Environmental Science and Policy 111 (2020) 83–90

Contents lists available at ScienceDirect

Environmental Science and Policy

journal homepage: www.elsevier.com/locate/envsci

Short communication

Game over or play again? Deploying games for promoting water recycling and hygienic practices at schools in Ethiopia

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ARTICLE INFO

Keywords:
Games
WaSH
Innovation
Handwashing
Wastewater treatment
Schools
Ethiopia

ABSTRACT

Worldwide, every year 525 000 children under the age of five die from diarrhoea. The simple act of washing hands with soap and water can prevent more than one-third of diarrhoeal disease cases. In the densely populated urban areas of the developing world, handwashing wastewater is commonly discharged to the environment without any treatment, creating unhygienic situations and breeding places for different vectors and wasting a valuable resource. However, this relatively clean wastewater can be treated and reused using simple technological solutions. The objective of our water innovation is, therefore, twofold: improving children's health through stimulating handwashing at schools while at the same time demonstrating the feasibility of water conservation through low-tech, nature-based treatment and safe reuse of handwashing wastewater for irrigation and toilet flushing. To enhance the intrinsic motivation of children and school staff to adopt this innovation, four educational games were developed drawing on theories used in gamification of learning, such as social learning theory and engagement theories. This paper provides an overview of the games and the main results of the game testing. For promoting hygiene among school children, a board and a card game were developed based on the F-diagram – commonly used by water and sanitation practitioners to illustrate the main routes for pathogen transmissions from faeces. In addition, the system linking handwashing wastewater collection, treatment and reuse for irrigation and toilet flushing was simulated by the development of two board games which targeted school children, school staff and the operators of the treatment system. The prototypes and final versions were tested in two schools in the Oromia region in Ethiopia – while the treatment system (constructed wetland) for handwashing wastewater is located in one school. Children that play-tested the games were generally enthusiastic and eager to play repeatedly, which demonstrated that board and card games are appropriate tools to engage with this young target group. We conclude that there is a large potential for development, use, and upscaling of educational games for more sustainable WaSH interventions.

1. Introduction

1.1. Water, sanitation and hygiene

Interventions in the water, sanitation and hygiene (WaSH) sector are very cost-effective in preventing a large part of global disease burden (Cairncross et al., 2010). In 2015, the United Nations (UN) introduced seventeen Sustainable Development Goals (SDGs) as universal targets (UNGA, 2015) where SDG 6 is entitled "Ensure availability and sustainable management of water and sanitation for all". Here the UN for the first time use the word 'management' as a goal in WaSH, implying that only infrastructure improvement is neither sufficient nor sustainable. The latest report on progress in realization of the SDGs highlights the urgency of the situation: "Despite progress,

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https://doi.org/10.1016/j.envsci.2020.05.016
Received 19 September 2019; Received in revised form 7 May 2020; Accepted 19 May 2020

accelerated action is needed to provide billions of people with safely managed drinking water and sanitation" and that "Water stress affects people on every continent, requiring immediate and collective action" (UN, 2019).

Children are especially vulnerable to the current situation. In 2015, one third of all primary schools were lacking basic WaSH services (UN, 2019) and worldwide every year 525 000 children under the age of five die from diarrhoea (WHO, 2017). The simple act of washing hands with soap and water can prevent more than one-third of diarrhoeal disease cases (UNICEF, 2004). Even though the link with children's health is well known, maintaining good handwashing practices on a longer term has been identified as a challenge (Ejemot-Nwadiaro et al., 2015).

At the same time, with the constant growth of the human population, the need for freshwater is increasing. This creates an urgent need for alternative water resources and for an increased water use efficiency. In the densely populated urban areas of the developing world, handwashing wastewater is commonly wasted and discharged to the environment without any treatment. This leads to unhygienic situations and creates breeding places for different vectors, also at schools where large numbers of children face inadequate sanitation facilities. Being generally relatively clean (Eriksson et al., 2002), this handwashing wastewater can be collected, treated and reused on site using simple technological solutions. When properly implemented, the treatment and reuse of handwashing wastewater can bring benefits to the WaSH at schools by preventing the uncontrolled presence of wastewater on the premises, while increasing availability of water for toilet flushing and irrigation.

1.2. School WaSH in Ethiopia

In Ethiopia, 37 out of 39 million school-age children lack basic hygiene services at their school and only about half of all schools are considered open defecation free (UNICEF and WHO, 2018). The Government of Ethiopia recognizes the importance of school WaSH improvement. Under the One WASH National Programme (OpenWASH, 2016) the responsibility of different Ministries in Ethiopia was elaborated. The Ministry of Health acknowledges that more appropriate facilities should be designed, that are easy to clean with a limited water supply, safe to use, and built to meet the specific needs of girls and boys at schools. The involvement of school children as stakeholders is very much needed (Ethiopian Ministry of Health, 2017). Innovative approaches are required to engage school children in school WaSH, in order to sustain proper WaSH practices on the longer term.

1.3. Games in WaSH

Although the potential of games has been recognized for a long time, recent literature reviews show evidence that games - both digital and analog - may have a positive impact on children's cognitive skills (Neugnot et al., 2015), that serious (digital) games may have a positive impact on knowledge and skills acquisition (Boyle et al., 2016) and that games can be effective for other purposes such as healthy lifestyle promotion (DeSmet et al., 2014). Also, potential to foster transformative change and more sustainable practices has been commonly attributed to games (Rodela et al., 2019).

International NGOs working on school WaSH improvement have already been using games for learning and for triggering behaviour change (WaterAid, 2019; Trick or Treat for UNICEF, 2020). There is little clarity however, how, and to what extent, game elements like game mechanics, game play and player experience, contribute to the game efficacy (Baranowski et al., 2016). The success depends on the combination of several elements that appeal to different player types. Most research moreover has focused on western cultures and overlooked that contextual and motivational factors may be different on other continents (Orji et al., 2018).

Several trends are noticeable in relation to use of games in the water sector: games are used to address different perspectives of the stakeholders where water is a contested resource, and maps are used as a board or a playfield (Abrami et al., 2012; Basco-Carrera et al., 2018). Most of the games for children are based on the Snakes & Ladders type in which success is purely dependent on luck as a result of throwing dice, and therefore do not take advantage of reinforcement principles to encourage desired behaviour. In the games that address hygienic practices the game play is commonly an outdoor activity conveying simple main messages (Trick or Treat for UNICEF, 2020). Sanitation games are available to a much lesser extent, though their potential is increasingly being recognized. Integrating games for children in school WaSH strategies has been tried earlier (Mooijman et al., 2010; United, 2019). However, documentation about the methodology used in the game development and research results on their effectiveness is scarce.

2. Approach

2.1. Objectives

Our integrated approach has multiple objectives: improving children's health by using games for raising awareness of benefits of handwashing and sustainable sanitation, while demonstrating the feasibility of water reuse through implementation of low-tech, nature-based treatment of handwashing wastewater at schools.

Though gaming and simulation are being used to assist stakeholders in managing complex resource dilemmas in socio-ecological systems on a water shed or regional level (Anon, 2005; Speelman, 2014), the application of games for addressing socio-technical systems for water reuse and improved WaSH at the school level is novel.

2.2. Hardware & software of school WaSH

"Improved access to hardware and changes of the behaviour at the household are critical interventions" (WSSCC and WHO, 2005). Recognizing this, our innovation aims at addressing both the hardware and software aspects of school WaSH while taking a bottom-up approach and adapting to the local situation.

To promote water reuse at schools in Ethiopia, a low-tech treatment system was designed and constructed in a primary school in Adama, Ethiopia. The implemented water treatment and reuse system is

Fig. 1. Schematic representation of the system for treatment of handwashing wastewater and reuse.

schematically represented in Fig. 1. The core of the system is a constructed wetland (CW), a nature based treatment technology that mimics the conditions occurring in a natural wetland (Hoffmann et al., 2011). A combination of biological and physical-chemical processes take place during treatment resulting in significantly improved water quality (Halalsheh et al., 2008). Different types of CWs exist (Tilley et al., 2014; Vymazal and Kröpfelová, 2008), all commonly preceded by a settling tank or septic tank to prevent blockages. For the WaSH intervention at the school in Adama, a horizontal subsurface flow CW with an area of 10 m^2 was implemented as part of the hardware, located next to the handwashing facilities and latrines.

For addressing behaviour change and the "soft" aspects, a commonly used visual tool was integrated in the intervention: the F-diagram. For more than half a century sanitation practitioners worldwide use the F-diagram to describe and visualise faecal-oral transmission routes (Black and Fawcett, 2008). The F-diagram, developed by Wagner and Lanoix in 1958 (Wagner and Lanoix, 1958), can be an effective tool to guide the hygiene promotion, awareness and behaviour change by active involvement of communities and accelerate the dialogue in WaSH implementation (David et al., 2009). The F's in the diagram are standing for: faeces, fluids, fields, fingers, floods, flies, food and faces. The tool visualises the relationship between the F's indicating the possible transmission routes for excreta related diseases.

3. Games for improving school WaSH – experiences from the field

The timeline of the co-creation of the four game prototypes was as follows: the authors first designed and tested two games around the socio-technical system depicted in the Fig. 1, namely the games Clean & Green School (CGS) and Water Go! (WG). After field observations that handwashing facilities were not extensively being used by children for handwashing, the idea for two games inspired by the F-diagram subsequently emerged: WaSH quartet (WQ) and Fly Over (FO) – aiming at raising awareness of the importance of handwashing. Fig. 2 gives a schematic overview of the topics of the different games and how these correlate. The target audience for 3 of the 4 games are primary school pupils (ages 10–14), whereas the game WG specifically targeted operators of the WaSH hardware elements presented in Fig. 1.

3.1. Games co-creation process

All four games followed the same co-creation process during their development (Fig. 3): the local situation was analysed by a group of local and international multi-disciplinary experts with the aim to understand the real needs and the target audience; ideas for design were generated; followed by the development of the first prototypes that were tested in an iterative process with multiple testing rounds. The feedback and experiences gained during the game play were incorporated, and finally the games were developed.

3.2. Situation analysis, first testing & iterations

At the beginning, the Companion Modelling (ComMod) methodology was deployed for understanding the socio-technical system around WaSH in schools. Based on the ARDI method (Etienne et al., 2011), a model with different interactions was elaborated for constructing a simulation of the system in the form of a board game. The first versions of the CGS and WG games were tested with students and teachers in Ethiopia in the autumn of 2017. Test results and observations provided indications for improvement and objectives for redesign of the game – accenting a better understanding of the whole system and triggering behaviour change.

Modelling software Mental Modeller (Gray, 2020) was used as a tool for capturing the individual knowledge and perceptions of strengths of interrelations between the F's in the F-diagram. The exercise with Mental Modeller provided the opportunity to connect F's not originally captured in the F-diagram, which highlighted category Flies to have high centrality - later used in the design of the WQ and FO games.

For affecting students' behaviour and for increasing awareness of the importance of sanitation and hand washing in particular, a game should engage and motivate the students to play repeatedly. Drawing on theories used in the gamification of learning (Kapp, 2012), such as social learning theory and engagement theories, different versions of games (prototypes) served as platforms for children to learn from one another through observation. As an example, the redesigned CGS game offered more elaborated and varied game play, enhancing the effect on behaviour by relating the game mechanics with the desired behaviour in real life. This was done by Heijn in 2018 (Heijn, 2018) by the addition of persuasive techniques within the gameplay for a resulting change in attitude (Kors et al., 2015). The redesigned CGS game was tested again in Ethiopia in June 2018. The overview of the four developed games is given in the Table 1.

4. Field-testing

After multiple testing rounds in the Netherlands, the prototypes of the games Clean and Green School and Water Go! were tested in Ethiopia in autumn 2017, and based on the discussions and observations it was evident that the CGS game needed redesign, whereas only minor changes seemed necessary to the WG game. The redesigned and improved versions were tested again with target groups in June 2018 and results are presented here. Following the same principle, after multiple testing rounds in the Netherlands, the prototypes of WQ and FO were tested in Ethiopia with the small target groups in February 2019 and based on the results and observations, new versions for the Ethiopian setting were co-developed.

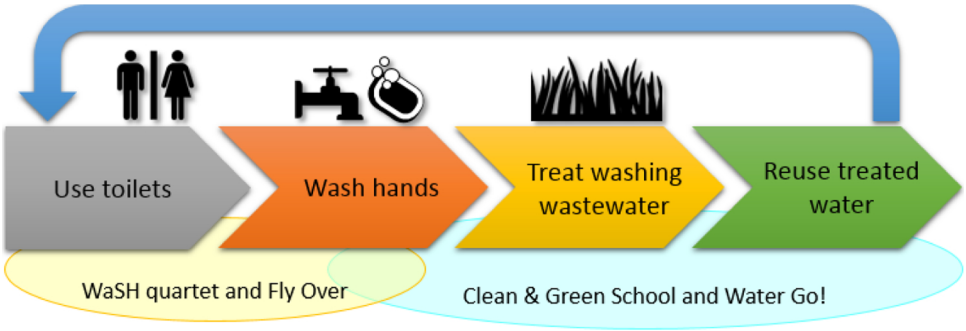

Fig. 2. Focus of the different games and their overlap.

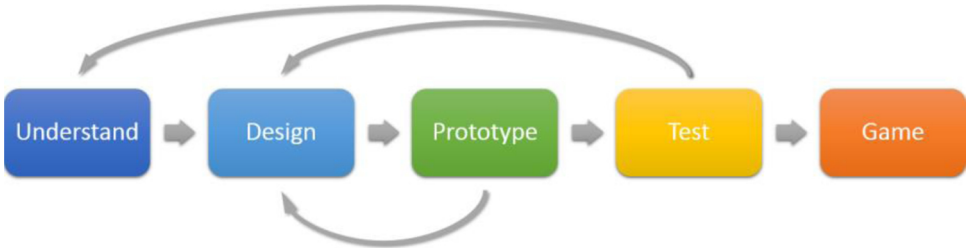

Fig. 3. Iterative co-creation process during game development. The games underwent several design and testing phases, improving the prototypes by incorporating specific feedback obtained during and after testing, as well as ideas and understanding gained during the entire process.

4.1. Clean and Green School & Water Go!

The Clean & Green School game was tested by both school students (n = 8) and teachers (n = 6) in a school in Adama where the CW was constructed. Though children are the primary target group, teachers and school staff are relevant, as they are the ones who will use the game on the long term as an educational tool and will encourage students to play it. Both groups participated in the game evaluation, which was done through a questionnaire and observations. A selection of the evaluation results for the students and the teachers is shown in Figs. 4 and 5 respectively.

The main messages from the game - the importance of hand washing after toilet use, options for recycling of treated wastewater - were clear to all students and teachers (not shown in graphs).

The participants understood the board fields and the game rules, and when asked if they would like to play it again 75% of the students answered positively (62.5% strongly agreed and 12.5% agreed), while all teachers answered positively (100% strongly agreed). It was also clear from the answers that obtaining a reward (a flower, or a filtered water drop) motivated the participants to continue playing, whereas the aspect of throwing a dice was not popular with all pupils, in particular the special dice. It was observed that Ethiopian students were not acquainted with board games with dice. Also even though the game was played very fast, several pupils answered they had to wait too long for their turn.

The Water Go! game was tested with six adults responsible for the functioning of the CW: cleaning staff, the school guard, the school principal and the constructor of the CW. Prior to the game test, the group was taken to the CW where it was shown how fields on the board match the actual situation: handwashing basin is field number 1, settler is field number 2 on the board, etc. Open discussion was used to address the game play experiences, as several of the people from the test group were illiterate. The players provided very positive feedback: “This is recreation and education”, “Interesting for the country. Creates new job opportunities.”

4.2. WaSH Quartet and Fly Over

The WQ and FO prototypes were played and evaluated by students of two schools in Oromia region – in Sendafa and Adama. As previously mentioned, both games are based on the F-diagram. A total of 10 students evaluated the WQ whereas 14 of them took part in the FO game evaluation (see Fig. 6). In both cases all participants answered positively when asked if they liked the game, and also indicated that the rules were clear (not shown in the graphs). Similar to the board game for the CGS, also in the case of the FO board game not all students were comfortable in using the dice.

5. Discussion and conclusions

Sustainability of WaSH interventions in schools remains a challenge in many parts of the world. In our approach, hardware interventions - implementation of constructed wetland for the treatment of handwashing wastewater, was combined with educational games around the CW system and for promotion of hygienic practices - as software intervention. Several theories on motivation, persuasion and learning can inspire game design, while the playability of a game and its effects on players can only be determined by evaluation with the target group. The developed games have been tested and evaluated on location with small groups using questionnaires, observations and interviews. In general, the results show that the players appreciate easy to understand rules, regular activity and turn taking, introduced rewards, and a close match with reality.

Different contextual factors require involvement of committed local experts in games co-development and facilitation of evaluation during testing. Unexpected events, such as political instability on a regional or local level, and changes in school management, may cause delays in project implementation and extra time and flexibility should be accounted for during the planning phase.

Evaluating prototypes of the game before developing the final version is an essential exercise. Even when testing with smaller groups, important information can be obtained to make the game more engaging and to make it convey its messages more clearly. The experiences in Ethiopia with the Clean & Green School game and the Fly Over board game, showed that especially the students are not always positive about using dice as a means of advancing in the game. Therefore, the latest version of the Fly Over game that is being implemented in the visitors centre of Addis Ababa Water and Sewerage Authority (AAWSA) uses a spinning wheel instead.

Another identified issue is the use of evaluations by young Ethiopian students. Ethiopian culture, as opposite to individualistic Western cultures, is highly collectivist. Research shows that children in Sub-Saharan Africa are to a lesser extent used to fill in questionnaires and stating personal opinions, which can lead to being uncomfortable (Stubbé-Alberts, 2018) and providing either socially desirable answers or not carefully reading the question. The latter might have happened with the CGS game, where many pupils indicated they had to wait very long for their turn (Fig. 4) while the observations showed that game play went very fast. It is possible that the students overlooked that this was the only negative question (the meaning of the scale was opposite to all other questions). Furthermore, the answers were all very positive indicating that games can be useful tools to engage with school WaSH interventions.

When comparing the players reactions during field testing of four games, the players were the most enthusiastic while testing Water Go! game – which was played with two teams of three. Game Fly Over – a cooperative game played against the fly instead against each other – was played with great enthusiasm as well. In both games, players are not competing against each other, which may be the reason that made players more comfortable and is also in line with the collectivist culture.

Eventually, for the upscale of our innovation, the intention is to distribute the games on a wider scale so the actual effect on awareness and behaviour change, which are the ultimate goals of the games, can

Table 1
Main characteristics and aims of the games.

Game name and type	Props	Aim	Target audience	Description
Clean & Green School  Board game 15 – 20 minutes	- board - 1 pawn per player - 1 regular dice - 1 tailored dice - 30 clean water drops - 30 treated water drops - 12 flowers	Realizing that hygiene is important and that the treated water from handwashing can be reused for flushing of toilets and watering plants in school.	School children age 10+ (2–4 players)	Players take turns in throwing a dice and the number on a dice indicates how many fields a player can move their pawn. Some fields on the board require from the player to take actions and make choices – e.g. wash hands or throw a tailored dice. When washing hands, a clean water is used, and treated water is produced. The player obtains a flower after performing hygienic practices and reusing treated water for irrigation. The player who first obtains three flowers is the winner.
Water Go!  Quiz based board game 20 – 30 minutes	- board - 1 regular dice - 2 pawns - cards with questions about possible CW problems - cards with maintenance tools	Learning how to ensure that a CW system works, by doing maintenance when needed to keep the water flow through the system, so it can be reused at the end.	School staff responsible for CW operation and maintenance (teachers, guards, cleaning personnel, etc.) (1+ players)	The game can be played with one or more players (divided into teams). At the start players receive a set of tool cards. Players roll the dice and move the pawn the indicated number of fields. If a player rolls an odd number, they get a card with a question about a CW problem. A player can use one or more maintenance tools to fix the problem (or none). For each problem solved a player gets two points and moves to the next field.
WaSH Quartet  Card game 20 – 30 minutes	Six sets of 4 cards ("quartets"): - safe drinking water - safe sanitation - clean hands - safe food - unhappy flies - safe health	Learning which activities are needed to achieve safe drinking water, safe sanitation, clean hands, safe food, unhappy flies and safe health.	School children age 10+ (3–4 players)	The game is played with three or four players, with the aim to collect most quartets – sets of four. Each activity card indicates the category it belongs to and lists the other 3 activities of its set. Players take turns in asking others to hand them a specific card. If they guess right they obtain the card. If the other person does not have that card it is their turn to ask.
Fly Over  Co-operative board game 10 – 15 minutes	- board - 1 pawn - 1 fly - spinning wheel (or tailored dice)	Learning about the basic WaSH categories and how they inter-relate	School children age 7+ (1+ players)	The game can be played with one or more players who compete against a fly. After spinning the wheel, the arrow can point to the field with a child or a fly, indicating who can move to the next field. FO takes players on the journey through the water use cycle. The goal is to choose the right path necessary to safeguard health and reach the end field before the fly.

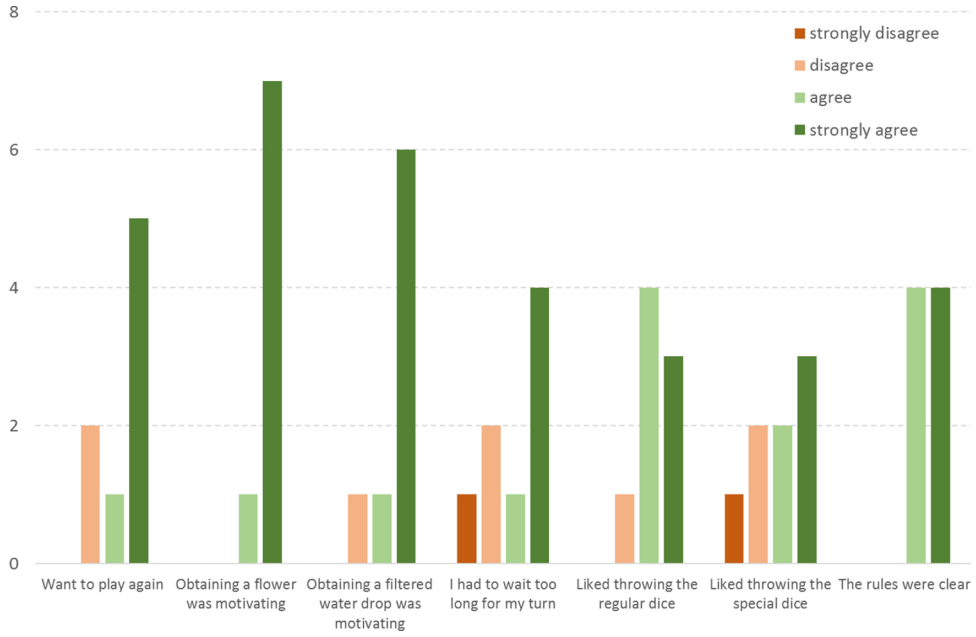

Fig. 4. Clean & Green School game evaluation results, students of Adama primary school (n = 8).

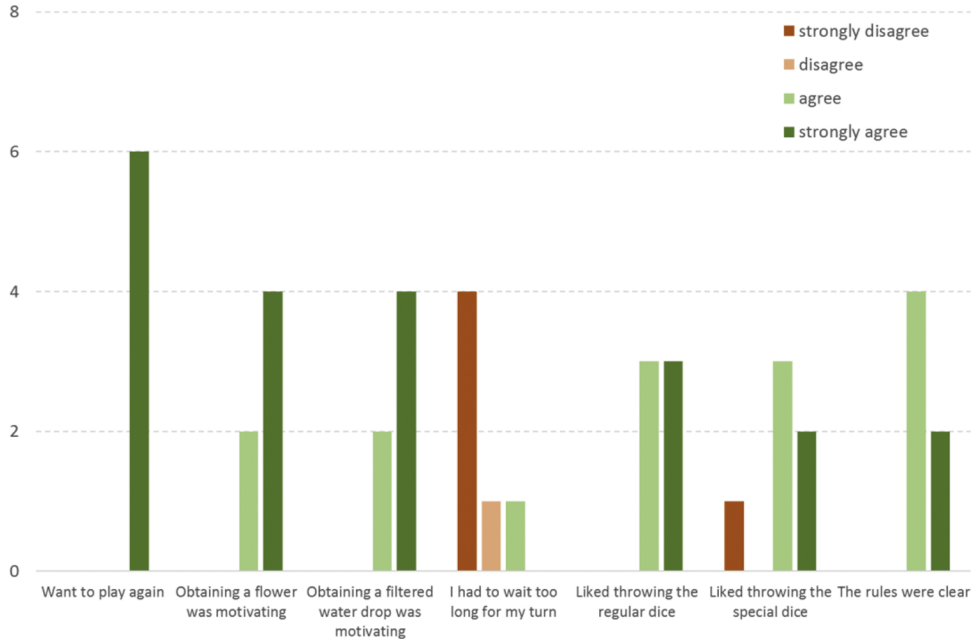

Fig. 5. Clean & Green School game evaluation results, teachers of Adama primary school (n = 6).

be measured over a longer period of time. School WaSH clubs initiated by the Ethiopian Ministry of education (Ethiopian Ministry of Education, 2017) are seen as a promising medium for promotion of the developed WaSH games. Financing of innovation is continuously reported as the critical factor in upscaling of innovation (Wehn and Montalvo, 2018). Currently, games often get stuck at prototype level or stay within research programs only. When ready-made games are sold to large organizations, accompanied by assistance of local game developers (providing explanation as service), games may become commercially viable. Using different channels to bring games to the market is important to reach out at larger audiences. Currently, the WaSH quartet game is in the process of being embedded in the awareness programs at city level through AAWSA and is translated into two local Ethiopian languages, English and Arabic.

Based on the experiences with these case studies in Ethiopia, we conclude that there is a large potential for development, use, and upscaling of educational games for more sustainable WaSH interventions.

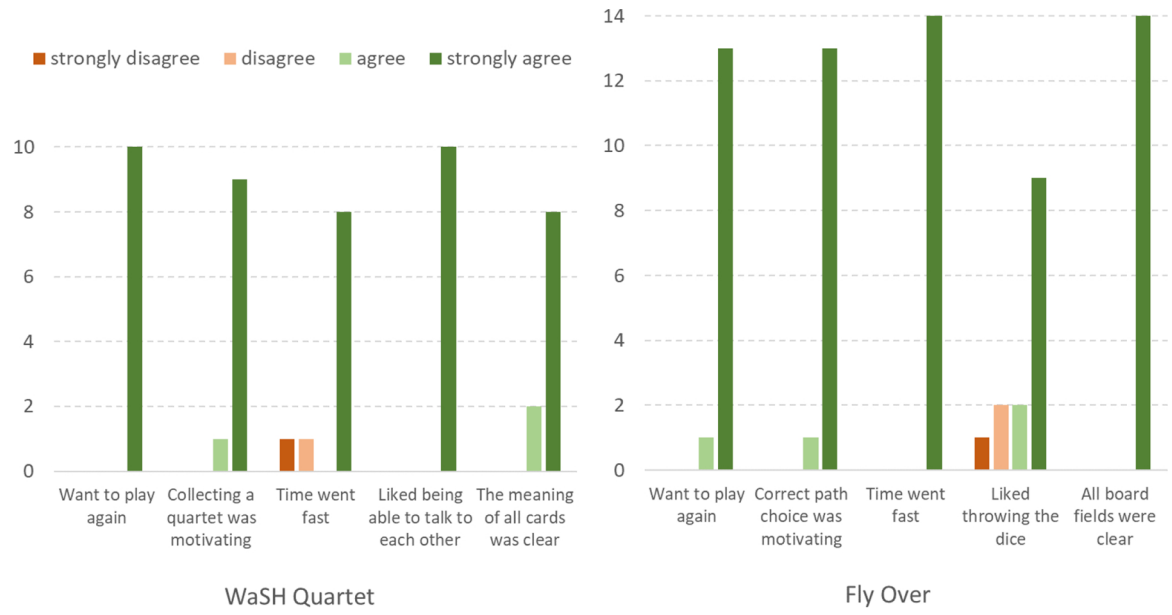

Fig. 6. WaSH Quartet (n = 10) and Fly Over (n = 14) evaluation results, students of primary schools in Sendafa and Adama.

CRediT authorship contribution statement

Darja Kragić Kok: Conceptualization, Methodology, Formal analysis, Validation, Writing - original draft, Writing - review & editing, Supervision, Project administration, Visualization. **Iemke Bisschops:** Conceptualization, Formal analysis, Visualization, Writing - original draft, Writing - review & editing, Project administration. **Lenneke Knoop:** Validation, Conceptualization, Writing - original draft, Writing - review & editing, Supervision. **Lemma Tulu:** Validation, Conceptualization, Writing - original draft, Writing - review & editing. **Katarzyna Kujawa-Roeleveld:** Formal analysis, Writing - original draft, Writing - review & editing. **Nardos Masresha:** Validation, Conceptualization, Writing - original draft, Writing - review & editing. **Joske Houtkamp:** Methodology, Conceptualization, Writing - original draft, Writing - review & editing, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

This research was conducted with support of VIA Water Programme funded by the Dutch Ministry of Foreign Affairs and The Netherlands Enterprise AgencyFDW12ET06.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.envsci.2020.05.016.

References

Abrami, G., et al., 2012. Wat-a-game, a toolkit for building role-playing games about integrated water management. In: International Congress on Environmental Modelling and Software (iEMSs). Leipzig, Allemagne: IEMSS.
Baranowski, T., et al., 2016. Games for health for children-current status and needed research. Games Health J. 5 (1), 1–12.
Basco-Carrera, L., et al., 2018. An adapted companion modelling approach for enhancing multi-stakeholder cooperation in complex river basins. Int. J. Sustain. Dev. World Ecol. 25 (8), 747–764.
Black, M., Fawcett, B., 2008. The Last Taboo - Opening the Door on the Global Sanitation Crisis. Earthscan.
Boyle, E.A., et al., 2016. An update to the systematic literature review of empirical evidence of the impacts and outcomes of computer games and serious games. Comput. Educ. 94, 178–192.
Cairncross, S., et al., 2010. Hygiene, sanitation, and water: what needs to be done? PLoS Med. 7 (11) p. e1000365.
Anon, 2005. In: Bousquet, F., Trébuil, G., Hardy, B. (Eds.), Companion Modeling and Multi-Agent Systems for Integrated Natural Resource Management in Asia. International Rice Research Institute (IRRI), Los Baños, Philippines.
David, N., Mumuni, O.K., Awuku, N.N., 2009. Participatory Hygiene and Sanitation Transformation (PHAST): a Methodology for Sustainable Hygiene and Sanitation Behavior Change With Experience From the Bawku West District of Ghana in West Africa Regional Sanitation and Hygiene Symposium. Accra, Ghana.
DeSmet, A., et al., 2014. *A* meta-analysis of serious digital games for healthy lifestyle promotion. Prev. Med. 69, 95–107.
Ejemot-Nwadiaro, R.I., et al., 2015. Hand washing promotion for preventing diarrhoea. Cochrane Database Syst. Rev. 2015 (9) p. CD004265-CD004265.
Eriksson, E., Auffarth, K., Henze, M., Ledin, A., 2002. Characteristics of grey wastewater. Urban Water 4 (1), 85–104.
Ethiopian Ministry of Education, 2017. National School Water, Sanitation and Hygiene (SWASH) Strategy and Implementation Action Plan. Federal Democratic Republic of Ethiopia, Addis Ababa.
Ethiopian Ministry of Health, 2017. School Health Program Framework. Federal Democratic Republic of Ethiopia, Ministry of Health, Addis Ababa, Ethiopia.
Etienne, M., Du Toit, D.R., Pollard, S., 2011. ARDI: a co-construction method for participatory modelling in natural resources management. Ecol. Soc. 16 (1), 44.
Gray, S., Mental Modeller.
Halalsheh, M., et al., 2008. Grey water characteristics and treatment options for rural areas in Jordan. Bioresour. Technol. 99 (14), 6635–6641.
Heijn, F., 2018. WaSH - the Green & Clean School Board Game, a Redesign (unpublished Bachelor Thesis). Department of Information Science, Utrecht University, Utrecht, the Netherlands.
Hoffmann, H., et al., 2011. Technology Review of Constructed Wetlands - Subsurface Flow Constructed Wetlands for Greywater and Domestic Wastewater Treatment. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, Eschborn.
Kapp, K., 2012. The Gamification of Learning and Instruction: Game-based Methods and Strategies for Training and Education. Pfeiffer, San Francisco, USA 336.
Kors, M.J.L., van der Spek, E.D., Schouten, B.A.M., 2015. A foundation for the persuasive gameplay experience. In: 10th International Conference on the Foundations of Digital Games (FDG 2015). Pacific Grove, CA, USA: Foundations of Digital Games.
Mooijman, A., et al., 2010. Strengthening Water, Sanitation and Hygiene in Schools – a WASH Guidance Manual With a Focus on South Asia. IRC International Water and Sanitation Centre, The Hague, the Netherlands, pp. 308.
Neugnot, M., Gagner, C., Beauchamp, M.H., 2015. The use of games in paediatric cognitive intervention: a systematic review. Int. J. Phys. Med. Rehabil. 03.
OpenWASH, 2016. Ethiopia's One WASH National Programme. The Open University UK/ WorldVision Ethiopia/UNICEF.
Orji, R., et al., 2018. Personalizing health theories in persuasive game interventions to

gamer types: an African perspective. In: Proceedings of the Second African Conference for Human Computer Interaction: Thriving Communities. ACM: Windhoek, Namibia. pp. 1–12.
Rodela, R., Ligtenberg, A., Bosma, R., 2019. Conceptualizing serious games as a learning-based intervention in the context of natural resources and environmental governance. Water 11 (2), 245.
Speelman, E.N., 2014. Gaming and simulation to explore resilience of contested agricultural landscapes. Farming Systems Ecology. Wageningen University, Wageningen, the Netherlands, pp. 221.
Stubbé-Alberts, H., 2018. Designing Learning Opportunities for the Hardest to Reach / Game-based Mathematics Learning for Out-of-school Children in Sudan. Utrecht University PhD thesis.
Tilley, E., et al., 2014. Compendium of Sanitation Systems and Technologies. Swiss Federal Institute of Aquatic Science and Technology (EAWAG).
Trick or Treat for UNICEF. Game: Relay for Water. Available from: https://unicefkidpower.zendesk.com/hc/en-us/article_attachments/360001529883/Game_Relay_for_Water.pdf.
UN, 2019. The Sustainable Development Goals Report 2019. United Nations, New York.
UNGA, 2015. Transforming Our World: the 2030 Agenda for Sustainable Development. United Nations General Assembly, New York.
UNICEF, 2004. Child Survival Fact Sheet: Water and Sanitation. [cited 2019 September 9th]; Available from:. https://www.unicef.org/media/media_21423.html.
UNICEF and WHO, 2018. Drinking Water, Sanitation and Hygiene in Schools: Global Baseline Report 2018. New York.
WASH United, 2019. WASH in Schools. [cited 2019 September 17th]; Available from:. http://www.wash-united.org/wash-in-schools/articles/our-work-programs-wash-in-schools.
Vymazal, J., Kröpfelová, L., 2008. Wastewater Treatment in Constructed Wetlands With Horizontal Sub-surface Flow. Springer, Netherlands XIV, 566.
Wagner, E.G., Lanoix, J.N., 1958. Excreta Disposal for Rural Areas and Small Communities. World Health Organization.
WaterAid, 2019. Discover Our Brand New Games. [cited 2019 September 17th]; Available from:. http://www.wateraidgames.org/home.
Wehn, U., Montalvo, C., 2018. Exploring the dynamics of water innovation: foundations for water innovation studies. J. Clean. Prod. 171, S1–S19.
WHO, 2017. Diarrhoeal Disease Factsheet. [cited 2019 July 1st]; Available from:. https://www.who.int/news-room/fact-sheets/detail/diarrhoeal-disease.
WSSCC and WHO, 2005. Sanitation and Hygiene Promotion - Programming Guidance. Water Supply and Sanitation Collaborative Council & World Health Organization, Geneva, Switzerland.