has always been a sensation and universal appeal to mass media, whether it comes to Chess games relayed from Trans-Atlantic cables matches in 1861, chess played during the Space-mission in 1970 or Najdorf's blind-folded simultaneous in Argentina 1944 reaching the news media in Europe in the heart of World War II. During the Information Age, inventors and pioneers of technology turned to their chess wisdom to appreciate the knowledge representation and gain deeper insights into scientific, mathematical, economics, engineering, and technology fields. . The very nature of the digital representation of Chess embedded within a perfect zero-sum game and the applied nature of formulation of massively sprawling game trees and evaluations encapsulate scientific, technology, engineering, and mathematics (STEM) principles. The achievement of general-purpose computing expanding the trade-off in memory vs. search and its enabling technologies have continued to thrive with artificial intelligence (AI), Cognitive Architectures, and Information Communication Technologies that have all become the foundations of today's technology-integrated society.

Further, with extraordinary achievements coming with children from early teens, and international federation efforts to popularise chess for children, as a global movement for securing the future of chess, there has fundamental shift to relating Chess and its social opportunity to classroom pedagogies. The Game of Chess, a drosophila of reasoning, is a unique opportunity for nurturing children into systemic thinking approaches that naturally embrace the higher-order thinking skills required for STEM aspiration. However, Vuk (2022) recognise the clear exclusion of chess in both pre-collegiate and higher education and continues to highlight missing romantic links between Chess and Natural science in the context of developing lessons in creativity for students to unleash various analogies that consistently illustrate sporadically with positions from real-life chess games. Simon and Chase (1997) brought the interest in nurturing cognitive architectures and chess engines with powerful AI-based search engine technologies to explore bounded rationality and expand the limits of human cognition. However, in reality, a core perspective that is least considered in chess is the deeper understanding of the goal-based approach to chess that nurtures systemic thinking. Kasparov (2010) in his epic best-seller How Life Imitates Chess limits the contextual dynamics of the Material-Time and Quality factors to drive the systemic dynamics within the game of chess. However, the Last three decades have spawned with Computer-assisted Game Preparation, after the class of AI technologies has long surpassed human gaming abilities in chess. Further, it is important to consider the sophistication of the combination of such *digital attributes* with *seamless technologies* that combine within the realms of gaming to bring a true and immersive learning experience that is collectively appreciated in the context of chess within classroom settings.

Fisher DM and the Systems Thinking Association (2023) claim that the sequence of system thinking concepts and capacity building are appropriate to the very start of education processes and throughout K-12 education. The ability to understand systems, predict their behaviours, and devise modifications to them to produce desired effects are all within the realm of gaming experience with chess that can now grow as a part of classroom processes. Fisher and the Systems Thinking Association (2023) further recognise systemic thinking skills should help children be able to analyze the systems around them. The opportunity of gaming in chess can offer a systemic model for merely driving a highly distributed simulation experience and identification of thoughts and choices that align with consistent ways of doing things. With Chess, Scaling up with serious digitally pervasive infrastructure provides a unique opportunity to relook at the classroom ecosystem for digital, game, and technology integration for nurturing children-led aspirations.

Edwards (2013) examines the wider context of integrating technologies with digital games for play-based pedagogies within early childhood curriculum. Lai et al (2014) focus on adding social Elements to Game-Based Learning whilst Abdul Jabbar & Felicia (2015) popularly review game-design feature engagement for facilitating Social Engagement and learning. Nikiforidou (2018) focuses on tailoring practice within the early childhood classroom. Najmeh et al. (2020) discuss the implications of children-centred aspects of health, participation, and contextual engagement for digital gaming experience with the combination of embodiment, active learning, entertainment, and fun. O'Rourke et al (2017) bring insights into commercially available for primary school children digital game technology within classroom applications that are consistent in delivering the fluency of concepts and performance. All, Nunez Castellar and Van Looy (2016) develop an elaborate framework assessing the best practices within digital games to reinforce the understanding of what entails brings performance. In stark contrast, Lai et al (2014) observations on including social actions intervention-type projects have the advantage of being children-led. Georgios et al (2023) explore a complex understanding of playful interventions for sustainability awareness in educational environments. Jie et al. (2020) expand the context of a welfare model to support young people from online Cyber victimization to loneliness and neglect with online digital games. These contexts are useful to be measured across classroom environments with game-based learning approaches.

First, the opportunity to actively scale the outreach of chess far exceeds the notion of exploring the domain knowledge of chess within a rationale of delivering unique learning experiences. The second opportunity however is passively accumulating the gaming experiences that demonstrate an evolution of a playing style that in turn nurtures system thinking experience. Thus, it is of paramount importance to motivate the paradigm of Digital-Game-Technologies within the context of an immersive classroom setting and understand goal-based learning behaviours.

This paradigm delves into exploring four questions on what works within such immersive settings:

1. How do Digital Game Technologies in chess translate to systemic thinking in classroom settings?
2. How do generations of Digital-Game-Technologies-led products shape, organise, and scale classroom participation?

3. How do Digital Game Technologies vary utility from simple digital chess equipment engagement to dynamically configurable adaptive Chess Computers within an immersive classroom setting?
4. How does the communication emerge around the participants and how it is nurtured through an empowering leadership context?

Thus, it is important to examine and illustrate the various positive scenarios to introduce digitally immersive experiences with a generation of digital game technologies for explaining the socio-imagination, usability, and scalability of children-led processes.

2. Settings the Broad Context of Digital Experience with Chess:

The modernizing effort in gaming came with the Digital Chess clock, where Fischer proposed an incremental clock and Bronstein presented a delayed clock to an electronically controlled system of timekeeping to build the first generation of Digital-Game-Technology products into chess. Equally, the sensation of the Internet, the evolution of chess engines and broadcasting technologies, and the adaptation of chess to the internet brought technologies up to date for chess gaining universal access. The context of the triple point of *digital, game, and technology* experience within the constraints of the classroom settings progressively explains the socio-personal contexts of self-motivation, skill-building, co-located engagement, and independent learning and group engagement activities for building systemic advocacy to chess from conventional classrooms to digital immersive space like online, blended and co-located learning environments.

2.1 Context of Gaming Experience: Digital Immersion

Although Chess has reinvented itself into the realms of online gaming and e-sports, the full potential of the *digitally immersive Chess experience* is relatively less explored both within the context of today's available technologies and possible applications within gamification (Chessity.com, 2018). The goal of organising the understanding of systemic thinking in the context of game-based learning is exploited with the understanding of the context of digital for a game of chess. Thus, the deployment of digital technologies for chess has to deliver these multiple utilities in addition to enabling a fair and equitable environment in classrooms. Further, the context of children's engagements within educational settings is expressed in terms of the generation of technologies used with an increasing level of sophistication and computation intensity from a piece of simple digital equipment used for playing, time-keeping, and broadcasting which are passive intelligent systems, to more adaptive Learning systems offering the seamless integration with human perception and machine intelligence.

A conceptual framework evolved with the help of the literature survey is illustrated in Figure 1.

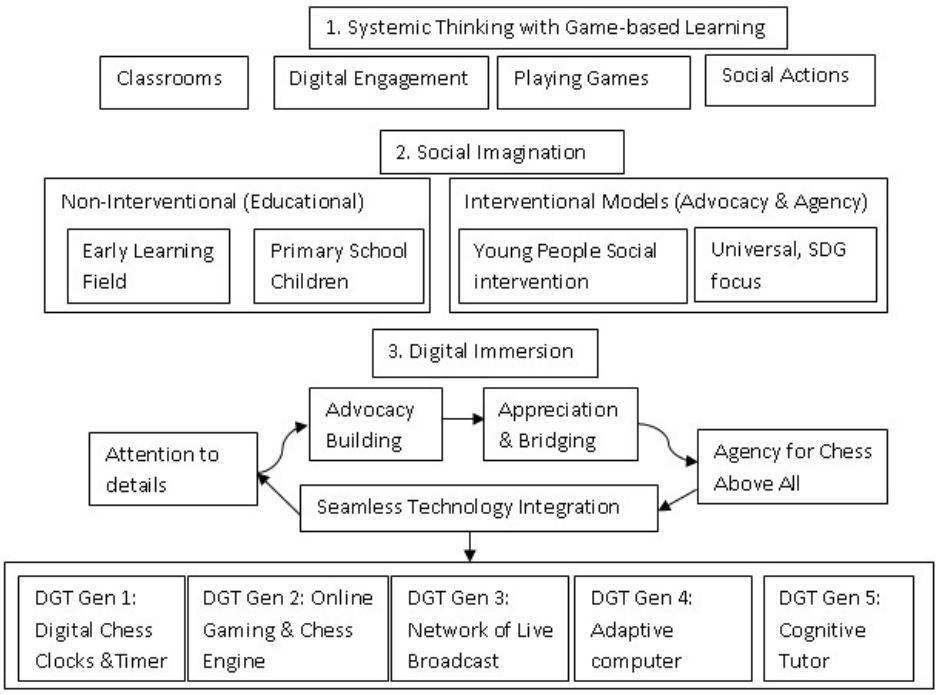

Figure 1: Systemic Inputs for the Digital Immersive Learning Environment

2.2 The Digital Touch for Enhancing Chess Experience

Chess is categorically cast as a mind game, yet Chess pieces selfdom move by themselves on the board. You need the engagement of players to move the pieces around the chess board. This demonstrates a temperament to control the board with the turn-based game with the attempt to shift the equilibrium of each move with the dynamics of play. Although, the game of chess itself is a perfect zero-sum game and has no uncertainty. The digital ways determine the shifting of these dynamic factors more accurately than human perception of the chess position. There is so much computing power in today's chess engine that it surpasses the human ability to accurately arrive at an evaluation based on a forced sequence of moves. Whilst Chess players rely on experience and familiarity in handling the position, computers have better AI searches to summarise move generation. Thus, new opportunities emerge to digitally search through millions of positions and index them with accurate evaluations. Whilst touch is very much the controlled experience in gaming and builds the proactive nature of the Chess experience, the digital touch means the opportunity to unlock and reveal the insight of gaming with AI and Generative AI technologies or it may even amount to impatience to simply look at computer-generated moves for the possibility of right move generation to deepen the opportunity in the position. However, the generation of digital products gives a thoroughly transforming experience through better control and seamless sifting experience across the chess board, computationally exhaustive game trees, automated move and plan generation, and accurate and precision of clock times. Thus exclusive and exhaustive knowledge of chess is reduced to a few impatient clicks on a mouse button with the use of a chess engine on one end. On the other end, chess players have already turned to the effective use of artificial intelligence (AI) for the positive agency for both authoritative and co-creation experiences to direct learning and evaluation of chess position that progressively deepens the understanding. Thus, it increasingly provides opportunity for children and young people to use online, digital equipment, with or without AI-built-in capacity.

2.3 Tangible Gain to Digitally Immersive Classroom Experience

It is of paramount importance to understand that the immersive experience with chess aims to provide a complementary experience of mainstream education and fundamental belief. This is from a rationale that children have prior experience and understanding of the classroom ethos. In such a context, the introduction of the first contact programme for chess and the subsequent opportunity to take the outcome and learning to a whole classroom or whole school is an interesting idea to conceive, however, it is difficult to pursue with rigour. To close this loop, the social imagination of the classroom is considered with engagement across the early-year programme, primary school programme, and young people's engagement in the context of social actions in learning and sharing.

Further social imagination is enriched by expanding access to co-located environments to encourage and nurture both physical outreach and co-located learning. It is also important to understand how they translate this experience back into mainstream education and conserve their agency for digital game technologies. This will start to demonstrate leadership in children and shape how they start to communicate their approach to breaking down complexity, problem-solving, goal-driven development, and systemic thinking.

2.4 Accessibility, Engagement, and Limiting Cases

The response to digitally immersive experiences for people with sensory impairment is fairly straightforward with chess, as reasonable adjustments are available for blind and visually impaired people and deaf-blind communities with the help of adaptive boards.

Further, the inclusive aspect of chess can be harnessed well, if the immersive environments can be understood well and the participation of children and young people from such socially disadvantaged communities can all be carefully integrated without losing their qualities and inequalities.

An immersive experience with chess may additionally offer a therapeutic experience. However, the challenge is continually engaging children's cognitive abilities and masking the disruptive behaviour problems that can disengage them from the classroom.

3. Method

In this paper, a mixed methodology is employed to develop a contextual framework for understanding the top-down approach to deploying digital game technology to achieve engagement goal-driven development. Systemic thinking nurtured an immersive learning environment and social imagination within chess. The emphasis on *what is collectively recognised* as the utility value of the infrastructure in both personal and

shared classroom space will be triangulated based on the 4 research questions that progressively help to understand and construct the digital experience.

A set of the first 6 progressive case studies is examined to understand a divergent view of individual learning experience within a collective and inclusive classroom environment. All the case studies will have a component of *Study by watching, playing games, and Problem-solving as activities as* a bottom-up approach to demonstrate how children collectively harness the access to digital immersive experience and build fluency within the digitally immersive classroom settings. Case study 7 integrates the co-located peer learners both physically and by sharing videos and notes of hands-on work to further feed the social actions and reinforce the group engagement. This strengthens the agency and advocacy for chess as the visitor. Case study 8 integrated the proxy of learners, facilitators, and organisers to observe and report on broadening the impact, scale, and organisation within contemporary thematic programmes like children-friendly approaches, and children-led and women-led empowerment programmes.

An in-vivo observational methodology is employed to further synthesise the understanding of the digital immersion in the case studies to form an evolutionary step towards systemic thinking in the context of (a) advocating children-led activities (b) driving an agency for game-based learning and (c) fluency building and (d) reciprocal interest generating activities to progressively build a *Digitally Immersive Chess Experience*.

4. Results

The activities and outcomes from case studies reporting from various geographical locations are consolidated to understand the context of continuous engagement with chess and its utility value to classroom participation and collective learning as an output.

Case 1 – Mongolian Chess in Schools Aspiration: A unique effort to conserve the international exposure and agency of Mongolian school children who have achieved medals in Asian and World Cadet Championships and within the in Ut-Tsai school programme. The school invested in professional chess assets to set up a SMART classroom to conserve the professional experience with the help of international chess trainers for the agency, a Deep-sea Chess programme for digital advocacy for problem-solving activities for Early-years, and established a zone of proximal development with chess prodigies and professionals. Children collectively maintained professional conduct.

Case 2 – Madrid Chess Academy & CASTLE for ADHD Children: Madrid Chess Academy setup a full professional chess academy with a permanent installation of DGT Live infrastructure to support an outreach with ERASMUS+ CASTLE Project delivering the primary school chess curriculum in Spain with an innovation for the whole-family engagement for children with special education needs. The project achieved a positive introduction to the Case-1 environment and support for the continuous participation of children with ADHD and Autism. Children build a desire to engage with Chess without behavioural issues.

Case 3 – Venezuela and Gibraltar run workshops for creativity education with chess and additionally run a programme especially to support Children with Special education needs. Both workshops were part of an international outreach programme with chess. The main difference is that Gibraltar used DGT Centaur, Adaptive-Chess-Computer, illuminated board within the FIDE Infinity Project Promotion, whereas the Venezuelan academic programme focused on using “PHIONICA-based Gaming Protocols” printed on a Delphi design Chess board. This provided a constructivist approach, enabling skill-mixing, in the context of aesthetics in chess. Children who were visually anchored to the chessboards were absorbed in the workshops.

Case 4 – Welsh Programme with Digital Chess Computer for facilitating children to *independently learn and transfer* activity to incrementally learn to build peer groups. Two DGT Centaur Adaptive-chess-computers were used, during the pandemic lockdown, and two groups were clustered within the community and within school groups, to engage in digital board experience with chess computers. A daisy chain is established to compare the approach with neighbourhood circles and friends in the school to strengthen curiosity and reciprocal thinking. Children communicated their aspirations well with their neighbours about their chess experience.

Case 5 – Problem-solving exercise with online learning for Indian children in the US and India run by Intellect Arena, India with collocated children. To expand a context of conscious, immersive experience online (in Zoom and LiChess.org server), Children with no prior exposure to chess were engaged to build a consistent chess etiquette with a simple paradigm "Learn-Immerse-Value-Engage". Although this focus on fluency and competitive building, the children's engagement was very stable, developed a complementary character, and focused on the transition from a beginner working out around 750 to 1000 exercises within 8 weeks and engaging in 100 games in 24 weeks.

Case 6– Children-led Bridging Experience: With an integration exercise of children, (Physical visit to India and sharing videos of hands-on experience classrooms in Sri Lanka) about self-discovery of DGT Centaur, a digital chess computer operating features, children powerfully self-organised and learn. Children's tendency to influence each other is more with the target group. Children naturally engaged in bridging activity by sharing their insight into exploring DGT centaur and seeing feedback on how others engaged with digital equipment. The Srilankan children continued to work among themselves intensely, 6 of 24 children qualified for the National Chess Championship within just 8 weeks of self-regulated learning and bringing extraordinary performance with chess.

Case 7– Application in an international context for an agency for Digitally Immersive Chess Experience: A women-led community outreach programme to engage digital chess experience, as a skill-building experience that can be transferred to a home country environment based on what works in the context of hands-on experience within an immersive chess festival. In contrast, the stockpile of innovation with digital chess assets in Srilankan schools is tried within the context of women-led for a capacity building programme for implementing a whole region approach as led by the Northern Province Education Department to swiftly replicate cases 4, 5, and 6 in a week to understand and observe the grassroots for the agency for chess. Opportunity connected communities in tandem and bring measurable insights for the advocacy of Women-in-technology for turning to these innovations with the potential to scale on engagement for heavily dispersed refuge communities in the South Asia region and the Southeast Asian region for the promotion of young leaders with an agency for digitally immersive technologies.

Theory of Change	Social Imagination	Digital Immersion	Programme Instances	Incubation/Transfer
(1) Systemic Thinking for Goal-Based Engagement	Young People in Isolation	(3)Social Intervention	**Mongolia/Spain:** Conserving International exposure with chess.	Chess infrastructure for etiquette building
Early Year Field	Children in Primary Schools	(4) Welfare Focus	**Gibraltar/Venezuela**: Drawing to digital immersive design workshops (SEN&D)	Holistic community participation and Immersive experience
(2) Advocacy – Education	(5) Social Action in the context of Classroom experience	(6) Sustainability (SDG4) led a programme for self-directed learning	**Welsh**: Children-led experience Pandemic Diary: Learning and Guideline	Etiquette: Self-discovering, independence & personalised interaction.
US/UK – South Asia & Thailand Cluster: Scalable Context for Women led Designing Safe-space for a social incubator for chess	**Gibraltar:** International Projects students & Women-led experience for Social Actions, and FIDE Infinity	**India/Sri Lanka:** Bridging experience through Children Led instigation & Children's Interaction led Instigation	**India/US**: Online Learning Group, Co-located Learning. (Fluency & Competency building)	Shared aspiration and determination in an immersive setting.
Agency and Reciprocal interest: Incubation supports scale and organisation	Advocacy building: Continuous Engagement	Appreciation: Bridging and Handholding Experience	Attention: Digital to Game(DG) and Technology to Game(GT)	(7)Seamless Integration Digital-Game-technology

Figure 2: Evolutionary Cycles of Digitally Immersive Chess Experience

5. Discussion

There are very few studies in chess seeking to bring an understanding of what *chess-playing children* bring to classroom ethos. The case studies bring a collective exercise for understanding the output of the classroom through proper etiquette building for children and shared incubation of ideas for self-discovering, independently engaging, and personalising the learning experience. The context of understanding Chess infrastructure has become visible in the context of deploying Digital-game-technology for holistic engagement. This offers a systemic engagement as opposed to isolating children based on a single policy intervention of nurturing their innate or acquired talent capital with chess. This was evident from both the extreme case of Mongolian and Madrid for how children regarding their intellectual ability built the agency for chess. This was

also consistent across Gibraltar and Venezuelan implementation when conventional chess boards were replaced with DGT Centaur and Delphi-design. Further, with the bridging case studies across the Diasporas in the UK, India, and Sri Lanka the reciprocal interest in using the DGT Centaur swiftly moved the interest in attending to details to strong performance for developing an agency for chess. Thus, the digital nature of the game of chess is revived within the context of socially immersive experiences for children and young people with seamless integration of digital game technologies. Further, the emerging perspectives of children-led thinking especially looking into the socio-cultural opportunity are interesting from the context of how chess can be seen as a game to grow with for nurturing systemic thinking. Thus, translating these intricate digital designs for harnessing classroom engagement is never-the-less an important convergence for system thinking that is increasingly used in STEM education as positioned by Vuk (2022).

6. Conclusion

The interplay between digital and technologies in the scope of game-based learning is intriguing from a point of transforming the aspiration of children working in such immersive classroom settings. Digital Game Technologies first offers the social imagination for children to progressively nurturing higher-order thinking through hands-on engagements that create an invisible aura for scaling the classroom experience beyond its obvious boundaries. Further, the progressive outputs of case studies bring a useful theory of change by gradually building from the context of positively introducing a digitally immersive chess experience to children-led development for progressively nurturing systemic thinking. The novel implementations built around positive instances of harnessing *digital immersion in classrooms* for purpose build exposure in a social context to develop concept, fluency, and reciprocal learning experience in chess and provide a *Seamless technology-immersive* space for observing children's shared learning environment. The case studies allow insights into what works in the realm of children-led processes that can be contextually scaled without Socio-cultural-economic and geographical barriers.

Whilst, it is still unclear how a holistic engagement alone is sufficient for self-discovery and participation within the immersive setting, as these case study outputs only point to the feasibility of positive hands-on engagement. However, chess in school aspirations need not be delivered so painfully by exerting pressure on the children's curriculum time. Instead, chess can be incubated and transferred into how grassroots engagement can be shaped, scaled, and sustainably organised to satisfactory levels. More research is needed to quantify measurable impacts on a collective adaptation of such classrooms from these progressive experiences.

7. Future Work

Future research opens up in two directions. Firstly, enriching the perspective of the social actions that digital game technology deployment with chess can strengthen for support a uniquely gratifying experience of expanding the context of co-located learners with shared learning experiences. Secondly, the researching perspectives for rightly value-claiming the utility value for these digitally immersive environments for effectively translating to STEM agency and leadership. This will further have implications for the possibility of selecting the candidate technologies with a far-reaching impact beyond the context of acquiring chess etiquette for engagement to empowering educational and social change projects.

Acknowledgments

This work is intended to acknowledge and celebrate the life of the late Mr. Albert Vasse, co-founder of DGT BV, and his efforts to drive quality of chess Innovation for 25+ years contributing to the first and second-generation digital game technologies along with Mr. Ben Bulsink, co-founder DGT BV and original inventor of DGT Digital Chess Clock and Digital Boards. A special thanks to Mr. Hans Pees, CEO, DGT BV, and Ms. Stephanie Bedius, MD, DGT BV for transforming that legacy by bringing the cost-effective third and fourth generation of DGT Products and propelling DGT BV through its current 30th year in leadership in Digital Game Technology Innovation for Chess from Enschede, Netherlands. All four have spent time to encourage the original efforts behind these works. Further, this work is not possible without selfless and generous contributions from several distinguished members and supporters of the chess fraternity from organisations of varying shapes, sizes, and complexity. We are indebted to several local authorities and their councilors, Education Departments in Sri Lanka, and UNESCO IBE and IIEP in particular who have encouraged our direction through the uncertain times to explore the meaningful context for Chess. A special mention for timely contributions of DGT infrastructure procurement by Cllr Prasanna Ramarathnam towards spearheading '*Children-led Understanding & Experience (CLUE) project*' with the voluntary support of his daughters, Miss Jyotnsa and Miss

Divya, to develop a case for future Women in Technology. Finally, the authors are indebted thanks to Mr. Arun Muthusamy, CEO South Asian Chess Council for jointly exploring the stock of innovation in chess on the use of digital advocacy for applications on social justice and peace education. We thank him for his support on development scenarios for engaging communities to enhance remote, rural, regeneration, reintegration projects and expand the opportunity to work with regional and international organisations.

References

Abdul Jabbar, A., & Felicia, P. (2015). Gameplay engagement and learning in game-based learning: A systematic review. Review of Educational Research, 85(4), 740–779. https://doi.org/10.3102/0034654315577210.

All, A., Nunez Castellar, E. P., & Van Looy, J. (2016) Assessing the effectiveness of digital game-based learning: Best practices, Computers & Education, Volumes 92–93, Pages 90-103, ISSN 0360-1315, https://doi.org/10.1016/j.compedu.2015.10.007.

Chase, W. G., & Simon, H. A. (1973). Perception in chess. *Cognitive Psychology, 4*(1), 55–81. https://doi.org/10.1016/0010-0285(73)90004-2

Digital Game Technology.(2023) Our story.[Online] Available at https://digitalgametechnology.com /about-us (accessed Mar 8, 2023).

Edwards, S. (2013). Digital play in the early years: A contextual response to the problem of integrating technologies and play-based pedagogies in the early childhood curriculum. European Early Childhood Education Research Journal, 21(2), 199–212. https://doi.org/10.1080/1350293X.2013.789190.

Fisher DM and the Systems Thinking Association (2023) Systems thinking activities used in K-12 for up to two decades. Front. Educ. 8:1059733. doi: 10.3389/feduc.2023.1059733.

Georgios M., Joerg H., Michail G., Andreas F., Pavlos K.(2023). Playful interventions for sustainability awareness in educational environments: A longitudinal, large-scale study in three countries, International Journal of Child-Computer Interaction, Volume 35, 100562, ISSN 2212-8689, https://doi.org/10.1016/j.ijcci.2022.100562.

Jie F., -Xingchao W., Zhonglin W., Jiayan Hu. (2020), Cyber victimization and loneliness among Chinese college students: A moderated mediation model of rumination and online social support, Children and Youth Services Review, Volume 115, 105085, ISSN 0190-7409.

Kasparov, G. (2010). How Life Imitates Chess: Making the Right Moves, from the Board to the Boardroom. United Kingdom: Bloomsbury Publishing.

Lai, C.H., Lin, Y.C., Jong, B.S. and Hsia, Y.T., (2014). Adding Social Elements to Game-Based Learning. Int. J. Emerg. Technol. Learn., 9(3), pp.12-15.

Malola Thittanimuttam et. al (2016) Goldfish Grows to the Size of the Tank. How analogous is chess in Schools? Conference Proceedings, International Conference on Chess in Schools ICCS 2016, Tsagkador, Armenia.

Najmeh B et al. (2020) The effective components of creativity in digital game-based learning among young children: A case study, Children and Youth Services Review, Volume 116, 105227, ISSN 0190-7409, https://doi.org/10.1016/j.childyouth.2020.105227. (accessed Mar 17, 2023).

Nikiforidou, Z. (2018). Digital Games in the Early Childhood Classroom: Theoretical and Practical Considerations. In: Danby, S., Fleer, M., Davidson, C., Hatzigianni, M. (eds) Digital Childhoods. International Perspectives on Early Childhood Education and Development, vol 22. Springer, Singapore.

O'Rourke, J., Main, S. and Hill, S., (2017) Commercially available digital game technology in the classroom: Improving automaticity in mental-maths in primary-aged students. Australian Journal of Teacher Education, 42(10), pp.50-70.

Plass, J.L., Mayer, R.E. and Homer, B.D. eds., 2020. Handbook of game-based learning. MIT Press.