

Design and Approach to Digital Game- Based Learning

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Executive Summary

Education is a fundamental human right, enshrined in a range of global statutes. It provides a pathway to life-saving information, to protective resources and spaces, and it is the most effective pathway to increasing life chances and to reducing poverty and inequality (High-Level Panel of Eminent Persons on the Post-2015 Development Agenda, 2013). A number of studies agree that access to education can serve as a protective factor for children, including access to support and help with issues of abuse, access to life-saving information, and access to safe spaces (Burde & Linden, 2012; Rose & Greeley, 2006; Winthrop & Matsui, 2013). In complex emergencies and fragile states where there are multiple developmental and political challenges, there is more pressure and fewer

Innovation and Technology

In the outline of the global policy framework above, traditional approaches are seen as being unlikely to meet the existing needs of global education in the immediate future. One key area of opportunity has been promoted, namely 'the use of digital games in education [which] can increase access to learning opportunities' (UNESCO Institute for Statistics, 2009, p. 9). Whilst there is material which heralds digital game-based learning (DGBL) as a relatively simple way of giving children in the developing world access to education (Bender, Kane, Cornish, & Donahue, 2012), there is also scepticism that this enthusiasm may relate specifically to marketing of digital games for learning or distance learning products (Daniel, 2010; Krstić, 2008). To address this scepticism, additional studies in the Global South (Daniel,

resources for education. In addition, the challenges of protection, social development, and psychosocial well-being affect a child's experience of education.

Recent years have seen a 'shift in the global conversation on education from a focus on access to access plus learning' (UNESCO, 2017), including indicators of success from access to a focus on quality (Petrosino, Morgan, Fronius, Tanner-Smith, & Boruch, 2012). However, the resources needed to deliver education via traditional, formal access modalities are unlikely to be found (Burnett & Felsman, 2012). Additional challenges, where children may drop out, fail exams, or not succeed in learning during their education (UNESCO, 2017; UNICEF, 2013) also invalidate access as a standalone indicator of successful provision.

2010; Latchem, 2012; Power, Gater, Grant, & Winters, 2014; Selinger, 2009) focused on lessons learnt and agreed on these points:

1. Successful projects focus on content and infrastructure instead of on the provision of hardware;
2. A range of partners need to be mobilised, including governments and the private sector, to aid in the creation of an enabling environment; and
3. DGBL should be interpreted broadly, and practitioners should be prepared to consider how mixed-media programming might be appropriate for different groups.

The introduction of educational technologies has not changed human beings' fundamental capacity to learn, but it has profoundly changed how ideas and practices are communicated (Beetham & Sharpe, 2007). It can be argued that there are really no models of digital game-based learning per se – only re-enhancements of existing models of learning. The challenge is to describe how technology allows underlying processes common to all learning to function effectively (Mayes & de Freitas, 2007). The role of technology may be primarily to get remote learners into a position to learn as favourably as if they were school-based, rather than offering a new learning method. This example is more a new model of educational delivery than a new model of learning. According to

Biggs (1999), good pedagogical design ensures that there is total alignment between the curriculum we teach, the methods we use, the learning environment we choose, and the assessment procedures we adopt. A principled approach should be taken, using a set of contextualised practices that are constantly adapting to circumstances.

Research shows that educational programmes with or without the use of technology applications have not always been successful in developing countries (Bitew, 2008; UNICEF, 2009; Unwin, 2009). The three most important factors for an educational programme to be successful are: 1) location, 2) flexibility, and 3) continuity (UNICEF, 2009).

Can't Wait to Learn: The Intervention

To address the aforementioned challenges to education in underserved regions, Can't Wait To Learn (CWTL) created technological education programmes for the Middle East and Africa. The project began in 2011 when a consortium of stakeholders, including the Sudanese Ministry of Education, Ahfad University for Women, War Child Holland (WCH), and The Netherlands Organisation for applied scientific research (TNO), developed a digital game for mathematics based on the Sudanese national out-of-school maths curriculum, in order to make basic education available where formally trained teachers or schools are not present. The game was evaluated by a quasi-experimental design during two pilots. The game was

played for a maximum of 5 times a week, 45 minutes a day over six months (the control group received informal education). The results demonstrated a significant increase in mathematical knowledge and motivation to learn when compared to the control condition of face-to-face-teaching.

The successful educational outcomes of the Sudanese Mathematics Game in 2012 and 2014 paved the way for the creation of the CWTL programme and its implementation of a mathematics game in Jordan, Lebanon, and Uganda. In addition, a reading game was designed and is currently being piloted in Jordan and Sudan.

Can't Wait To Learn's Unique Proposition

CWTL focuses on the factors suggested by UNICEF (2009) to make a successful educational programme. The intervention provides an appropriate location for accessing learning materials and supplementary face-to-face contact; flexibility in learning alongside other demands of the family, which might interrupt a traditional school schedule; and the opportunity for progression into the mainstream

educational system, if desired by the learner and their family. This is in line with the more general conclusion of Clark (2002) who asserts, 'in order for technology to improve learning, it must "fit" into students' lives...not the other way around' (p. 1). The educational game and context in which children play reflects these success factors of educational programmes in developing countries.

Concept and Theory of Change

Given that remote communities often lack any sort of educational provision, the games developed by our programme support autonomous, self-paced learning and educational continuity. The games are flexible in terms of the schedule, which allows students to perform household tasks when their caregivers and families require help. They can follow an individual learning path, skipping a few days whenever household tasks prevent them from joining learning sessions and continuing at their own level whenever they can. In some contexts, like in Sudan, children should prepare for official exams, which allows them to enroll in regular education. This means the curriculum of the game must be the same as the official curriculum for out-of-school children, with an official endorsement from the Ministry of Education of each country.

Can't Wait To Learn Games

The CWTL games were developed in order to make basic education available without teachers or formal institutions, through a serious game made available on hardware that was placed in a community and supported by local facilitators. CWTL has developed two different games: one for mathematics and one for reading (discussed in more detail in Chapters 3 and 4, respectively). Both games have been designed as single player games within a game world. The maths game was designed as a city builder game, while the reading game was designed as a social game. In both the maths and reading game, children decide whether they want to watch an instructional video, check their progress, or play a mini-game. Both CWTL games provide several levels of pedagogy. The first level is that of the game world, which provides the connecting narratives for the second level of separate mini-games (games within games that provide educational tasks). The game world (discussed in detail in Chapters 3 and 4) asks the player/student to help characters achieve goals in their lives, like becoming a goat herder or doctor. Half of the jobs are familiar roles within the target communities, such as a cook, tractor owner, or brick maker. The other half are known to the children, but are less familiar, like a teacher, nurse, doctor, and engineer. In a playful way, this helps the children to broaden their future perspectives.

The theory of change driving CWTL is two-fold:

1. The theory of change at the level of the child - if a child has access to appropriate, quality education, they are more likely to stay engaged with education and have increased resilience and future opportunities.
2. The theory of change at the level of formative research (which can provide the foundation for future iterations of the programme if it is proven successful) - if the power of innovative education technology is coupled with a strong partnership and context specific approach, then disadvantaged children can be provided with previously unavailable chances to access cost-effective, quality education opportunities.

The second level, that of the mini-games, has a different pedagogy, with direct feedback on performance and consequently less control over the environment. Each mini-game addresses a specific mathematical or reading concept. Some mini-games have variations that can be used for several mathematical or reading concepts, and all mathematical or reading concepts can be practised within several mini-games. This was designed to help the children understand the mathematical or reading concept while staying motivated. Progress through the game is based on performance; the number of correct answers within a certain time-frame determines whether children can continue to a more difficult mathematical or reading concept. This ensures that players always work at their own level and pace.

Can't Wait to Learn's Stages

The CWTL programme is built on relationships with Ministries of Education, local NGOs (in each country), game software companies, educational research organisations, and visual design experts. Countries are identified by their ability to structure a scale-up and by the strength of their relationships with non-governmental entities. Once a country is identified, CWTL conducts a stakeholder analysis and identifies more partners that could help to

implement the programme. Central to the programme is the relationship with the Ministry of Education, along with defining their degree of involvement in the programme's development. Once all this has taken place, an educational needs assessment is conducted for that country or region. This assessment then provides insights or recommendations for the digital game application, in particular the language and mathematics levels. While the application itself is produced by a game

development company, the visual design, assets, video, and audio recordings are produced in a co-creative process with the region where the digital game will be implemented. The in-country roll-out is initiated by preparing the schools or learning centres for programming. This includes a safe space for the children, as well as having charging and tablet storage in place. Teacher and IT training are also taking place during the initial roll-out, as well as locating potential Training of Trainers (ToTs).



Figure 1. Can't Wait to Learn Programme Stages

Report Overview

With this report, the programme partners and War Child Holland present their educational digital games for out-of-school and in-school at risk students, called CWTL. This report focuses on the various game elements and processes employed for an innovative digital game designed to scale. These are important for the humanitarian sector, given the challenging context in which the digital games were implemented.

Chapter 1 provides an introduction to digital game-based learning (DGBL) and how it fits in relation to other terms, such as serious games, e-learning, and edutainment. Chapter 1 also discusses the elements of games, such as game modes, aesthetics, mechanics, narrative, and rewards. It concludes with a discussion of the three theories of game design that were incorporated in the design of CWTL.

Chapter 2 describes the current educational crisis for children in the developing world, particularly those living in emergency contexts. We propose tablet and mobile-based interventions as an area of opportunity that has the potential to mitigate the lack of education in underserved populations. We review some successful educational tablet and mobile interventions in Africa and South

America. Chapter 2 includes a discussion of how digital game-based learning could be a possible tool to close the learning gap for underserved populations and, in particular, why CWTL is closing this learning gap. Chapter 2 concludes with our desk assessment on each of the four countries we now serve: Sudan, Jordan, Lebanon, and Uganda.

Chapters 3 and 4 document the design of both the maths and reading games, respectively.

Chapter 3 describes the maths game created for Uganda and Chapter 4 describes the reading game created for Jordan. In describing the design and development of the CWTL games, we draw from the game design elements and theoretical frameworks mentioned in Chapter 1. We highlight the co-creation process of the visual elements of the games and present the educational design for each game. We conclude with our approach to quality assurance and the process of how we assess the games' success or failure through the management portal.

Chapter 5 provides a summary of the conclusions of the CWTL programme and the future of the programme.

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Acronyms and Abbreviations

| | | | |
|------|--|--------|--|
| CWTL | Can't Wait to Learn | ReHOPE | Refugee and Host Population Empowerment Strategy |
| DGBL | Digital Game-Based Learning | SDT | Self Determination Theory |
| EFA | Education Funding Agency | SDG | Sustainable Development Goal |
| GoL | Government of Lebanon | TNO | The Netherlands Organisation for applied scientific research |
| IDPs | Internally Displaced Persons | ToTs | Training of Trainers |
| LCRP | Lebanon Crisis Response Plan | USAID | The United States Agency for International Development |
| LWB | Libraries Without Borders | UNESCO | United Nations Educational, Scientific and Cultural Organization |
| MDGs | Millennium Development Goals | UNHCR | United Nations High Commissioner for Refugees |
| MEHE | Ministry of Education and Higher Education | UNICEF | United Nations International Children's Emergency Fund |
| NFE | Non-Formal Education | WCH | War Child Holland |
| RACE | Reaching All Children with Education plan | | |



Digital Game- Based Learning

Technology for Educational Delivery

As described in the executive summary, technology has not changed human beings' fundamental capacity to learn, but it has changed how ideas are communicated (Beetham & Sharpe, 2007). With this clarification, one can understand technology as providing a new model of educational delivery rather than a new model of learning. Further, Chard et al. (2008) argue that the choice of media does not influence learning, as differences in instructional design prevail over the method of delivery. The difference between passive and active learning combined with clear and concise instruction usually determines variation in learning outcomes. This means that in the use of educational games, the design of instruction delivered by these games, including gamification, is of crucial importance.

This is in line with Wouters, van der Spek, and van Oostendorp (2009) who argue that certain points should be considered in game design: the alignment of learning outcomes and game type, the alignment of game complexity and human cognitive processes, attention to cognitive and motivational processes, and research on specific mitigating effects, like gender. Various meta-reviews and meta-analyses show the cognitive and motivational effects of educational games in general. In their meta-analysis of 32 studies, Vogel et al. (2006) compared traditional classroom teaching to computer gaming or interactive simulation and found that educational games had an overall positive effect. Furthermore, significant higher cognitive gains and a more positive attitude towards learning were observed in subjects using interactive simulations or educational games versus traditional teaching methods.

This seems to be the case for boys as well as girls, although the low number of studies that reported statistics for males and females provides a reason to consider these results with caution. All age groups showed significant positive results for the use of computer gaming or interactive simulation. The type of activity and the realism of the pictures in the game does not appear to be influential. Wouters, van Nimwegen, van Oostendorp, and van der Spek (2013) investigated whether educational games were more effective in terms of learning and more motivating than conventional instruction methods. In their meta-analysis of 39 studies, they found that educational games were more effective in terms of learning and retention, but were not more motivating than conventional instruction methods. Learners using educational games learned more than those taught with conventional instruction methods in certain instances: when the game was supplemented with other instruction methods, when multiple training sessions were involved, and when players worked in groups.

Despite the effectiveness of technology for learning, and particularly the learning success in underserved regions (Pitchford, 2015; Rosas et al., 2003) discussed in Chapter 1, there is a hesitancy in educational settings about the validity of digital games for learning. There also appears to be some confusion about what games actually are. In this section, we address the perceptions of games for learning and the required shift in the educational field. Next, we define digital games, discuss the components and the elements of games for learning, and briefly review the definition of games for learning. We conclude with the theoretical frameworks that drive digital game-based learning (DGBL), including self-determination theory, the theory of flow, and game design patterns.

Perceptions About Games for Learning

Within the field of education, there is still the presumption that games are a leisure activity with little pedagogic value. Many education professionals have difficulty accepting that games can be used as educational tools. This apparent lack of acceptance stems from certain factors, namely that educators often have difficulty integrating games into the classroom because there are too many games to choose from, and they lack a method for selecting the right game for a specific educational purpose (Prensky, 2001b). Since the field of digital game-based learning is still relatively new, it is difficult to classify games, rate their quality, and support educators in making a better selection.

Educators may also not understand the differences between games and game-based learning (addressed in the next section of this chapter). Wouters et al. (2013) propose that the 'difference between leisure computer games and serious games is that the former are chosen by the players and played whenever and for as long as they want, whereas the type of game that is used and the playing time are generally defined by the curriculum in the case of serious games'. It is very plausible that a lack of decision-making autonomy can affect the motivational appeal of digital game-based learning in the classroom (Boyle et al., 2011).

Finally, many educators are not yet aware of how their role may change with digital game-based learning. This includes a shift in their didactic approach, which can be uncomfortable and can engender resistance. According to Magnussen and Hanghøj (2010), the teacher

shifts back and forth between four roles: instructor, playmaker, guide, and explorer (Figure 2). As the instructor, the teacher plans and communicates the goals of the game so that they are balanced with the educational goals. As a playmaker, the teacher communicates the roles, goals, tasks, and dynamics that will be experienced from the player's perspective. As the guide, the teacher must evaluate all the different phases of the game in order to understand how to better facilitate the game for players. Finally, as the evaluator, the teacher re-plays or supports players in revisiting areas of the game that will support a higher degree of learning. These roles sit between two dimensions of meaning, namely game practices and curricular goals, and these might converge or diverge depending on the relationship between the students, the teacher, and the game. The second dimension is the shift between seeing the game players as students (when connecting the game outcomes with the curricular goals) or seeing the game players as gamers (as actors within the gameworld). In sum, educators who use games may not yet understand what digital games are or what their limits and possibilities are. Furthermore, they may not yet understand how their role may become multifaceted, where they may provide brief but intense analyses and explanations of digital games, combined with longer periods of observing student activity and offering comments aimed to coach students (Abt, 1987). This approach is very different from the traditional didactic method in which the educator's primary role is to transfer knowledge directly to the students.

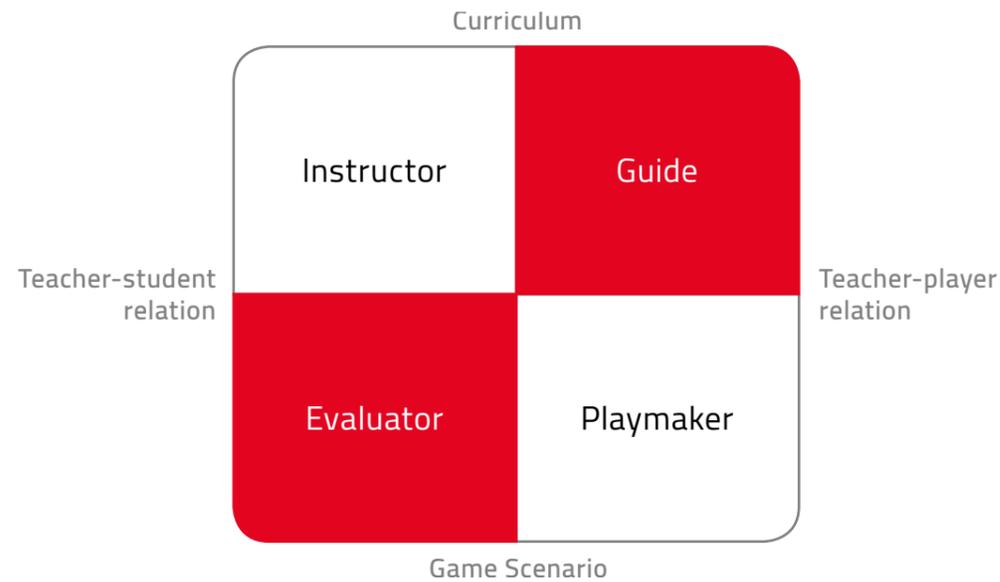


Figure 2. The shifting roles of game-based teaching. As illustrated in "Rethinking Design-Based Research: Redefining 'Design' in Relation to Educational Games", by R. Magnussen and T. Hanghøj, 2010, In Z. Abas, I. Jung and J. Luca (Eds.), Proceedings of Global Learn Asia Pacific 2010--Global Conference on Learning and Technology (pp. 1594). Penang, Malaysia: Association for the Advancement of Computing in Education (AACE).

Digital Games

Digital games are popular throughout the world among people of different age groups, genders, ethnicities, and cultures. In 2016, the global video games market was valued at 17.69 billion US dollars (Statistica, 2018). The wide distribution and rapid development of these technologies have contributed to the growth of the medium as a whole. Accessibility, low cost per person, engaging graphics, and a high level of interactivity make

games highly appealing (Girard, 2013). We can now play games using a variety of hardware, including console systems, PCs, mobile devices, tablets, virtual reality headsets, and smartwatches. Because of the ubiquitous nature of digital games, there may be assumptions about what games are and what they are not. In this section, we will define digital games, digital game-based learning, and describe the elements that comprise games.

What is a digital game?

Often in game design literature, the term 'play' is defined in relation to games. For example, games can be considered objects that prompt play (Schell, 2008). But what is play? Play can be an activity that gives pleasure (Gilmore, 1966), a free movement within a rigid structure (Salen & Zimmerman, 2004), or an activity that indulges curiosity (Schell, 2008). With the many definitions for play, it stands to reason that there would be just as many to define games.

Games have been defined in various ways, including as an exercise of controlled systems (Avedon & Sutton-Smith, 2015) and as artificial conflicts mitigated by rules in which players try to reach specified outcomes (Salen & Zimmerman, 2004). Fullerton (2004) defines games as closed systems that engage players in conflict and in unequal resolution. Costikyan (2013) claims that games are interactive structures with goals and rules that function only within those structures.

With so many definitions, how can games be defined? We prefer Schell's (2008) definition whereby games are objects that prompt play. Schell identified ten qualities in all games: (a) games are entered willfully; (b) games have goals; (c) games have conflict; (d) games have rules; (e) games can be won or lost; (f) games are interactive; (g) games have challenges; (h) games can create their own internal value; (i)

games engage players; and (j) games are closed formal systems (p. 34). He defines a game as 'a problem solving activity, approached with a playful attitude' (p. 37).

We will therefore define digital games as games possessing Schell's 10 qualities that are designed for digital technology, including (but not limited to) computers, consoles, mobile phones, and tablets.

What is digital game-based learning?

The rise of digital games informs all aspects of human development and organisation and particularly impacts education and learning. The market for digital game-based learning has doubled since 2013 and is estimated to be around 248 million US dollars in 2018 (Baanville, 2016). Educational games include language learning applications (e.g., Duolingo), stress reduction apps (e.g., Calm), children's games available online or in schools, and many other examples. Children are especially drawn

to digital games because they have been exposed to technology from a very young age as 'digital natives' (Annetta et al., 2009; Bekebrede et al., 2011; Prensky, 2001b; Westera et al., 2008). The availability of different types of games for learning as well as differing definitions make it difficult to agree on exactly what games for learning are. Breuer and Bente (2010) provide a good summary and map to digital games and learning and how these relate to other similar definitions.

Serious Games

As shown in Figure 4, digital game-based learning is a subset of the serious games genre. Michael and Chen (2006) define a serious game as a game 'in which education, in its various forms, is the primary goal, rather than entertainment'. This definition, they argue, does not preclude serious games from being entertaining. Likewise, some games whose primary goal is entertainment also have a strong learning component. We prefer the more robust definition of serious games--as games with the primary goal of engagement and motivation, 'which contribute to the achievement of a

defined purpose' (Susi et al., 2007, p. 5). We also prefer the following criteria to define the usefulness of serious games: (a) active involvement and stimulation of all players; (b) sufficient realism to convey the essential truths of the simulation; (c) clarity of consequences and their causes in both rules and gameplay; and (d) repeatability and reliability of the entire process (Michael & Chen, 2006, p. 38). Closely related to serious games are other categories, including entertainment education, e-learning, and edutainment (Breuer & Bente, 2010).

Entertainment Education

Entertainment education describes all learning that has an entertainment quality. This can include both digital and non-digital experiences. As shown in Figure 4, serious games are a subset of all entertainment education.

Edutainment Games

The term 'edutainment' arose in the 1990s for children's games in K-12 educational settings (Michael & Chen, 2006). These early computer-based learning games focused on reading, math, and science and often included animal graphics or television characters. The graphics and characters provided the entertainment

component (Michael & Chen, 2006) with a focus on textbook curriculum rather than building skill sets (Breuer & Bente, 2010). Edutainment games are a subset of entertainment education, game-based learning, serious games, and digital game-based learning.

E-learning

E-learning is a general term used in psychology and computer science to describe computer-based learning (Breuer & Bente, 2010). E-learning is not purposely designed for entertainment, although it may be highly engaging and include entertainment components.

E-learning enables remote learning and provides flexibility to the learner. Some serious games are a subset of e-learning. E-learning itself is a subset of game-based learning and entertainment education.

Digital Game-Based Learning

As seen in Figure 4, digital game-based learning includes any learning that is on a computer or online (Prensky, 2001a); therefore DGBL is a subset of entertainment education, game-based learning, serious games, and e-learning. According to Prensky (2001a), the best way to combine digital games and learning would be to take into account the audience, the subject

matter, the business and political context you are in, the technology available, the resources and experience that can be brought to bear, and the distribution. Digital game-based learning also requires consideration for engagement and learning, and both have to be equally present in DGBL. Figure 3 below illustrates this point.

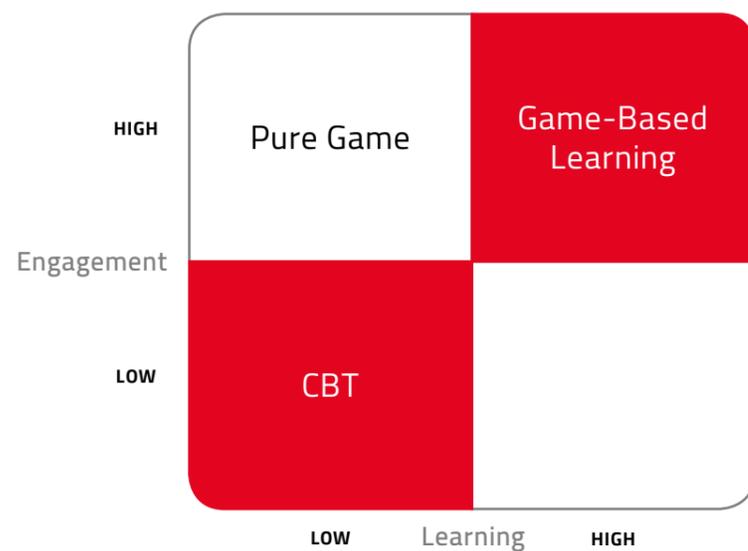


Figure 3. Digital game-based learning comes only when engagement and learning are both high. Adapted from Digital Game-Based Learning (p.149), by M. Prensky, 2001a, St. Paul, Minnesota: Paragon House.

Digital Games vs. Digital Game-Based Learning

It could be argued that the only difference between digital games and digital game-based learning is the 'extra' learning component. This argument, however, does not adequately delineate the differences between the two. These differences can include (but are not limited to) game flexibility, game design, game technology, integration of course curriculum, production, and team composition. Michael and Chen (2006) state that a key difference is in 'the simulation of real world and processes' (p. 29). The effect of a video game for entertainment only needs to approximate real world

circumstances, but a DGBL must precisely simulate aspects of reality. For example, a medical DGBL must be highly realistic; if a simulation is about a surgical procedure, both the simulated kidney and the procedure itself must be as close to reality as possible. DGBL must assess the consequences of a player's decision in a precise way, otherwise a real patient's life could be placed at risk. This is particularly critical in Can't Wait To Learn (CWTL), as the child must show real improvement in their math and language skills outside of the game environment.

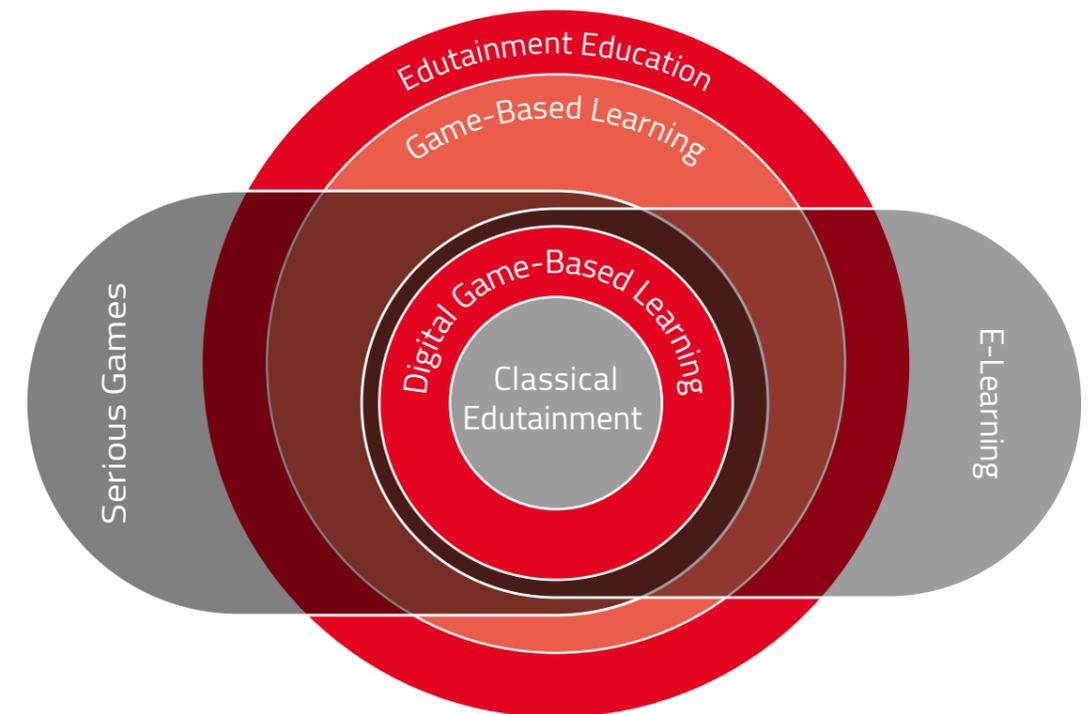


Figure 4. The relationship between serious games and related concepts. Reprinted from "Why so serious? On the relation of serious games and learning" by J. Breuer and G. Bente, 2010, Journal for Computer Game Culture, 4(1), pp.7-24.

Michael and Chen (2006) propose other important differences, summarised in this table:

Table 1: Digital Games vs Digital Game-Based Learning

| Type | Digital Games | Digital Game-Based Learning |
|------------------------|---|---|
| Hardware and Software | The latest hardware is always the most desirable. | Hardware and operating systems are budget-dependent, and the latest system is therefore not always possible. |
| Richness of Experience | Players always want bigger, faster AI and more immersive worlds. | Time and budget limit the quantity of content. |
| Cultural Themes | Some degree of cultural taboos and blind spots are acceptable. | Cultural themes must be accurate. |
| Random Results | Random results are present in all games to create diversions for the player. | Rules, objectives, consequences of actions and reasons for those consequences must be clear to the player. |
| Time Compression | How and when a player must react depends on creating the most engaging and entertaining experience. | How and when a player must react depends on what will best help the player learn the skill. |
| Simplification | Experiences are simplified to be more fun, even if they do not accurately represent real life (e.g., driving a car in a racing game). | Experiences must mimic reality as closely as possible. |
| Frustration | Experiences, while authentic, are devoid of realistic elements to avoid frustrating the player. | Frustration in realistic elements may be helpful to players in real world scenarios. |
| Communication | Communication is idealistic and perfectly curated. | Communication may not be perfect and is a more realistic reflection of how people interact. |
| Testing | Testing focuses on iterative game design and play progression. | There are two types of testing: 1) Game testing, focusing on play progression, cultural appropriateness, progression of learning, and game design. 2) Serious games usually also have an academic component in which technology must be integrated to assess whether the player is achieving learning objectives. |

In summary, DGBL has specific challenges and requirements that game designers need to address.

Components of Digital Game-Based Learning

In this section, we highlight the components that make up games: the basic elements and additional elements.

Basic Elements

Games have four basic elements: mechanics, narrative, aesthetics, and technology (Schell, 2008). In digital games for learning, an

additional element is the curriculum or skill set (de Freitas & Jarvis, 2008). These elements are the building blocks of games.

Mechanics

Mechanics define a game's rules, procedures, and goals (Schell, 2008). Mechanics function within a defined game world. For example, the mechanics of Pac-Man involve the movement of the character in two directions - up and down and side to side. This allows a character to achieve the goal of eating pellets while being able to run away from other characters in a maze.

Pac-Man, one game mode involves the character eating pellets while trying to avoid ghosts, but a second game mode allows the character to eat the ghosts after eating a super-pellet. As the game switches from a defensive to an offensive stance, it switches between these two modes.

Mechanics function within different game modes (configuration of gameplay) (Sicart, 2008), and mechanics can differ within a single game depending on the game mode. In

Mechanics are also linked to the other elements in the game. For game mechanics to function, the correct technology must be selected, along with aesthetics and a story that supports the mechanics.

Narrative

Narrative refers to the events that occur within a game. Narrative creates meaning or empathy, enabling players to connect emotionally to the game and its characters. An effective narrative allows a player to feel emotions along with the characters (Marsh et al., 2016). The game narrative asks the player to take on an empathic posture. This approach supports replayability for several reasons. First, a narrative approach does not reveal itself completely the first time around (Marsh et al., 2016), which engages the player. Second, the narrative assists players in setting and prioritising goals that support an empathetic posture within the game (Belman & Flanagan, 2010). Third, a

successful narrative will encourage players to recall the events of the narrative in a personal way (Lidwell, Holden, & Butler, 2010). Finally, the narrative keeps the player aligned with the game's learning goals; the player remains interested even when they do not have as much control as they would like within the game.

The mechanics and the story must complement each other. For example, Toru Iwatani, Pac-Man's creator, based his game on the story of Popeye. Popeye was a regular man who did not do very well in fights, but when Popeye ate spinach, he became very strong. Similarly, Pac-Man's main character gains strength by eating super pellets.

Aesthetics

Aesthetics refer to how a game looks, sounds, and feels. Aesthetics are the most important aspect of a player's experience. For this reason, technology should be localised to meet the 'cultural expectations of local users, support their complex activities in concrete contexts, empower their agency, and mediate their identities' (Sun, 2012, p. xiv). Aesthetics can include a game world's visual design, characters,

objects, action buttons, audio, and video. In Pac-Man, Iwatani attempted to create gender-neutral aesthetics to appeal to both girls and boys. He also wanted to make the game humorous, so he chose ghosts with different personalities. Though designed for Japanese audiences, Pac-Man's neutrality made it a worldwide phenomenon (Champagne, 2013).

Technology

Game technology can be either foundational or decorative (Schell, 2008). Foundational technologies create new experiences, while decorative technologies improve on technologies that already exist. This distinction is important for reasons of access, time consumption, and resources. Decorative technologies generally require less time and fewer resources to develop, while foundational technologies typically require highly skilled

programmers and considerable time and experimentation. Foundational technologies are usually at the cutting edge and, therefore, have fewer information resources to draw from. When originally developed for the already existing arcade system, Pac-Man used decorative technology and programming language. However, when it was later programmed for the Atari console system, Pac-Man's technology became foundational.

Curriculum and Core Activity

All games contain the four basic elements discussed above. Digital games for learning require an additional element that contributes to learning (de Freitas & Liarokapis, 2011). Behind the technology is generally a curriculum or a task-based system that determines what skills are presented, when they appear, and in what order. The curriculum also dictates the number of times a task must be completed to achieve a certain skill level, as well as the outcome if the task is not completed. The core activity in a digital game for learning is, therefore, the completion of educational tasks, which allows the player to progress through the game.

De Freitas and Jarvis (2008) provide a helpful model that explains how game design, instruction, and assessment intersect in DGBL (Figure 5). They present a hybrid approach which blends didacticism with game design elements. In their model, learning is facilitated through clear learning objectives, player goals, and learner content. Instruction is delivered through the game itself, while assessment is delivered through a combination of debriefing and internal system feedback that assesses a learner's progress and feeds this information back into the game.

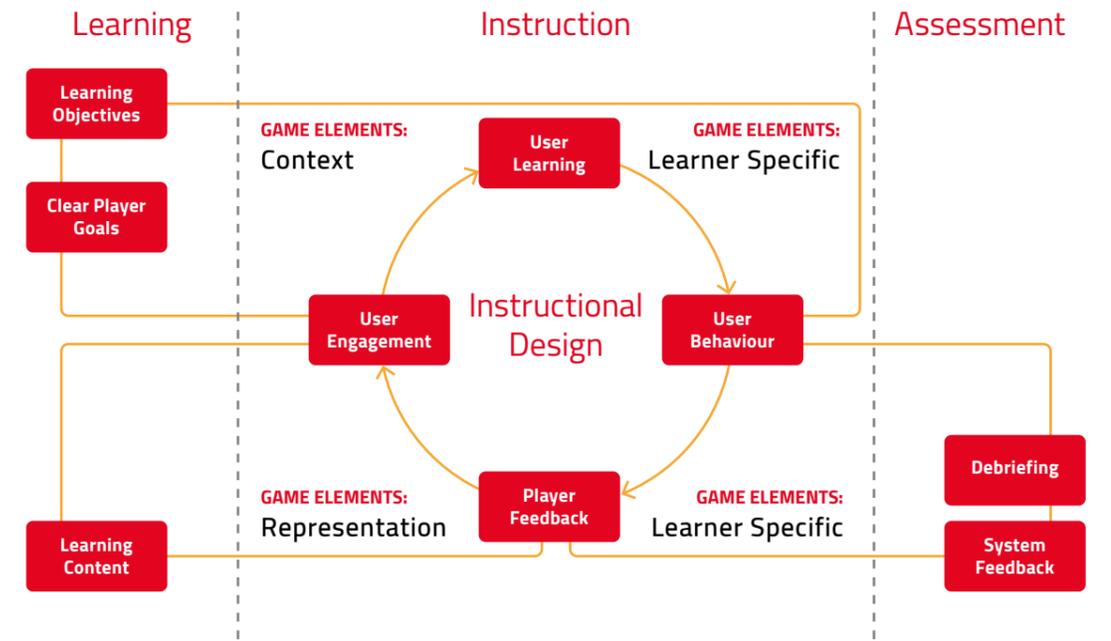


Figure 5. Exploratory game design model. Reprinted from "Towards a development approach for serious games", by S. de Freitas and S. Jarvis, 2008, In T.M. Connolly, M. Stansfield, E. Boyle (eds.), Games-Based Learning Advancements for Multi-Sensory Human-Computer Interfaces: Techniques and Effective Practices, pp. 215–231. Hershey, PA: IGI Global.

For video games, four different types of reward schedules exist (Wang & Sun, 2011):

Table 2: Types of Reward Schedules

| Reward Schedule | A reward is received after... |
|----------------------------|--------------------------------|
| Fixed ratio schedule | ...a fixed number of actions |
| Variable ratio schedule | ...a random number of actions |
| Fixed interval schedule | ...a fixed interval of time |
| Variable interval schedule | ...a variable interval of time |

In game-based learning, rewards are an essential component of progression. Since players generally have less control than in entertainment games (due to restrictions imposed by the learning goals), rewards can support the player in feeling more autonomous and in control of the game.

Additional Elements

Theme

Every one of a game's elements are equally important. A player most readily notices aesthetics, followed by mechanics, story, and technology (Schell, 2008). Decisions about each element inform the other elements and themes tie all these elements together. According to game designer Kevin Sheehan, a 'theme is consistently used to describe the base lesson or truth that serves as a foundation for a story.

Balance

The combination of these elements should provide a balanced experience of the game. A game should be internally consistent and fair. Flaws that allow certain players to gain advantages or games that are not fun are not well-balanced (Rollings & Adams, 2003). Particularly in educational games, balance ensures that players achieve a certain skill level. For example, when presenting numbers to children within a game, didactic exercises at

Progression

Progression is the path a player can take from the beginning of a game to its end. Progression falls under two categories: player and game (Bycer, 2013). Game progression refers to the course a designer sets for the player to complete the

Rewards

Rewards motivate players to progress through the game and keep the player playing. Rewards can include currency rewards, rank rewards, mechanical rewards (increasing statistics), narrative rewards (uncovering a new piece of the story), emotional rewards (when a player has helped someone in a game), new toys, new

And while this may allude to theme only applying to decisions involving narrative, it can also apply to decisions about the ludic nature of a game' (Sheehan, 2012). Themes help players to resonate with the game. While the theme is often unseen, it plays a significant role in balancing and tying together all the elements of a game. It is this balance that supports players' experience of flow within a game.

the beginning would start off small with easily achievable rewards, to both maintain the active learning component while keeping the child engaged in the play.

An imbalanced game can cause cognitive overload. Educational objectives must be balanced so the material, its presentation, or the effort needed to complete it do not force unnecessary cognitive processing (Killi, 2005).

game. Player progression includes the checkpoints the player must move through in order to advance from level to level. In educational games, progression usually occurs when the player has mastered a task or learning objective.

places (uncovering new locations in the game), completeness (finishing a certain level), or victory (defeating an adversary) (Only a game, 2005). The rewards a game designer chooses depend on the game's mechanics and the overall goal of the game. The timing of these rewards is also important for player engagement.

Categories of Digital Game-Based Learning

Marc Prensky (2001a), an educator and designer, presents some categories for digital learning games. These categories also define and inform the type of game design needed to achieve the learning objectives of the games. These are presented in the table below:

Table 3: Categories for Digital Learning Games

| Domain | Definition |
|---|---|
| Intrinsic vs. Extrinsic | In intrinsic games, the content is part of the game structure. In extrinsic games, the content and the game structure are less tightly connected. |
| Tightly Linked Games vs. Loosely Linked Games | Similar to the intrinsic and extrinsic perspective. A tightly linked game is designed around specific content, whereas the content is separate from the game in a loosely linked game (but the game can 'hook' the player into going back and forth between the game and the content). |
| Reflective Games vs. Action Games | Non-stop action offers fewer opportunities for reflection, while role-playing, puzzles, or simulations require a slower pace and more reflection. |
| Hard-Wired Games vs. Engines and Templates or Shells | In hard-wired games, reusability is not a consideration. The design of the game and the content is optimised for the player experience, but it is expensive. A shell game is the opposite. Videos, graphics, and text sit outside of the game, but they are pulled into the game at the correct time to be seen by the player. An approach between these two is called an 'engine'. |
| Synchronous (Real-time) Games vs. Asynchronous (Turn based) Games | Synchronous games will continue playing even if the player has paused, while asynchronous games wait for the player to return to play. |
| Single Player vs. Two Player vs. Multiplayer vs. Massively Multiplayer Games. | Most digital learning games are single player with the exception of those that require team coordination (e.g., military applications). |
| Session games vs. Persistent-State Games | Session games exist as long as players are playing; if paused, all players are paused from playing. In persistent-state games, the world of the game does not disappear; the world is always continuing and developing. |
| Video-based games vs. Animation-Based Games | Representation of characters are either video or animation based. Video assets tend to be more realistic but are larger in size and can limit interactivity. Animations allow for more freedom and are less expensive. |
| Narrative-Based Games vs. Reflex-Based Games | Narrative can add emotional impact to the game, while stimuli in reflex-based games are presented quickly by a computer and are well suited for language learning. |

Theoretical Frameworks of Digital Game-Based Learning

Four core theories drive DGBL. The first is self-determination theory, which encompasses the core drivers for motivation (Ryan & Deci, 2000). The second concerns flow, or a state of presence and enjoyment, which is essential for player motivation. It is the balanced combination of mechanics, story, aesthetics, and technology that creates for the player a state of presence. The third theory involves Gee's

game-based learning principles, derived from Gee's studies of entertainment games. Fourth is the model developed by Staffan Björk and Jussi Holopainen that supports design, analysis, and comparison of games. They describe this model in their book *Game Design Patterns*, which describes the interactions that occur repeatedly in game play (Björk & Holopainen, 2003).

Self Determination Theory

Social psychologists Richard Ryan and Edward Deci developed self determination theory (SDT) in 1985 at the University of Rochester (2000). They focused on the social-contextual conditions that support self-motivation and psychological well-being. For example,

motivation can be either extrinsic or intrinsic. People may be motivated out of fear or coercion (extrinsic motivation) or because they find value in an activity (intrinsic motivation). People who are intrinsically motivated are generally engaged, excited, and confident.

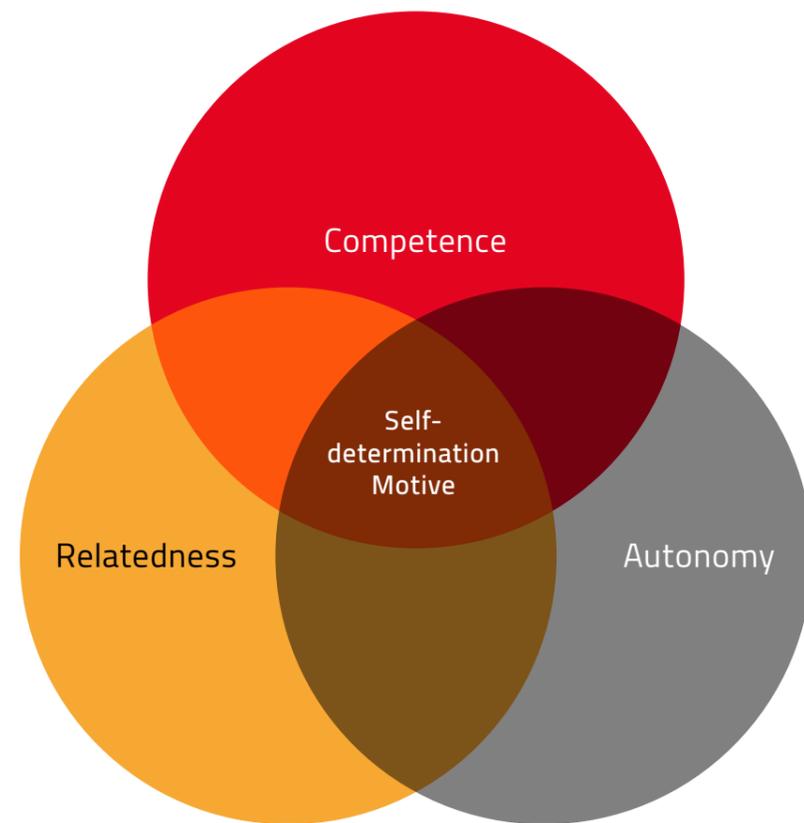


Figure 6. Self-Determination Theory of student motivation. Reprinted from "The 'What and Why' of goal pursuits: Human needs and the self-determination of behavior", by R. M. Ryan and E. L. Deci, 2000, *Psychological Inquiry*, 11, p. 227–268.

Ryan and Deci (2000), in what they have termed cognitive evaluation theory (CET), identify three human needs that foster intrinsic motivation: competence, relatedness, and autonomy (Figure 6). In digital game-based learning, competency occurs when the player acquires new knowledge and skills. Relatedness arises when the player feels a connection with other players and/or the game characters. Autonomy occurs when the player experiences a sense of choice and control within the game.

These three factors are interrelated and must be incorporated into digital game-based learning in order to successfully motivate players. For example, positive feedback supports the development of competence and autonomy. Feeling competent is often a result of autonomy; to feel competent, a player must experience the freedom to choose their behaviour. If the game environment is too controlling, the player will have less autonomy and competence and, therefore, less intrinsic motivation.

Intrinsic motivation also increases when social contexts support security and relatedness. While proximity is not necessary, the feeling of having a 'secure relational base' (Ryan & Deci, 2000, p. 71) is central to intrinsic motivation.

Flow

The concept of flow is credited to psychologist Mihaly Csikszentmihalyi (1990). Csikszentmihalyi discovered that activities such as rock climbing, playing chess, and dancing brought people into such a deep state of absorption that nothing else seemed important to them. A flow experience is one of deep concentration, immersion, and enjoyment.

The term 'flow' has been used extensively in digital games and in games for learning. Research has shown that flow creates a positive impact in games for learning (Webster,

Ryan and Deci (2000) conclude that these principles apply to activities which already naturally hold an intrinsic interest for people and where there is an appeal for aesthetic aspects, newness, or challenge. This conclusion relates to the theory of flow, which is discussed in the next section.

Fostering motivation in game design also requires taking advantage of a player's behavioural momentum, which is the tendency to continue playing after investing time and effort (Schonfeld, 2010). For example, if a player has spent ten hours playing a game, the player will be motivated to continue because they will feel useful, even if the actions required in the game are not actually productive in the person's life. A similar concept is that of blissful productivity, the idea that working hard while playing a game elicits a state of bliss not reached through relaxation (Schonfeld, 2010). Blissful productivity supports the premise that human beings find meaning in rewarding work. For example, on average gamers spend approximately 22 hours per week playing games (the equivalent of a part-time job), often after a full day's work. Their willingness to work hard, perhaps even harder than in real life, suggests that they achieve blissful productivity in the game world. Blissful productivity is an outcome of flow.

Trevino, & Ryan, 1993). Flow arises from the player's engagement with a well-balanced game. In order for a game to induce flow, the game's challenges must match the player's skill level. If the game is too difficult, the player may feel overwhelmed, but if the game is too easy, the player may be bored. Both scenarios will lead the player to stop playing the game. This can be particularly problematic in an educational game, where the goal is to gain skills. The goal of a digital game for learning is to keep the player in a flow state by systematically matching the player's skill level.

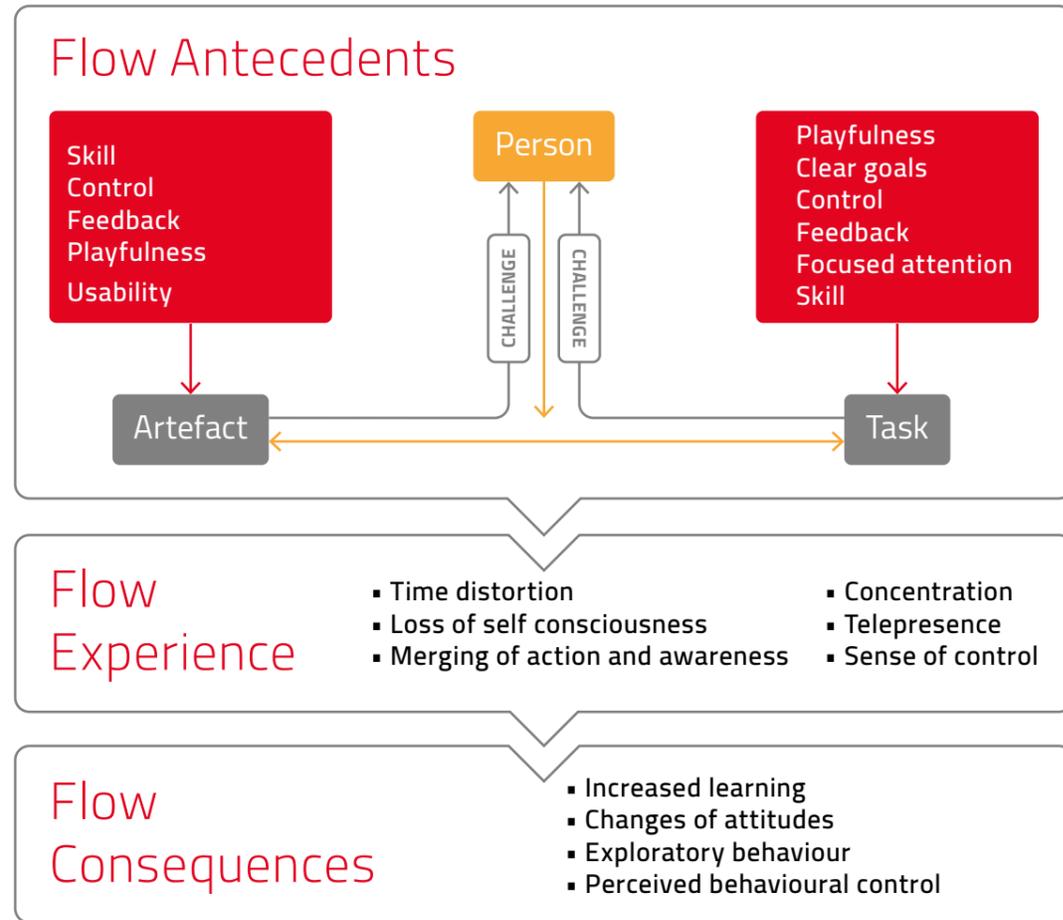
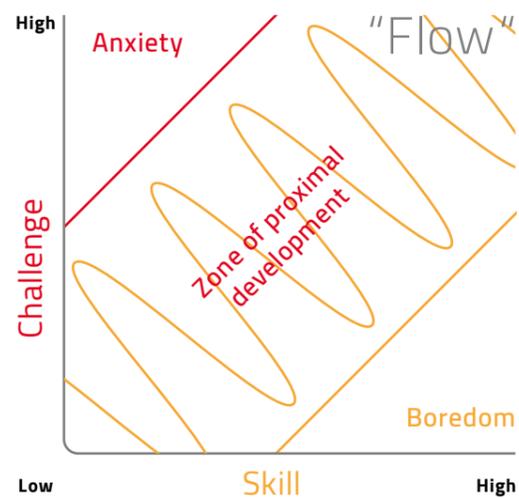


Figure 7. Framework of flow in computer-mediated environments. Adapted from "A person-artefact-task (PAT) model of flow antecedents in computer-mediated environments" by C. M Finneran and P. Zhang, 2003, International Journal of Human-Computer Studies, 59(4), p. 475-496.



The three channel model of flow (Figure 8), shows that both challenge and skill must be present for a player to experience flow. Too much challenge, when the player's skill set is low, can create anxiety. A low level of challenge when a player's skill level is high can create boredom for the player. Both a high level of anxiety and boredom decrease player engagement and intrinsic motivation.

However, when the skill level of the player is in balance with the level of challenge, this area is called the zone of proximal development and in this case the player enters a state of flow.

Figure 8. Three channel model of flow. Adapted from Beyond Boredom and Anxiety, by M. Csikszentmihalyi, 1975, Washington: Jossey-Bass Publishers.

One of the models that supports flow in educational based games is PAT (person-artifact-task). Researchers Finneran and Zhang (2003) created the PAT model to explain that a well-balanced educational game requires the interplay between the person (player), the artifact (game), and the task (the curriculum) shown in the flow antecedent

section below (Figure 7). If the task and the game are complex, the learner can become distracted (Pearce & Howard, 2004). The interplay between the person, task, and artifact then creates a flow experience, which includes time distortion and loss of self. This in turn has learning consequences such as increased learning, attitude changes, and exploration.

Gee's Game-Based Learning Design Principles

Gee's game-based learning principles are well recognised throughout the serious games literature. Gee derived 36 learning principles from his review of many entertainment games (Gee, 2003), and digital game designers often employ these principles to enhance learning. These principles are supported by research on human learning and cognition and are often cited in both the academic serious game

literature (Djaouti et al., 2009) and the production of educational digital games (Michael & Chen, 2006). The principles are divided into several domains, including semiotic domains of learning, learning and identity, meaning and learning, telling and doing for learning, cultural models for learning, and learning as social. The following table summarises the learning principles and their corresponding categories:

Table 4: Gee's Learning Principles

| Domain | Learning Principle | Definition |
|---|---|---|
| Semiotic Domains Sets of practices that include ways to communicate meaning (including oral or written language, images, symbols, artifacts, graphs, sounds, and gestures) (Gee, 2003, p. 18). | Active, critical learning principle | The learning environment (including how the meaning is presented) supports active, not passive, learning. |
| | Design principle | Appreciation for design and design principles is key to the learning experience. |
| | Semiotic principle | Appreciation for interrelations within and across signs (images, words, actions, symbols, and artifacts) is key to the learning experience. |
| | Semiotic domains principle | Learning requires mastering, to some degree, signs and being able to participate, to some degree, in the affinity group or groups connected to them. |
| | Metalevel thinking about semiotic domains principle | Learning requires active and critical thinking about the relationships between signs and applying these to other semiotic domains. |
| Learning and Identity Formation In order to learn, a person must add a new element to their identity. They must see themselves as a learner willing to commit time, effort, and active engagement in a new semiotic domain. | Psychosocial moratorium principle | Learners are able to take risks in a space where there are no real world consequences. |
| | Committed learning principle | Learners expend significant effort within a virtual identity to which they feel some commitment and in a virtual world that they find compelling. |
| | Identity principle | Learners can acquire and experiment with new identities when they have real choices in developing the virtual identity and when they have plenty of opportunity to connect the relationship between the new identity and the old one. |

| Domain | Learning Principle | Definition |
|--|--|--|
| Learning and Identity Formation (continued) | Self knowledge principle | The virtual world fosters increased self-awareness and understanding of the learner's current and potential capacities. |
| | Amplification of input principle | Learners receive substantial benefit for a small amount of effort. |
| | Achievement principle | Learners of all levels receive intrinsic rewards from the beginning. Rewards are tailored to each learner's level, to the amount of effort they expend and to their growing mastery and highlight ongoing achievements. |
| | Practice principle | Learners spend considerable time in engaging experiences and have many opportunities to try to succeed at tasks. |
| | Ongoing learning principle | Learners are constantly adapting to new and changing conditions in order to reach higher levels. They therefore experience cycles of learning, automatization, undoing automatization and then re-organizing automatization. |
| | Regime of competence principle | Closely tied to the ongoing learning principle, the learner gets plenty of chances to function at the edge of his or her skill set. Experiences are challenging but not overwhelming or impossible. |
| | Meaning and Learning Stored associations or links between experiences. Video games can encourage situated, experiential and embodied forms of learning and thinking (p. 76). | Probing principle |
| Multiple routes principle | | Gives learners multiple ways to progress so they have choices and can rely on their own style and strengths to resolve problems. |
| Situated meaning principle | | Learners store associations or links between experiences. Meanings of signs (e.g. actions, objects, artifacts) arise through personal experience. |
| Text principle | | Learners understand texts in terms of personal experiences or "embodied experience." Gee writes, 'Learners move back and forth between texts and embodied experiences' (p. 108). |
| Intertextual principle | | After achieving embodied understanding, learners understand texts as a group or genre of related texts. This understanding helps the learner make sense of individual texts. |
| Multimodal principle | | Meaning and knowledge arise from the mix of signs (images, texts, symbols, design, sound), not only from words. |
| Material intelligence principle | | Materials and the environment hold knowledge, and learners interact with the knowledge stored in material objects. |
| Intuitive knowledge principle | | Knowledge that is intuitive in nature, particularly in connection with a group, is an important part of learning and should be valued equally to verbal and conscious knowledge. |

| Domain | Learning Principle | Definition |
|---|---|---|
| Telling and Doing Video games support a balance between directly guiding the player and letting the player explore and discover on their own. | Subset principle | Learning takes place in a simplified part of the whole domain. |
| | Incremental principle | Situations are organized early in the game. Early yearly cases lead to generalizations that help learners understand later cases. |
| | Concentrated sample principle | Fundamental signs are presented in the early stages so learners can practice. often and learn these signs well (p. 137). |
| | Bottom-up basic skills principle | Skills are learned within the game's early stages rather than in separate introductory sections or outside the game's context. |
| | Explicit information on-demand and just-in-time principle | Learners receive on demand and in time information, so they can access information when they need it or later when they want to see it again. |
| | Discovery principle | Direct explaining is limited, enabling the learner to discover and experiment independently and in a self-directed manner. |
| | Transfer principle | Learners have many opportunities to practice and to apply what they've learned in later cases, including opportunities to reconsider those earlier cases. |
| Cultural Models Ways in which a game can reinforce or challenge a player's learning model. | Cultural models about the world principle | Learners are led to think about their worldview while still respecting their own identity, abilities and social affiliations. |
| | Cultural models about learning principle | Learners are led to think about their perspective about learning identity, abilities and social affiliations. |
| | Cultural models about semiotic domains principle | Learners are led to think reflectively about their cultural models of a semiotic domain while still respecting their own identity, abilities and social affiliations. |
| Social Models As thinking is at its core a social process, technology provides opportunities for people to think and act with others in ways that are not always anticipated. | Distributed principle | Meaning is distributed across all aspects of learning, including learner, objects, symbols, environment, tools and technology (p. 197). |
| | Dispersed principle | Learners distribute knowledge by sharing with others, some of whom are not seen face-to-face. |
| | Affinity group principle | Learners are members of groups that are bonded through shared endeavors, practices and goals (rather than race, gender, nation, ethnicity or culture) (p. 197). |
| | Insider principle | Learners are active in the learning experience from beginning to end. They can be insiders, 'teachers', and 'producers', not just consumers. |

Many of Gee's theories relate closely to SDT and flow. As most games base their designs on SDT and flow, Gee's game principles are also pertinent.

Game Design Patterns

Game design tends to follow patterns. Staffan Björk and Jussi Holopainen (2004) examined the mechanics of entertainment games and extracted patterns from them. They also examined concepts and design methods from other fields, including architecture, software engineering, and interaction design. They devised a structural framework and a list of game design patterns.

The structural framework includes a game instance, a game session, and a play session. The patterns were divided into three different types: bounded design patterns, temporal design patterns, and objective design patterns.

The table below summarises what these are composed of:

Table 5: Summary of Game Design Pattern Structural Framework

| Bounded Category | Temporal Category | Objective Category |
|---|--|--|
| Most Abstract | Less Abstract | Least Abstract |
| Consists of the goals, rules, and game modes. Describes what activities are allowed or not allowed in a game. | Consists of actions, events, closures, end conditions, and evaluation functions. Describes temporal events that occur during gameplay. | Consists of players, interfaces, and game elements (dice, cards, characters) and includes physical and virtual cases. These elements have both control/action structures and information structures. |

To define the patterns, Björk and Holopainen followed a five-step iterative process: recognise, analyse, describe, test, and evaluate. If a game passed this five-step process, it was included in the game design pattern manual. If the pattern was not clear or was untestable, it was merged with another pattern or discarded. Through this process, Björk and Holopainen merged mechanics, developed names for abstract patterns, and disposed of unclear mechanics. They developed over 200 game design patterns, which are listed in their book *Patterns in Game Design* (2005). While it is not within the scope of this document to list all of the game design patterns, some of these patterns were incorporated into the design of CWTL.

Summary

In summary, these elements and theoretical frameworks serve as an orientation to the two CWTL games, maths and reading. CWTL incorporates many aspects of these theories; in describing the design and development of CWTL games, we will draw from the game design elements and theoretical frameworks mentioned in this section.



Digital Game-Based Learning for Underserved Populations

Educational Technology for Children in Emergencies

Education for children in the developing world is in crisis. Children growing up in complex emergencies are at the sharp end of global development challenges. Around the world, 36% of the 58 million out-of-school children live in countries that have war and violence, with the majority of these children being girls. More than one third of refugee children globally are missing out on primary education (UNICEF, 2015). The scale of problems facing children in emergencies is vast and growing. Whilst there is unlikely to be the money, resources, or traction for a traditional response that can meet these needs, there are opportunities for technology to begin to bridge the gap. The number of children, and the impact on their lives of living in a fragile and chaotic environment without education, means that finding solutions is an emergency in itself (Daniel, 2010; Tooley, Dixon, Stanfield, 2008).

During a humanitarian disaster, a country's educational infrastructure is significantly affected, and spending on schools and teachers decreases. These impacts make it even more difficult for low resourced countries to reach the sustainable development goals (SDGs) of universal primary education. Basic (primary and lower secondary) education helps reduce poverty by improving health, increasing productivity, and equipping people with the skills they need to participate fully in the economy and in society. Investment in education contributes to the accumulation of human capital, which is essential for generating higher incomes and sustained economic growth. According to the 2002 World Bank report 'Returns to Investment in Education,' workers with higher education tend to earn more than those with less education in every country studied (Psacharopoulos & Patrinos, 2002).

In September 2000, The United Nations Millennium Declaration was signed which committed world leaders to combat poverty, environmental degradation, hunger, disease, illiteracy, and discrimination against women. The Millennium Development Goals (MDGs) were derived from this Declaration and were in place until 2015. Until 2015, there had been a range of serious criticisms leveled at the MDGs, which argued that the resources spent on trying to meet the MDGs had only been partially successful and new methods and paradigms were needed (Waltham & Sayed, 2013). The current agenda is the 'shift in the global conversation on education from a focus on access to access plus learning' (UNESCO, 2016b). Additional challenges, where children may drop-out, fail exams, or not learn enough during their education (UNESCO, 2016b) invalidate access as a standalone indicator of successful provision. There is a renewed focus on quality education and whether access should still be considered a suitable indicator of success. Several studies of the EFA (Education Funding Agency) framework have noted a shift away from seeing access as the only indicator of success towards a focus on quality (Morgan et al., 2014). Studies have also noted that the resources needed to deliver education via traditional, formal access modalities are unlikely to be found (Burnett & Felsman, 2012). For these reasons, it is even more important to have solutions that meet the SDGs by moving beyond the challenges that occurred while trying to meet the MDGs.

In addition to the focus on quality and learning outcomes, a critical area of focus is on education as a protective measure for children and communities:

Education for children whose lives have been affected by war is a vital protection measure... Lack of investment in and creative, participatory work on education for children and youth at risk makes a return to peace extremely difficult, if not impossible (Sommers, 2002, p. i).

One of the areas where the need is pressing for education to act as a protective measure for children and communities is the Middle East. Particularly in Syria, where the civil war is now in its eighth year, the capacity of basic social services such as education have been pushed to a critical point. The ongoing conflict and related displacement means that an estimated 1.3–6 million Syrian children aged between 5–14 years old are either out of school or only have irregular attendance. Extending the age range to include children aged between 15–17 years old increases the number of out-of-school children by 2.1–4 million (UNICEF, 2015).

Whilst they are exploring e-learning in the global North, Ng and Nicholas (2009) argue that the processes of engaging with mobile technologies has a range of positive impacts on life skill acquisition, such as self-direction, critical analysis of tasks and topics, and overall increased cognitive ability. In their review of education for children in Gaza, Jabr and Cahan (2014) found that formal schooling has less impact on cognitive ability in refugee contexts than in others. They conclude that there is a need to focus on establishing appropriate and recognisable education models which take into account the other aspects of refugee life, including protection, family support, developing life skills, and so on. All of these should be integrated into NFE models in a way that positively impacts on a student's 'ability to benefit from schooling' (Jabr & Cahan, 2014, p. 168). There are several successful tablet and mobile interventions for underserved children discussed in the next section.

Tablet and Mobile Interventions for Underserved Children

In the outline of the global policy framework above, traditional approaches are seen as being unlikely to meet the existing needs of education in emergencies. One key area of opportunity has been promoted, namely 'the use of interactive computer technology in education [which] can

increase access to learning opportunities' (UNESCO, 2009, p. 9). Whilst there is a huge range of literature on children and technology in general, the brief discussion here focuses on aspects which are relevant to the context of tablet interventions in the Middle East and Africa.

Mobile Phone Intervention in Kenya and Uganda

Recent years have seen a rise in digital learning programmes in Africa and South America. These programmes can be successful in providing quality education to children in remote or difficult circumstances, as they focus on curricular support modules using interactive audio recorded messages or SMS. For example, Xavier Project supports safe learning spaces for refugees in urban Kenya and Uganda by sponsoring students through language learning and vocational training. Xavier Project

collaborates with Eneza Education, a programme that allows users to call or text to receive quizzes and lessons (Eneza, 2018).

In their joint collaboration, Xavier Project uses Eneza's subject-specific quizzes, which are aligned with the Kenyan national curriculum. Students can also access Wikipedia or ask a tutor at the centre for help. The face-to-face interaction with tutors is a key community engagement tool, according to Xavier Project's

CEO, while access to the Eneza quizzes allows students to test their knowledge against standardised tests (Dahya, 2016).

Libraries Without Borders has also started several education initiatives. For example, the Ideas Box -- a mobile 'pop-up' multimedia centre and learning hub, offers educational resources to communities in need, including refugee communities (LWB, 2018). As part of the Ideas Box,

4000 Congolese refugees in Burundi's Kavumu and Musasa camps received access to the learning hub. The Ideas Box takes the unique approach of locally developing and creating the box, using local resources, and accounting for local norms and practices (Dahya, 2016). The materials include laptops, tablets, e-readers, and curricular materials. Resources are continuously updated based on users' interests, and local instructors support the users' learnings (Dahya, 2016).

Tablet Intervention in Zambia

Another Libraries Without Borders programme is Vernacular, an e-learning programme that covers a variety of reading activities for children in Zambia. Primary school children use Android tablets with software customised with the local language, artwork, and audio recordings. Children can practice reading and receive

immediate feedback. The programme was evaluated through a randomised control trial, which showed highly positive results with learning gains throughout 30 community schools. The software is designed so that it can easily be used in new language contexts (USAID, 2017).

Tablet Intervention in Malawi

Another example is the onebillion learning initiative in Malawi. A randomised control trial assessed the results of implementing onebillion's tablet-based numeracy and maths programme, which uses applications (apps) with games for children (Pitchford, 2015). This intervention delivered core mathematical concepts through colourful and engaging activities, allowing children to work at their own pace and practise particular skills. Progression was assessed by quizzes that required 100% accuracy, and children earned gold stars on passing each quiz as the teachers monitored their progress. Teachers delivered the intervention over eight weeks for 30 minutes a day. Children in the intervention groups reported greater learning gains than children in the control groups, with

significant improvements related to the maths tablet intervention over standard face-to-face teaching (Pitchford, 2015).

While the above examples are positive developments in mobile interventions for underserved populations, there is room to provide solutions that can increase engagement and provide children with the experience of being in flow. These solutions are more game-based, such as digital game-based learning (DGBL). One significant gap is the unanswered question of which game designs best offer a zone of proximal development and flow. It is also still unclear how to qualify games that are used for learning and those that are specifically developed for learning.

Digital Game-Based Learning as a Potential Solution

At its core, DGBL can be called 'Equitable Edtech', which is a tool designed to close the learning gap for the underserved (Klement & Erikson, 2018). Digital game-based learning is particularly suited to humanitarian crises in which large numbers of children cannot attend school and where classes are overcrowded and teachers are overburdened. In these situations, provision of quality alternative education opportunities must be scaled-up in underserved regions. Digital game-based learning is an effective, sustainable, and low-cost form of learning support and is, therefore, one of the most viable strategies to address this gap. The evidence on which this is based is less clear than the optimism it expresses. Overall, whilst the possible impact of DGBL is seen as being significant, many authors (Latchem, 2012; Selinger, 2009) agree with Daniel's (2010) cautionary statement:

While computers do enrich children's lives and encourage self-directed learning, they need to be embedded within a wider framework if they are to make a systematic contribution to achieving E[ducation] F[or] A[ll] (Daniel, 2010, p. 43).

The above quote cautions about the replacement of a formal educational system with an application based solution. Through this report we do not aim to neglect the social and psychological benefits of formal school attendance, but rather propose that DGBL can be a potential solution to bridge the gap for underserved populations. That said, DGBL is effective for the following reasons: (1) students will play games longer than they will engage in regular learning activities, (2) engagement increases as time is spent on tasks, and (3) increased time in tasks means an increased level of learning (Sigmund, Fletcher, & Chen, 2011).

Thus, DGBL can be effective in underserved populations for several reasons:

Cost-Effective

In traditional learning, longer learning periods incur additional costs, such as the salaries of teachers and the cost of materials. The per-unit cost of a game has the potential to be much lower. A good example is the German-based learning platform, Bettermarks, which was implemented in Uruguay in 2013. The platform was installed in Uruguay's public school system for middle and high school

maths at a cost of USD \$1.50 per student per year. Research by Centro de Investigaciones Economicas demonstrated an increase (2.6 standard deviation) in student maths scores over three years. To achieve this degree of academic success would require students to attend school an additional 1.33 months a year for three consecutive years, increasing costs for teachers, administration, supplies, and student resources.

More Effective Learning

Teaching through technology can be more effective than traditional teaching (Cassidy, 2004; Squire & Jenkins, 2003). Research already shows that games allow the brain to work more effectively and for longer periods of time (Pange, 2003). As motivation is key to learning and games are designed to be highly motivating (Schell, 2008), the potential for learning is higher. In their review of 32 articles for games and learning, Vogel et al. (2006) found that students had more cognitive gains

when they used simulations or games compared to those that used traditional learning methods ($z = 6.051$, $p < .0001$, $N = 8549$). This result may relate not only to engagement, but also to students' ability to direct their own learning journey. This self-direction can free teachers from traditional didactic presentation and allow them to focus on assessing students' strengths and weaknesses (Klement & Erikson, 2018). Therefore, the pace at which students are able to learn accelerates.

Quality Education for All

With DGBL, every student has an equal opportunity to receive a high-quality education. The games provide uniformity (which is more difficult to achieve with teachers who have individual preferences), differing abilities to motivate students, and varying levels of knowledge. When computer software is grounded in a well-constructed curriculum and appropriate for the child's developmental stage, digital games can support both teachers and students in their

Accessibility

DGBL supports increased accessibility to the four billion people in the world that have limited Internet access. Mobile technologies, such as tablets, are particularly suited to environments that lack educational resources or that have overcrowded classes and insufficient training (Pitchford, 2015).

Autonomous Learning

Digital game-based learning interventions in low- and middle-income countries have demonstrated improved achievement and increased motivation to learn while also creating a learner-centred environment. It is this learner-centred environment that enables children to work at their own speed and difficulty levels, giving them the opportunity to properly learn concepts and, therefore, improve their academic performance. Digital games give learners control over pace, order, and strategy (Garris, Ahlers, & Driskell, 2002). A sense of control determines whether learners have

Performance Feedback

When children learn autonomously by playing an educational game, the game itself should provide feedback on the correctness of their answers. The use of technology should enable active learning, with a focus on the activities and interaction of learners, instead of on content in the sense of pre-prepared learning

learning outcomes (Kucirkova, 2014). Student learning also depends to a large extent on the quality of teaching. Game-based education is less dependent on the school or government's ongoing financial situation in order to pay qualified teachers or assistants. A tablet can deliver one-to-one learner-centred interactive lessons in a consistent manner, making the school less dependent on the presence of a qualified teacher in the classroom.

While there are still barriers to technology implementation for remote regions. Digital game-based learning can offer accessibility through equitable education and providing access to education to an increased number of children.

'agency' and actually feel that they can influence events in the game. More learner control leads to higher learner motivation (Ryan & Deci, 2000). In addition, most DGBL games are designed to be single-player (Michael & Chen, 2005). This allows for asynchronous game design, in which the player can start and stop at their own pace (Michael & Chen, 2005). This capability promotes self-paced learning and allows players to develop their skill level as needed, without falling outside the zone of proximal development described by Csikszentmihalyi (1990).

materials (Collis & Moonen, 2001; Jonassen, Peck, & Wilson, 1999). Where we traditionally place this role with the teacher, sometimes using computer-programmes has an advantage: they are always able to consistently give feedback, which is something that is unlikely to happen in under-resourced, overcrowded

classrooms. In addition, adaptive feedback should be given (i.e., feedback on process as well as on results), allowing for children to react, think again, and receive tips to find the right answer. This approach increases attention and time on task, which in turn positively influences learning results (Carroll, 1963).

As games are coded for progression and reward systems, they are coded to provide immediate performance feedback. The player receives immediate feedback about how well they are learning the concepts, and they can make

Replicability

Digital learning games can be designed as hard-wired or shell games (Michael & Chen, 2005), or they can be designed between hard-wired or shell games (as in engine games). As discussed in Chapter 1, hard-wired games are designed to be used once, while shell games are designed to be replicated. The initial engine and curriculum databases are designed one time (with improvements

Motivation

Whilst learning without the support of a teacher, children will most likely not stay motivated over a long period of time unless they are intrinsically motivated. Learners who are intrinsically motivated engage in the learning process for 'its own sake, for the enjoyment it provides, the learning it permits, or the feelings of accomplishment it evokes' (Lepper & Lyengar, 1999, p. 349). Also, the more intrinsic the motivation, the more durable the learning may be (Trinder, 2013).

Assessment

Components of digital technologies, such as data storage and collection, detect learning gaps, encourage help-seeking behaviours, and refer the most at-risk children for further educational support. The ability of DGBL to continuously store large quantities of data is

adjustments as necessary. Performance feedback through reward systems also keeps players engaged and motivated. This motivation and engagement in turn creates the experience of flow (discussed in Chapter 1) for players. In this way, digital game-based learning supports the zone of proximal development (when the skill level of the player is in balance with the level of challenge) (Csikszentmihalyi, 1990). Thereby, the successful completion of tasks also supports players in developing a positive self-image and confidence, including feeling ambitious, creative, and optimistic (Beck & Wade, 2004).

and iterations), and only videos and assets need to be redesigned. The games can, therefore, be adjusted to match the learning objectives at each location without needing to be completely recreated. The advantage of DGBL is that it can be designed for replicability. This replicability allows for a design that can be duplicated and implemented in more regions with underserved children.

Research on digital mathematics interventions has shown increased motivation (Rosas et al., 2003), more positive attitudes towards mathematics (Ke, 2008), and a better mastery of mathematics for children in kindergarten and primary education (Li & Xin, 2010; Praet & Desoete, 2014; Räsänen, Salminen, Wilson, Aunio, & Dehaene, 2009; Steenbergen-Hu & Cooper, 2013).

not only essential in monitoring and evaluating programmes; it is also a groundbreaking concept in the humanitarian field, where few large-scale prevalence studies have been conducted involving children affected by armed conflict and displacement.

Why is Can't Wait to Learn Needed in Underserved Regions?

The literature also shows that learning games have positive learning outcomes. Several meta-analyses reported that games and interactive simulations were more dominant than traditional teaching methods for cognitive gain outcomes, learners demonstrated statistically significant positive effects of computer technology on mathematics achievement, and digital games for learning were found to be more effective for learning and retention when compared to conventional instruction methods (Vogel et al., 2006). Moderator analysis on these meta-analyses also indicated that interactive simulations, additional instructional methods, players working in groups, and a higher level of education all positively impacted results.

CWTLs validity has already been confirmed in a pilot study (Stubbé, Badri, Telford, van Der Hulst, & van Joolingen, 2016; War Child Holland, 2016) in remote villages in Sudan and is currently being piloted in Jordan, Uganda, and

Lebanon. Unlike other technology projects where teachers are required to help students practise learning principles, CWTL was designed to teach the mathematics curriculum without requiring prior knowledge or experience in a school setting. The results demonstrated significant increases in mathematical knowledge and motivation to learn when compared to the control condition of face-to-face teaching (Stubbé, Badri, Telford, van Der Hulst, & van Joolingen, 2016).

The programme has since expanded to other regions in the Middle East and Africa. When designing CWTL, the choice of initial programme countries (Jordan, Lebanon, Sudan, and Uganda) was made to allow for testing of the most common education in emergency modalities. The combination provides a good cross-section of the target groups found in education in emergency sectors more generally. The explanation of why these regions were selected is explained in the following section.

Regions for Can't Wait To Learn Implementation

Sudan

Sudan has experienced almost sixty years of conflict, beginning even before independence from the British in 1956. Africa's longest running civil war with what is now South Sudan lasted decades (Thomas-Slayter, 2003), and internal conflict has been rife in some areas of the country, notably Darfur. Before South Sudan seceded in 2011, Sudan was the largest country in Africa, and it remains a vast and diverse nation. Three of the 18 states that make up Sudan are still contested and are known as the Three Protocol Areas. Abyei, South Kordofan, and parts of Blue Nile State remain at war, although the context of the conflict (e.g., drivers, actors, etc.) remains dynamic.

Sudan is also home to more than two million internally displaced persons (IDPs) and around 300,000 refugees from neighbouring countries (UNHCR, 2017a). These dynamic populations are almost all based near Sudan's external borders. Across the country, communities suffer unequal access to social services and basic resources.

Despite these challenges, Sudan is relatively successful with regard to basic education. Rates of net primary enrolment are around 76.4% and completion is around 79.3% (UNICEF Sudan, 2017b). However, more than 3 million children aged 5–13 are still out-of-school (UNICEF, 2017b). There are significant

infrastructure challenges around school resourcing, poor learning outcomes, and low federal spending. The accessibility and quality of education for children in states affected by conflict also dramatically reduces: across the country, gross enrolment rates (GER) range from 85% in Al Gezira to 37% in East Darfur (Ministry of Education Sudan, 2012).

Children disadvantaged by their location, gender, or socio-economic background are also less likely to join a school and less likely to complete basic education. Populations on the move, such as pastoralist or nomadic groups, are not catered for, especially those whose traditional stock routes are cross-border (Dulvy, et.al, 2012). Three quarters of all nomadic children in Sudan aged 6–13 are out-of-school, and in four of the 15 states where nomadic populations are found, this rises to 100% (UNICEF, 2017b). In this context, complex and mutually reinforcing patterns of disadvantage – poverty, gender inequity, disability, conflict, and displacement – raise barriers to schooling and erode educational opportunities for children (UNICEF, 2017b). Formal education

opportunities are widely unavailable, and when available, often exclude the most vulnerable children. Girls are particularly disadvantaged due to socio-cultural beliefs, negative attitudes towards educating girls, the cost of schooling (both direct costs and opportunity costs, such as the loss of child labour), distances between schools and homes, safety concerns, and child marriage, especially in rural areas.

Any effort to make traditional basic education accessible for today's marginalised children in Sudan would require substantial investment, including. The recruitment of teachers, significant training and supervision provided to existing teachers, the construction of classrooms, and a drastic increase in government education budgets (Ali, 2014). New solutions are urgently required for the current generation of out-of-school children living in Sudan – solutions which tackle issues of access, equity, and quality. Innovative education technology, when coupled with a strong partnership and context-specific approach, could provide these children with a previously unimagined chance to access quality education opportunities.

Can't Wait To Learn Educational Goals for Sudan

In Sudan, we target out-of-school populations who, without innovative approaches, would not have access to any government-supported learning opportunities.

Lebanon

Seven years into the Syrian civil war has had a profound impact on Lebanon. The crisis resulted in making Lebanon the third-largest refugee-hosting country according to UNHCR Global Trends for 2017 and the host for the largest number of refugees from Syria (UNHCR, 2017a). Lebanon is also the host for around 450,000 refugees already living in the country. Lebanon has continued to host the largest number of refugees relative to its national population, where 1 in 6 people are refugees and 1 in 4 are Palestinian refugees. Three categories of vulnerable communities were

Research Aims for Sudan

A proof of concept study of Arabic language components and the Reading Game for use in remote village settings. This would determine whether the CWTL reading programme can be feasibly delivered to enhance the teaching and learning experience.

identified in Lebanon: 1.5 million vulnerable Lebanese, 1.5 million displaced Syrians, and around 320,174 Palestinian refugees. In an already suffering economy, the impact of war in Syria has added to increasing economic, social, demographic, political, and security challenges. The situation has resulted in contention over limited resources between host and refugee communities. However, there has not yet been open inter-community violence, but concerns are beginning to rise over Lebanon's fragile political and social balance.

The population influx to Lebanon has increased the demand on education services, not only in numbers, but also in terms of meeting different needs, since children coming from Syria face challenges learning the Lebanese curriculum. The education of children that come from displaced families is often disrupted because they either do not have access to school due to different reasons (economic reasons, lack of transportation, child labour, etc.) or they have to cope with a different curriculum and other educational challenges. Many children have missed school for several years and are now over-age, and some are discouraged from going to school in order to work and help bring income to the family. Others have witnessed serious acts of violence and are in need of psychosocial support.

The Government of Lebanon (GoL), in collaboration with UN agencies and national and international partners, developed the Lebanon Crisis Response Plan (LCRP) to provide humanitarian assistance and protection to almost 2.8 million highly vulnerable individuals. The education sector is an area that is suffering and where supply is not meeting demand. The Ministry of Education and Higher Education (MEHE) developed the 'Reaching All Children with Education' (RACE) plan. RACE was developed in 2014 in response to the Syrian Crisis and challenges in the education sector. The plan is aligned with the 'No Lost Generation' strategy developed by the UN, World Bank, and GoL. The plan will take place over several years and commits to providing 470,000 school-aged displaced Syrian and poor Lebanese children with access to quality education by 2016. Of this total, 200,000 Syrian children will be enrolled in formal education.

According to UNHCR July 2016 estimates, Lebanon hosts 488,236 children and youth (aged between 3–18 years). Of compulsory school-aged children (6–15 years old), 42% were enrolled in formal public education programmes during the 2015/16 scholastic year. As part of RACE, MEHE opened second shift schools in the afternoon in order to increase the capacity of public schools to take in the increasing number of children coming from Syria. The ministry also put in place incentives

like waiving documentation requirements for non-Lebanese children to encourage parents to enroll their children in schools. While great strides have been achieved in providing education to a significant number of vulnerable Lebanese and non-Lebanese, the enormity of the Syrian refugee influx has had a significant impact on an already compromised Lebanese public education system.

Can't Wait To Learn Educational Goals for Lebanon

In Lebanon, we target out-of-school populations who are over-age and have not been in school for a number of years and/or are not eligible for government-endorsed alternative learning or formal school programmes. We provide a pathway to these programmes for children in these situations.

Research Aims for Lebanon

These are the current projects in Lebanon:

- Determining whether there are improvements in children's numeracy competency and psychosocial well-being after using CWTL for 3 months and then for 12 months.
- Assessing baseline levels of numeracy competency and psychosocial well-being in out-of-school children attending partner organisations that will deliver CWTL.
- Determining whether there are differences in baseline numeracy competency and psychological well-being between various demographic groups of children.
- Determining which demographic or service implementation factors may lead to better learning outcomes from the CWTL programme at 3 months and at 12 months
- Determining which demographic or service implementation factors may lead to better engagement [attendance records] and retention [drop-out] with the CWTL programme at 3 months and at 12 months.

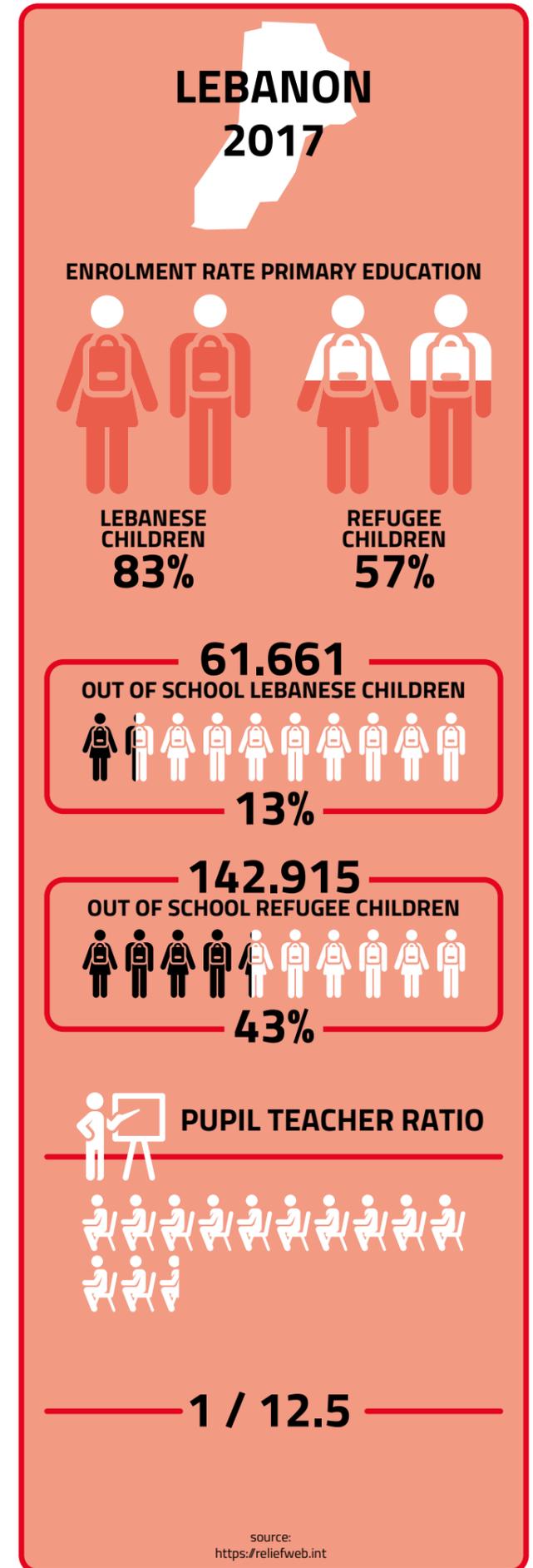
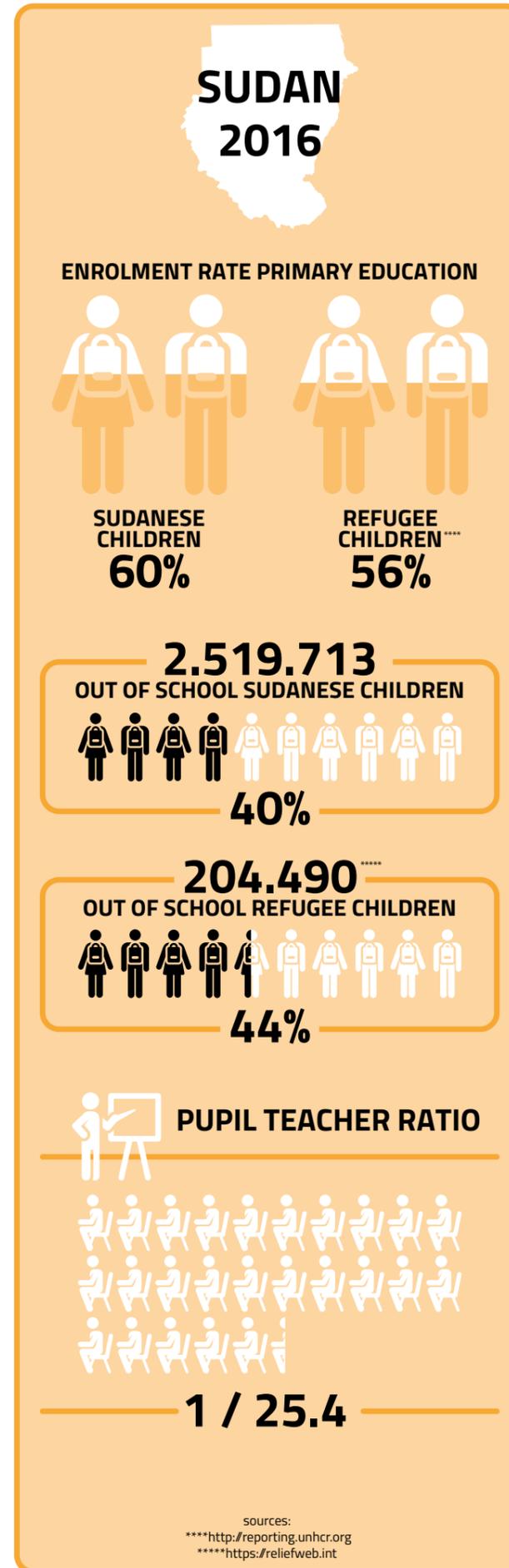


Figure 9. Primary School Enrollment in CWTL Regions.

Jordan

The Syrian conflict has placed an unprecedented burden on Jordan's public services, particularly its education system. Almost one third of the Syrian refugees registered with UNHCR are school-aged children between the ages of 5–17 (UNHCR, 2017a). While Jordan closed its borders to Syrian refugees in 2016, the formal Jordanian education system has been unable to adequately absorb the large numbers of school-aged Syrian children, leaving many Syrian children to grow up without access to formal education. While pre-war Syria had a school enrolment rate of close to 90%, these high enrolment rates have not translated to the Jordanian context. In the early years of the crisis, education assessments concluded there had been a downward trend in enrolment rates of school-aged Syrian children, which was largely attributed to access and financial factors. Factors such as financial difficulties among families, child labour, and early marriage have contributed to low enrolment rates.

Children who are able to enter the formal education system are often hindered by the schooling environment, leading to low levels of retention. Different dialect and curriculum, bullying and harassment, and practical difficulties such as distance and lack of transport to schools, has contributed to drop-out rates of Syrian children. Public schools in refugee-hosting areas in the northern parts of Jordan are often under-resourced and have difficulties adequately serving the Jordanian school-age population, let alone being able to cope with the increased pressure of additional students. Even prior to the crisis, some public schools operated on a double-shift system to increase classroom spaces. In 2013, the Government of Jordan expanded this double-shift policy to reach a total of 98 public schools, thereby providing more Syrian children with access to the formal education system. While this change in policy was welcomed by the international community, the quality of education provided has been affected and teaching resources have come under strain. This has had implications for both Syrian and Jordanian school-aged children who often struggle to keep pace with the Jordanian curriculum and are at risk of falling behind.

As part of the Jordan Compact presented at the London conference in February 2016, the Government of Jordan committed to ensuring that every child in Jordan would be able to access education in the 2016/2017 school year. This commitment was largely realised through donor-funded infrastructure initiatives which expanded the number of schools available to accommodate double-shifting, and a further 102 schools were upgraded to accommodate additional students. The second component of the initiative focused on ensuring that children who had been out-of-school for extended periods of time could accelerate their learning through an accredited catch-up classes programme which aimed to reach 25,000 Syrian children.

The Ministry of Education's (MoE) catch-up classes programme aims to bridge the learning gap to help facilitate children's reintegration into the formal school system. UNICEF is supporting the MoE initiative by targeting out-of-school children and underperforming children within schools (UNICEF, 2014). However, to date the programme has faced a number of challenges, including a lack of funding and space in which to implement the activities. Furthermore, the programme only targets children between the ages of 8–12, leaving many children unable to access return pathways to formal education. While some 170,000 Syrian refugee children are enrolled in the 2016/2017 school year, approximately 91,000 Syrian children registered with UNHCR remain outside of the formal education system. The most vulnerable and marginalised Syrian children remain unable to access education services due to a combination of financial barriers, lack of transport options, and a lack of documentation to register in schools. While the Government of Jordan has made significant policy changes to improve access to education, the focus to date has largely centred around infrastructure upgrades, and much remains to be achieved in terms of ensuring better quality education services for Jordanian and Syrian children alike.

Can't Wait To Learn Educational Goals for Jordan

In Jordan, we target host and refugee communities in a formal school system that is under stress due to the huge influx of refugees. In Jordan, we also target alternative learning centres.

Research Aims for Jordan

Upcoming projects include a quasi-experimental trial in Jordan to test whether integrating CWTL into formal classroom teaching can improve student literacy and numeracy competencies in overburdened formal schools.

- A proof of concept study of the mathematics and Arabic components for use in the formal public school setting to determine whether the CWTL programme can be feasibly delivered within the formal classroom setting to enhance the teaching and learning experience. This will be the first implementation experience with the Arabic component of the game and also the first implementation in a school setting.

Another project is the development and pilot of an Arabic literacy component to the game, alongside the mathematics.

These are the current studies in Jordan:

- A proof of concept study of the mathematics and Arabic components in Learning Support Centres to determine whether the CWTL game can be feasibly delivered to out-of-school children in Jordan.
- A full-scale cluster randomised controlled trial (RCT) in Jordan testing whether integrating CWTL into formal classroom teaching can improve student literacy and numeracy competencies and well-being (hope, self-esteem, and self-efficacy) in formal schools in Jordan.

Uganda

Uganda is currently hosting more than 1.3 million refugees, approximately one million of whom are from South Sudan, with smaller populations of refugees from the Democratic Republic of Congo and Burundi. Of the approximately 1 million South Sudanese refugees, more than 600,000 arrived within a period of 5 months from August to December 2016. The situation was initially dubbed 'the children's crisis' by the northern Uganda host population, as more than 60% of arrivals were children, many of whom were unaccompanied. Children of school going age now make up more than 65% of the entire refugee population.

The South Sudanese refugees in northern Uganda have fled a context of extreme violence and insecurity. Many have witnessed violence themselves or have lost family or loved ones to violence. This is often carried out along ethnic lines, but is sometimes due to the plundering of

villages by armed groups loyal to one of the warring factions of the South Sudanese People's Liberation Army, as well as criminal gangs taking advantage of the disorder caused by the conflict. The journey to northern Uganda is often made on foot, during which refugees often lack food, water, and shelter, and are left vulnerable to criminal activity along the way, including sexual violence. Although the exact number is not known, an estimated tens of thousands of children have crossed the border into northern Uganda unaccompanied by an adult or family member.

A needs assessment carried out by War Child in late 2016 on the situation of South Sudanese refugees in northern Uganda revealed a population with severe mental health and psychosocial support needs, on top of their basic needs for survival-- water, food, shelter, education, and medical care. Although the

government of Uganda, supported by the UN Country Team and the World Bank, quickly established a comprehensive and progressive policy toward the refugee influx (formalised in the Refugee and Host Population Empowerment Strategy (ReHOPE, 2017), the rapid nature of the influx and the sheer size of the refugee population strained the humanitarian response. Mental health and psychosocial support services are still scarce, while education services are reaching less than half of the school age population.

Those children who are able to access education – whether through the Uganda formal school system or through accelerated education programmes provided by non-governmental organisations -- are still facing major obstacles to learning. One of the key issues is simply the lack of resources. Classrooms are severely overcrowded, with teacher to student ratios at times reaching 1:100, while the average is widely cited as more than 1:60. This is due to a lack of classrooms and the lack of availability of trained teachers. In addition, there is a severe shortage of textbooks. South Sudanese children also experience difficulty adapting to the Ugandan curriculum: they face language barriers with teachers who do not speak the same mother tongue, and the curriculum is often in English; they have a heavy workload at home; and they experience corporal punishment, and sometimes sexual abuse, in the school setting.

The provision and quality of education has been a challenge due to the levels of poverty and history of conflict in the northern and eastern regions of Uganda. These regions continuously rank lowest in terms of school performance and literacy, and only 30% of children who enter primary school go on to complete their primary school education (African Educational Trust). Additionally, the conflict in the West Nile region and northern Uganda destroyed and shut down many schools, resulting in many children never receiving an education. According to the Africa Educational Trust, the fact that 'most schools

are unable to offer local language education, only makes matters worse' (Africa Educational Trust, 2018), and there is a lack of books and materials to help children learn how to read. It is clear that 'despite the number of people living in poverty in Uganda halving over the last decade, Uganda continues to struggle with inequality in the post-conflict North and the impoverished rural East of the country' (UNHCR, 2017a).

With the high influx of refugee children, the existing education infrastructure cannot cope with the scale of education needs, which requires increased availability of schools, provision of materials, and training of teachers (UNHCR, 2017b). In response, a number of INGOs are running accelerated education programmes based on a curriculum developed by Uganda National Curriculum Development Center, with support from the Norwegian Refugee Council. However, challenges of access and quality remain. According to War Child's Rapid Needs Assessment on the South Sudanese Refugee situation in Uganda (2016, p. 24), 'facilities in Bidibidi are overcrowded and student-teacher ratios are high. Windle Trust in Bidibidi reported that also language barriers are an issue as well as proper transition between the South Sudanese education and Uganda's education curricula for primary and secondary schools.'

A UNHCR report dating from December 2017 states that 53 percent of the refugee children attend primary school (including accelerated education) while only 10 percent are enrolled in secondary education, with the latter demonstrating a large gender gap (33 percent girls) (UNHCR, 2017b). An estimated 298,079 refugee children between the ages of 6–17 are out-of-school. This not only negatively impacts their education, but, according to a recent UNICEF report, the spectrum of protection risks faced by South Sudanese children is amplified by the fact that 64 percent of all South Sudanese refugee children between 3–17 years of age in Uganda are not enrolled in primary or secondary school (UNICEF, 2017a).

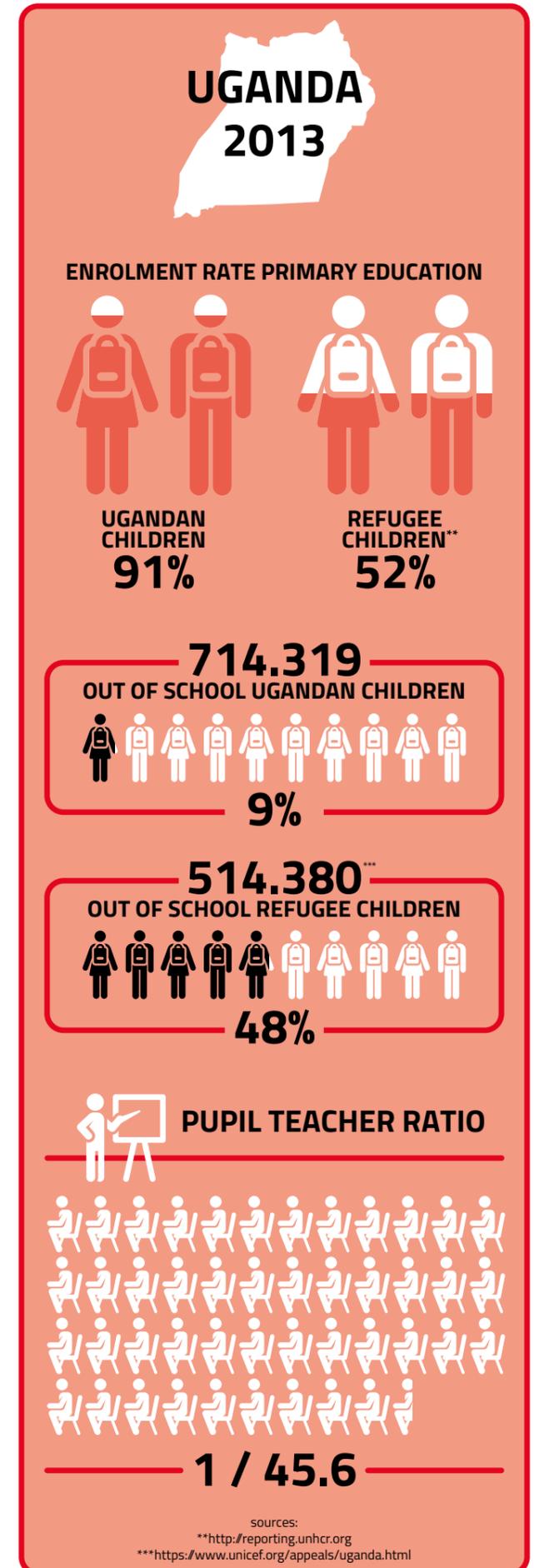
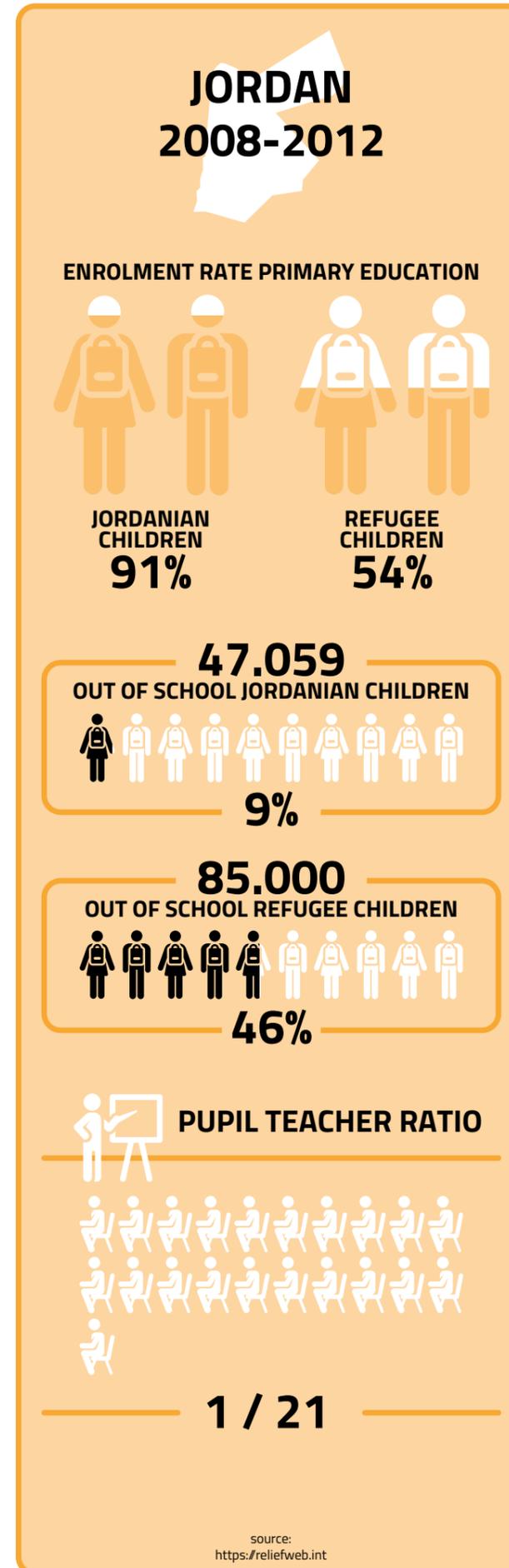


Figure 10. Primary School Enrollment in CWTL Regions.

Can't Wait To Learn Educational Goals for Uganda

In Uganda, we target the refugee settlements and the refugee population from and hosted in a low resource setting, who have had limited or no access to education before being displaced.

These are the current projects in Uganda:

- A trial period of the mathematics and reading components for use in the refugee camps to determine whether the CWTL programme can be feasibly delivered within the refugee setting to enhance the teaching and learning experience.
- Assessing baseline levels of numeracy competency and psychosocial well-being in out-of school children in the refugee camps attending partner organisations that will deliver CWTL.
- Determining whether there are differences in baseline numeracy competency and psychological well-being between various demographic groups of children.
- Determining which demographic or service implementation factors may lead to better learning outcomes from the CWTL programme at 3 months and at 12 months.

Programme Aims for Uganda

In this context, CWTL will be implemented as part of the accelerated education programmes. These are designed to support children ages 10–18+ 'catch up' to their age grade level by following a condensed curriculum or to achieve their primary school certificate in 3 years.

Summary

UNICEF's comprehensive 2017 report on the education emergency in the region outlines a range of challenges in educational delivery: access to formal education, including overcrowding; obstacles for children who previously attended school but have missed out on intervening years (e.g., recent changes in the Jordanian policy approach mean that children who have missed one whole year of school are no longer eligible to join formal education and must join the NFE route); accreditation and opportunities for further or higher education; and difficulties in moving between national curricula (UNICEF, 2018). Therefore, the rationale is to create an intervention and accompanying applied research framework which works at the junction between the need for a new model, the specific needs of children in the Middle East and Africa (in particular refugee children or those living in emergencies), and the opportunities presented by technology in bringing these together. The technology must be applied to improve access, to support the uptake of current systems to reach the most disadvantaged, and to leapfrog students into the formal system whilst equipping them with additional psychosocial, technological, and life skills. Our DGBL solution, CWTL, is designed to address the educational needs of underserved markets, the details of which are discussed in the next two chapters.



**Can't Wait To
Learn - Uganda
Maths Game**



Game Design in Uganda

The Can't Wait to Learn Maths game is designed to familiarise players with mathematical concepts, to help players complete challenges, and to provide players with opportunities to learn and improve mathematical skills. Can't Wait To Learn Maths is designed to help players develop an understanding of whole numbers, including concepts of correspondence, counting, cardinality, and comparison; represent, compare, and order whole numbers, and join and separate sets;

learn to add and subtract and develop strategies for basic addition and subtraction, including whole-number relationships (e.g., tens and ones); and develop understanding of base-ten numeration system and place-value concepts, including fluency with multi-digit addition and subtraction. This section reviews the design of the Can't Wait To Learn Mathematics Game, including its goal, core activity, design, curriculum, and quality assurance testing.

Pedagogic Background to the Maths Game

Since this project focuses on vulnerable children with little learning support from parents or teachers, we assume they have little informal mathematics knowledge. The opportunities to learn from everyday life situations in the community are scarce. Because of this, the approach for struggling learners was followed. One of the major issues in supporting struggling learners is to ensure there is a strong basis upon which to build. This corresponds with the concept of mastery learning (Bloom, 1985), where 'the students are helped to master each learning unit before proceeding to a more advanced learning task' (p. 4). Furthermore, struggling learners need explicit instruction (Milo, 2003; Timmermans, 2005). Research shows that struggling learners show less engagement during instruction (Bodovski & Farkas, 2007), and if this engagement is increased, performance increases as well.

A focus on 'time on task' could help to improve learning results (Carroll, 1963); all children can learn mathematics, but some need more time than others. To support struggling learners, instruction and exercises on the mathematical skills that are often acquired informally are

included in the game. In addition, direct instruction is given, which explains how to 'do it'. For Uganda, the language of instruction is basic, formal English. Though, Uganda has multiple languages of instruction, English was chosen due to the number of different languages spoken by the refugee/host groups. The instruction in the videos is provided by slightly older children (11–13 years old), which may increase the motivation to watch the instructional videos. Furthermore, these older children can also be seen as role models, increasing motivation to learn, as well as self-efficacy.



Figure 11. Uganda Maths Game; Open world with game guide.



Figure 12. Sample mini-game: Bus Game (learning principle: addition and counting). This addition game has two parts. First, the child has to count the number of people that are on the bus. As more people get on the bus, the child must use addition to find the total amount of people on the bus.

Overview

The design of the Maths Game resembles that of a city-building game (e.g., SimCity). In a city-building game, players must build, manage, and lead a town. These games provide continuous positive reinforcement and allow players to determine their progress by entering and exiting game sessions. They appeal to players' ambitions to build and collect an increasingly large and complex city (Krom, 2012).

The Maths Game also motivates players to help build a town, village, or city. Upon entering the game, the player sees an empty world with ten locations. Depending on where the game is published, the map is contextualised to match the children's familiar environment. In Uganda, for example, the map contains 10 locations in the rural West Nile Area.

Each location is linked to a different character, and a game guide explains the game's purpose. This game guide also orients the player,

describes next steps and required actions, and makes suggestions about certain characters to help. In this way, the player is introduced to the city-building process.

To begin the game, the game guide leads the player to a location with golden sparkles. When the player clicks on a location, a small instructional video appears in order to introduce a math concept. At the end of the video, a mini-game opens.

A mini-game is a didactic challenge or problem and consists of a number of questions. As each question is completed, a smiley face appears at the top of the mini-game screen. After successfully completing three mini-games, the player receives a star or brick that helps build a house. The player has several attempts at completing the mini-game. If those attempts fail, the player can begin again or review the instructional video.

As the Maths Game progresses, the mini-games build on the previous tasks and become more challenging. The numbers become larger, and the tasks within each mini-game become more complex.

There are 73 different types of mini-games in the curriculum for Grades 1–3. Upon completion of the Maths Game, players will have completed all the mini-games and will have helped the townspeople build their town.

In the following sections, we will focus on the game goal, the game narrative, the game mechanics, the visuals, and the rewards that support the player experience. We will then review the curriculum design and learning elements. The quality assurance process and game design assessment is also reviewed. We then conclude with a summary of the implementation for Uganda.

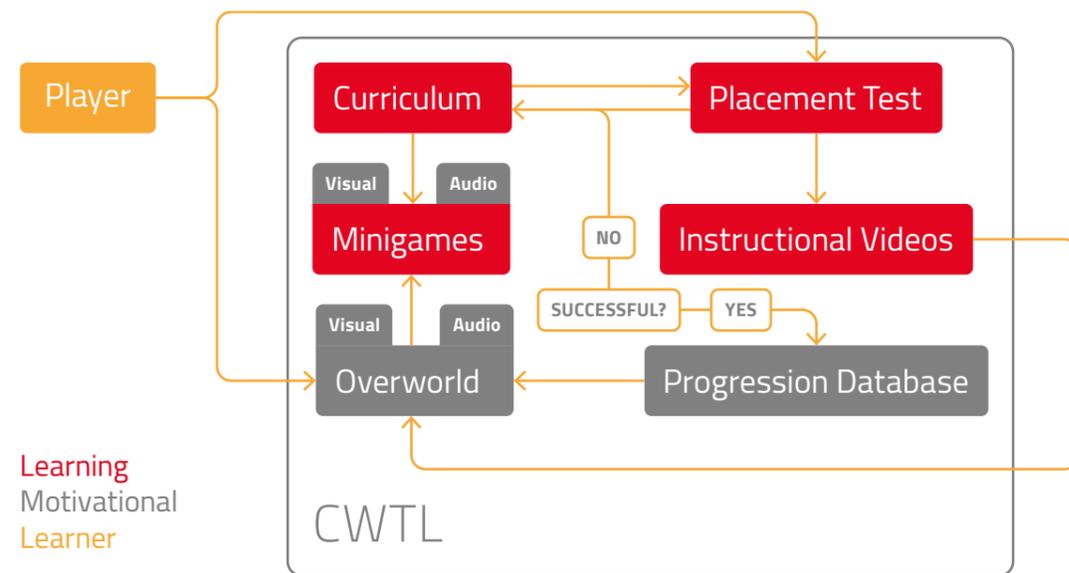


Figure 13. Summary of elements from the curriculum and game play functionality in the Uganda Maths Game.

Game Goal

Cognitive psychologists discuss how goal setting supports consistent management of human action. All games have goals and winning conditions. In digital game-based learning, digital games can have three goals (de Freitas & Jarvis, 2008). First is the didactic goal. In the Maths Game, the didactic goal is to have players successfully complete the maths curriculum for primary school Grades 1 through 3. A second goal is the one provided by the game

experience, including those provided by the reward systems. Establishing player experience goals at the outset, such as constructing a town, focuses the game design process on what the player will find interesting and engaging (Fullerton, 2004). The third goal is the assessment of mini-games and learning goals. The Maths Game captures information on how long a player plays, what mini-games they play, and which ones they complete.

Table 6: Elements of the Maths Game’s Development

| Domain | Team Composition | Process |
|--|---|--|
| Overall game design and development | Game development company and War Child product owner | The overall game design used the requirements for the Sudanese context, such as full school curriculum for certification, accessibility through tablets (of children in Sudan are unlikely to attend school), long-lasting tablets (for remote regions), and design that does not require interconnectivity. |
| Mini-game design and development | War Child educational specialist, War Child product owner, game designer, interaction designer, game programmer | The War Child educational specialist develops the learning goals and education objectives. These are discussed with the product owner, who then discusses the objectives with the game designer, interaction designer, and game programmer. Based on what is technically feasible, the initial idea for the education objective may change. The game is then designed with the interaction designer and game designer, it is developed, and then tested by the game development team. Once the game is complete, the product owner reviews the game and approves it for integration into the larger application. |
| Visual game design | Butterflyworks researcher, future players and users, local visual designers | During the needs assessment and the co-creation process, the local children provide input into the characters and design. Local artists are selected, and their work is presented to the children for feedback and iterations. This includes art in the game world, character art, and art for the mini-games. |
| Curriculum design | War Child educational specialist and War Child product owner | The local curriculum is mapped, and the order of learning objectives is determined. Per learning objective, the suitable mini-games are selected and placed into the curriculum. |
| Instructional video design and recording | War Child educational specialist and on-location videographers, War Child content manager | The educational specialist develops scripts, and War Child creates resources for the scripts. The video is scripted and actors, locations, and props are defined and determined in consultation with the educational specialist. The War Child content manager and educational specialist review the videos to ensure they adhere to content and educational goals. After audio approval, video is shared with the game development team and incorporated into the game. |
| Audio recording | War Child content manager, War Child product owner, internal language expert, and on-location audio producers | The educational specialist develops scripts, and War Child creates resources for the scripts. The voiceover actor is selected, and audio is recorded on location. The War Child content manager and product owner review the audio recordings to ensure the content has been correctly recorded. After audio approval, audio is shared with the game development team and incorporated into the game. |

Game Design

The Maths Game is designed as a single-player game for one child to play in their own game world. There are several advantages to a single-player design. First, the player can pause or stop their game session without syncing the session with other players' sessions, facilitating a custom learning experience for the child. Second, a single-player design provides designers more control over the difficulty levels while simultaneously giving the player control over the pace of learning. Third, a single-player design allows teachers or facilitators to better observe a player's progress and to provide the right level of support when needed (Cassidy, 2004). Fourth, a single-player design allows for an incremental implementation of the curriculum. This design allows players to experience the transfer principle (Gee, 2003), in which they can apply knowledge from earlier mini-games to more complex mini-games. Players also

experience the effects of the incremental principle (Gee, 2003), in which they have the opportunity to slowly progress from novice (learning numbers 1–10) to master level (being able to complete mathematical problems) (Zyda, 2005). Finally, the single-player design allows for ease of connectivity. Since the Maths Game is implemented in remote regions with limited connectivity and access to electricity, a multi-player design would not be possible.

The design of the Maths Game occurred in collaboration with several partners. Table 6 summarises the elements of the game's development.

In the following section, we will review the game design in detail. We first discuss the game's overworld, followed by the narrative, game activities, game mode, and visual design.

The Game World: Overworld

A game world is defined as an environment in which the gameplay or parts of the gameplay take place. The game world is also the space where the player interacts with the various game elements. The game world limits the playing area of a player's movements and creates a basis for a consistent reality logic, namely that the game does not have any inconsistencies or irregularities (Björk & Holopainen, 2005). This means that aspects of the game also mimic reality in a way that a

player would understand. For a player, this means that they can expect to see the same game world with the same elements and the same rules; there are no tricks or unexpected changes.

Play in the Maths Game begins with an open game world view. The Uganda game displays a top-down view, allowing players a commanding view while enabling them to distinguish between individual game elements.

Game Mode

A game mode is a configuration of the gameplay (Sicart, 2008), and a game can have different game modes. Each game mode can have different game mechanics or types of gameplay. In the Maths Game, the game world consists of two modes, city mode and mini-game mode. In city mode, the player can monitor their growing city and can focus their efforts to construct one of two sites. The choice of sites is limited for two reasons. This

limits complexity and allows players to master learning tasks while keeping the gameplay simple. It also enabled the developers to maintain a reasonably sized application for tablets with a low processing power, as allowing for more variety would have required more complex code and a larger application size. The mini-game mode contains the mini-games that launch when the player clicks on locations in the game world.



Figure 14. Empty game world Uganda.



Figure 15. Bird's-eye view of the completed overworld (world map) in Uganda.

Core Activity: Mini-Games

The Maths Game's core learning activity is the completion of the mini-game. A mini-game is an educational task or challenge that must be completed in order for the player to progress. Mini-games challenge players in several ways, including multiple-choice activities where the player must choose the correct answer, matching and arranging numbers and amounts, and writing answers correctly.

Mini-games are commonly associated with the game design concept of 'games within games' (Björk & Holopainen, 2005), which are games played completely within the framework of

Mini-game functionality includes these aspects:

- Every mini-game is fully explained with audio before it starts for the first time.
- Every task in a game is presented in audio. Players can always click the Guide button in the lower left corner to have the task repeated.
- When the player has performed the task, they need to click the Continue button at the lower right corner to continue.
- In tasks with multiple answers, a Confirm button appears to check the player's answers. After this check, the Continue button appears.
- A score is displayed at the top to show whether the player has performed the task correctly or incorrectly. If the player has made too many mistakes, he or she is directed to the Fail screen.
- After all tasks have been completed, the Continue button changes into the Finish button and/or leads the player to the End screen.
- On the End screen, the player can view the score bar to see how many mistakes they have made and the number of points they have received in this exercise. They can also see their player progression in the form of bricks or stars.

Core Mechanics

The core mechanic refers to the actions players take in the game. CWTL Maths uses two simple core mechanics, tapping and tap + hold. Tapping selects the direction of game play, and a player can tap to select a location. A player can also tap the correct answers within a mini-game and tap to move to the next

another game. From a game design standpoint, this design principle keeps the player's experience of reality consistent within a game and does not interfere with the player's immersion. Mini-games facilitate intrinsic motivation by offering players the ability to demonstrate mastery of their skills and abilities, as dictated by Gee's (2003) achievement principle. Increasing mastery creates cognitive immersion (Björk & Holopainen, 2005), in which the player fully focuses on problem-solving within the game. Cognitive immersion in mini-games (and the rewards discussed later in this chapter) support the player's competence and autonomy (Ryan & Deci, 2000).

mini-game. Tapping can also take the player to their own personal space, to view the videos, to have the guide repeat instructions, or to exit out of areas. The tap + hold mechanic, or dragging, can be used in certain mini-games whose elements must be dragged when counting numbers or objects.

Progression and Rewards

As mentioned in Chapter 1, progression can be divided into two parts: game progression and player progression (Bycer, 2013). In the Maths Game, these two types of progression are integrated. The player cannot progress without also mastering the mini-games as they are presented. According to Gee's (2003) achievement principle, players of all levels receive intrinsic rewards from the beginning, and the

game should be customised to each learner's level, effort, and growing mastery while signalling ongoing achievements.

This learning principle is evident in the way accomplishments appear in city mode. In this mode, the learner sees three metrics that let them know how they are progressing: mini-game progression, meter progression, and building progression.



Figure 16. Meter progression shown as a star.

Mini-Game Progression

The first level is the mini-game progression. Each mini-game contains a certain number of questions that must be answered in order to complete the learning goal. Together, these questions comprise a streak. The player can only get a certain amount of questions within a streak wrong before the mini-game is terminated. The player can then select the location and play again. The number of questions that can be answered incorrectly was default 1, but has been changed to be adjustable in the curriculum sheet (fault tolerance).

For the first streak, the player must complete one correct task (out of three presented) in a mini-game. Depending on the curricular requirements for that mini-game, the player sees between one and ten questions and must get a certain amount correct in order to pass. For example, in a five-question mini-game, the player sees three green circles and two yellow circles, indicating that three correct answers are required to complete the mini-game. When the player successfully answers the question, a smiley face appears on one of the green circles.

If the player does not answer the question correctly, an upside-down face appears on one of the yellow circles. Completing one cycle of questions is called a 'mini-game streak', also known as a 'winning streak' in game design (Björk & Holopainen, 2005). Successful mini-game streaks provide the student with mastery points, which accumulate to eventually change the student's in-game mastery level.

The mini-game streaks foster intrinsic motivation and a sense of succeeding at increasingly difficult challenges. The challenging and repetitive work required in these streaks is called the game's 'grind' (Björk & Holopainen, 2005). Despite this grind, players continue playing because they are not bored. Gee (2003) describes this phenomenon in his practice principle, which states that learners invest more time and effort in contexts and situations that interest them.

Meter Progression

If the player successfully completes the mini-game streak, they see a second level of progression, called a meter. The meter progression is shown as a star or brick. Once the streak is complete and the mini-game play is finished, the player sees a partially completed star or brick. When a player has completed enough streaks, the star or brick fills up and the player

Building Progression

The final progression is the building upgrade. When the child receives seven stars or bricks, the building upgrades to become larger and more complex. Once the building upgrades, the stars in the meter disappear. This invites the player to complete more mini-games, which in

When players progress quickly, they do not necessarily experience this grind. If players are able to learn the didactic principles in each mini-game quickly, they progress easily and may not have to work hard. For those who find the mini-game questions more difficult, the mini-games repeat until the player achieves the required level of learning.

The mini-game streaks allow educational experts to design the difficulty level in accordance with the maths curriculum content. According to Gee's (2003) regime of competence principle, the streak mechanic allows the learner ample opportunity to operate within, but at the outer edge of his or her skills and abilities. The game, therefore, feels challenging but not 'undoable' (Gee, 2003). This is most apparent when the player completes mini-game streaks to build and upgrade to the next level.

sees a full star or brick in the meter near the location they have chosen. The meter reflects Gee's (2003) multimodal principle, in which players ascribe meaning to symbols or designs. The meter progression can symbolise progress and achievement. Meter progression also supports engagement and continued motivation (Ryan & Deci, 2000).

turn completes stars with the end goal of upgrading the building. Players are, therefore, extrinsically motivated to construct new and larger buildings. This process creates a feedback loop that allows players to measure their game progress.



Figure 17. Building progression shown through upgrades.

The goal of reward design is to construct a system that can detect and appropriately reward everything the player wants to do. Since every game is different, every game needs a unique crafted reward system (Sylvester, 2013). Rewards, such as new building types in city mode, create a reinforcement

The Maths Game Narrative and Theme

The central theme of the Maths Game is community building. The player helps the residents of the town build their homes. This activity motivates the player by creating situated meaning (Gee, 2003). The characters remind the player of townspeople they may encounter in their daily lives, and the map resembles their home region. Players can, therefore, make associations between their own experiences and experiences in their online world. By developing relationships with, learning from, and helping the virtual characters, players become connected to and motivated by the virtual

Aesthetics

As mentioned in Chapter 1, aesthetics are the most important aspect of player experience. To ensure that CWTL players effectively connect with the game, and to empower player agency (Sun, 2012), all aesthetic elements, including art, audio, and video, are localised and support an immersive experience (Ryan & Deci, 2000).

schedule that provides the player with blissful productivity, or a state in which players feel happy for working hard and doing meaningful and rewarding work (Schonfeld, 2010). The timing of when players anticipate and receive rewards is key to motivation and to the flow experience (Csikszentmihalyi, 1990).

environment. These bonds deepen as players complete the mini-games and progress to further mini-games.

The Maths Game takes a world narrative approach to support the player's intrinsic motivation and autonomy (Ryan & Deci, 2000). The narrative of the Maths Game supports empathy (Marsh et al., 2016) and helps the player build a better bond by: (a) listening to the characters' stories; (b) helping the characters; (c) learning more about how the characters feel; (d) communicating regularly and positively; (e) doing things together; and (f) giving gifts.

Narrative and graphics must be accurately represented for cultural acceptance. Co-creation with local experts and the children can result in higher player engagement (Stubbé et al., 2017). For this reason, CWTL designers collaborated with children and local designers in Jordan on the visual design in the participatory research phase.

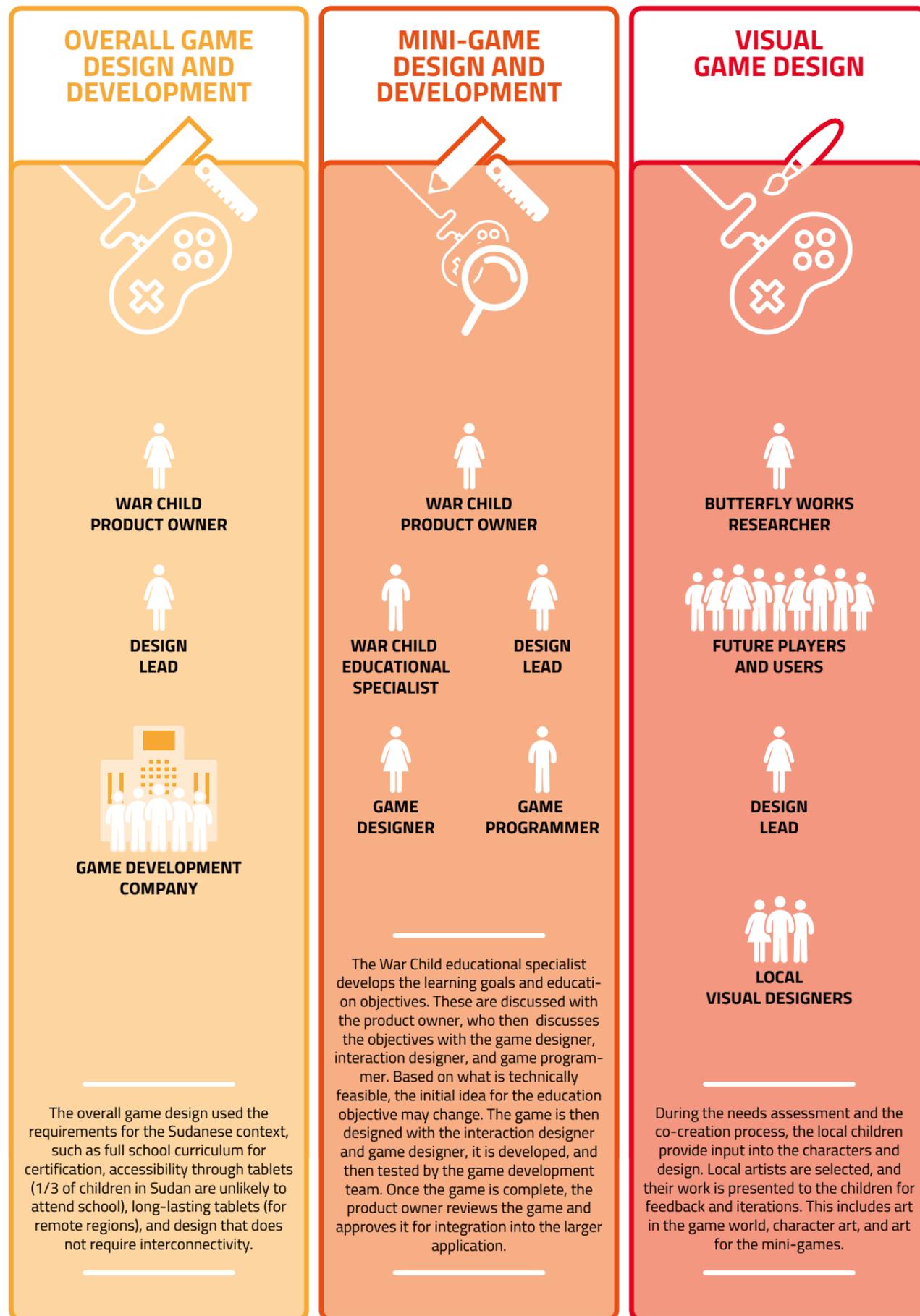


Figure 18. CWTL's Game Design Process.

Co-Creation

Participatory research is research conducted 'with those people whose life-world and meaningful actions are under study' (Bergold & Thomas, 2012, p. 2). This type of research is called co-creation or co-design (Sanders & Jan Stappers, 2008). In a classical user-centred process, the designer, researcher, and user work separately. The user is a passive contributor, contributing knowledge only through the researcher's inquiry rather than as an equal contributor. The researcher brings knowledge from observations and interviews. The

designer receives the researcher's report and designs the game. In participatory design (co-design), the research subjects are considered the experts and play a critical role in knowledge creation, idea development, and concept generation (Sanders & Jan Stappers, 2008). The designer and the researcher, who may be the same person, collaborate to gather users' insights (e.g., organising workshops). The designer plays a critical role in implementing the ideas. Figure 19 portrays these two different approaches:

CLASSICAL vs CO-DESIGN

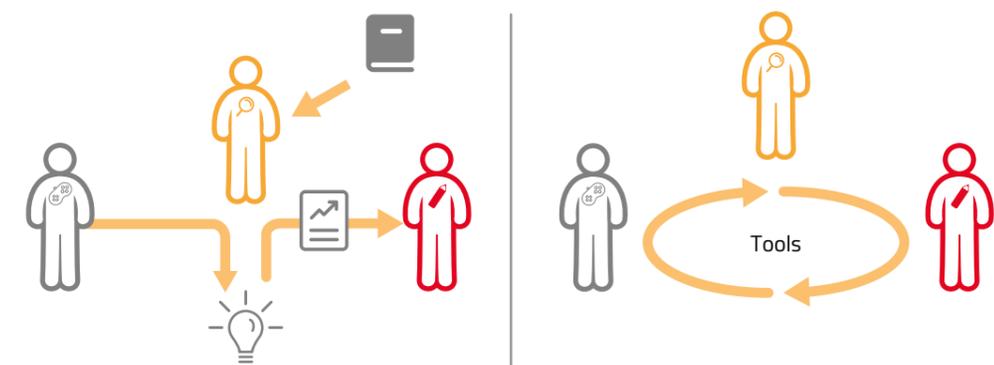


Figure 19. Classical roles of users, researchers, and designers in the design process (on the left) and how they are merging in the co-designing process (on the right). Reprinted from "Co-creation and the new landscapes of design" by E. B. N. Sanders and P. J. Stappers, 2008, *CoDesign: International Journal of CoCreation in Design and the Arts*, 4(1), pp. 5–18.

Participatory research aims to document users' lived realities, hopes, and dreams with sample narratives; identify visual artefacts relevant to users' lives; identify existing education challenges and opportunities relevant to the CWTL programme; and identify existing MHPSS issues, practice resources, and opportunities relevant to the Maths Game. This research provided information about the game's ideal visual design.

The participatory design research conducted for the Maths Game by Butterflyworks included five activities: social mapping (mapping the children's social environment), communication mapping (an overview of how people in the region communicate), photo observation (using photographs to understand

daily lived experiences), collaborative story-telling (understanding children's dreams, ideas of fun, and safety), and visual mapping (understanding a child's visual culture) (see Figure 20).

The visual mapping phase included a children and artists' co-creation workshop, with the goal of creating a game world design and art assets for maths, as well as beginning to collect input for the literacy games. This workshop was held in two locations: 1) In Arua, a team of four Ugandan illustrators sketched and designed graphic elements for the game under the art direction of Butterfly Works, and 2) In Imvepi, a settlement for South Sudanese refugees, Butterfly Works facilitated creative sessions with groups of ten children in four school locations on four consecutive days.

Each group of children participated in a similar set of activities:

- a presentation of the project
- an introduction to all children in the group
- a drawing exercise
- a clay modeling exercise
- a Lego building exercise

Day 1

Children were asked to draw objects and people from their environment and to create buildings and structures from Play-Doh and Lego. The design researcher and the designers observed the children and took notes and photographs during the process. The local designer used the children's drawings and

drawings from visual mapping and storytelling to begin defining the characters, the world map, and the buildings. Designers also created the navigation buttons for mini-games and the overworld. Items within the mini-games, such as fruits, vegetables, transportation, and other elements, were also designed and localised.

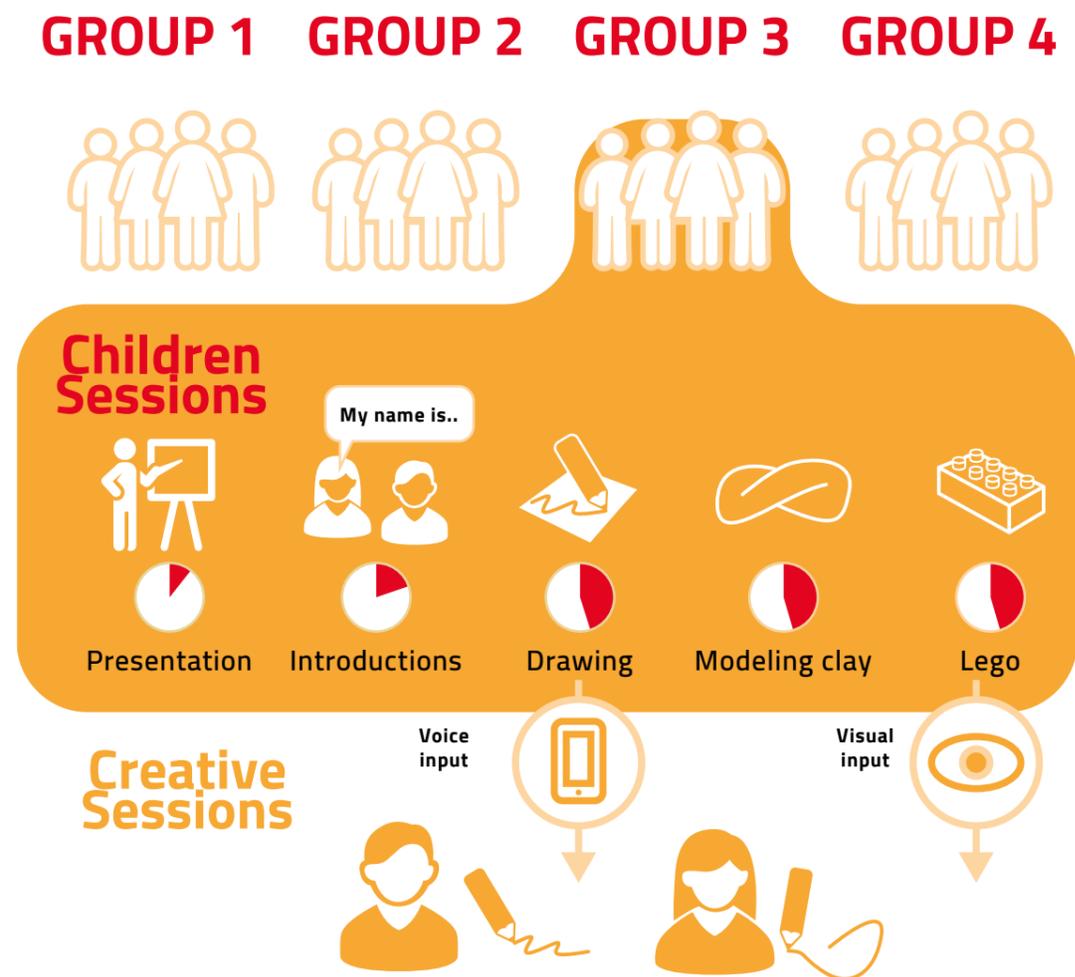


Figure 20. Participatory Research Process Summary for Can't Wait To Learn

Day 2

On the second day, the drawings created on Day 1 were tested, and researchers gathered additional input from the children on the following factors:

- The people in the community and their jobs.
- How children perceive urban areas and which cities do they know? What do those cities look like?
- How children perceive office work (e.g., Who works in an office? What do those people do in the office?).
- What a water source near their home looks like.
- How they perceive a hospital (e.g., What objects can be found there?).

The designers again elicited feedback from the children and then improved on the designs as necessary. They then shared the outcomes with the illustrators, who sketched the designs.

A selection of the sketches from Day 1 were sent to the workshop on Day 2. The designers showed the children these sketches and asked them for their preferences. Children first chose their favourite in each category, then they looked at a separate set of illustrations and described what they represented. This process helped reveal whether the children would recognise different jobs and activities. As a result of this co-creation, the designers created ten locations, the guide (Jane), and the characters for each location.

Guide

A player's first exposure to narrative appears as a guide who invites them to play the game with the following text:

This is your place. You live here with your community. As you will start to see, there are many different types of people living here: neighbours, relatives, and children your own age. They all have things they really like to do. Find out what they enjoy and help them to solve any problems they have. This way you can make them happy and then they will reward you. The more people you meet and make happy, the more exciting the place will become. And you have a place where you can exhibit your own creations and achievements! It is a place that you can fill with things you like! The more you do, the more beautiful it will become.

The guide character guides players through instructions on how to play the game and where to start. She encourages them to discover which characters they resonate with, supporting Gee's (2003) telling and doing domain. The Ugandan guide's name is Jane. Jane is a young female teacher with braided hair and with a book and chalk in her hand. She has a friendly smile and loves teaching many subjects.

As the game progresses, the guide character guides the player to different characters.



Figure 21. Uganda maths game's guide, Jane

Characters

Localised, culturally appropriate characters help players identify with the narrative and support Gee's (2003) commitment learning principle. The characters are young adults, as children look primarily to young people as role models. As players connect their real-world identity to their newly created virtual identity, they become more committed to the virtual world (Gee, 2003).

Like the people in the children's daily lives, every character has a skill. The game demonstrates that basic skills that can be learned at home, such as cooking or making bricks, can create income-generating opportunities. For example, cooking leads to owning a restaurant, and brickmaking leads to work as a builder.

These are the characters and their locations included in Uganda:

Table 7: Characters and Locations in the Uganda Maths Game

| Name of Character | Location | Vocation |
|-------------------|-----------------|---------------------|
| Isaac | Farm | Farmer |
| Joy | Restaurant | Cook |
| Rose | Hospital | Doctor |
| John | School | Teacher |
| Sadik | Garage | Mechanic |
| Peter | Furniture shop | Carpenter |
| Josephine | Market stall | Seller |
| Nelson | Computer centre | Computer specialist |
| Lily | Taxi stand | Taxi driver |
| Viola | Police station | Police officer |



Figure 22. Ugandan characters

The game's narrative and graphics needed to accurately represent local culture. When local experts and future players co-create a game's design, players experience a higher degree of engagement with the game (Stubbé et al., 2017). The co-creation process in the Maths Game resulted in a game world that includes

familiar objects and appropriately dressed characters (e.g., not showing the soles of their shoes). The buildings also represent familiar shapes, colours, and orientations. In Uganda, for example, the buildings mirror the asymmetrical building shapes found in that country's art.

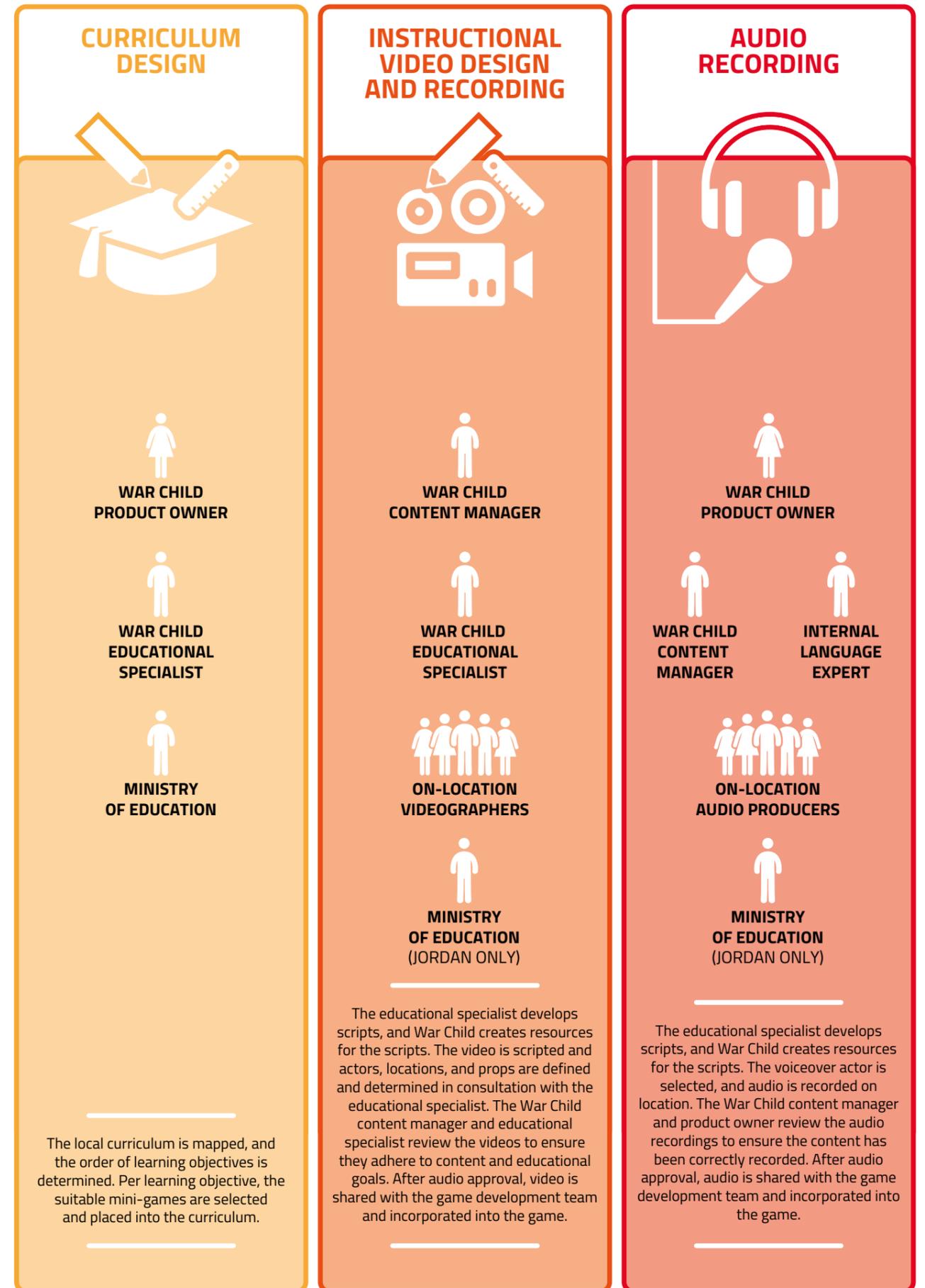


Figure 23. CWTL's Pedagogical Design Process.

Educational Design

The curriculum was defined by our educational partner, TNO. The didactic framework was co-developed with the Ministry of Education in each location. The following mathematical topics are covered as part of the mathematics didactic framework: 1) numerals, 2) addition, 3) subtraction, 4) multiplication, 5) division, 6) geometry, 7) fractions, and 8) measurements. The curriculum consists of 73 mini-games that cover the above domains of mathematics education.

The game's design also includes mechanisms that help players learn the game. The Maths Game employs cascading information theory (Schonfeld, 2010) to structure the complex learning activities.

Bubble Structure

Another game design domain within the Maths Game is the right level of difficulty (Björk & Holopainen, 2005), which refers to the intended level of difficulty the player experiences. Mini-game difficulty is determined by educational experts in a bubble structure. 'Bubble' or 'bubble level' refers to the game's different levels, and the bubble structure dictates which mini-games need to be played in which bubble. The bubble structure also includes the ranges for

A sample bubble structure is shown below:

| Learning Objectives | Bubble | Mini-game | Subject | Subtopic | Range | QType | Video | Questions in streaks | | | | | Fault tolerance in streaks | | | | |
|---------------------|--------|-----------|---------|----------|-------|-----------------|-------|----------------------|-----|-----|-----|-----|----------------------------|-----|-----|-----|-----|
| | | | | | | | | 1st | 2nd | 3rd | 4th | 5th | 1st | 2nd | 3rd | 4th | 5th |
| number 3 | 3 | 1000 | Numbers | ≤10 | 1-3 | SOUND_TO_OBJECT | 3 | 3 | 3 | 5 | 5 | 10 | 2 | 2 | 4 | 3 | 5 |
| | | 1000 | Numbers | ≤10 | 1-3 | OBJECT_TO_NUM | 3 | 3 | 3 | 5 | 5 | 10 | 2 | 2 | 4 | 3 | 5 |
| | | 1000 | Numbers | ≤10 | 1-3 | SOUND_TO_NUM | 3 | 3 | 3 | 5 | 5 | 10 | 2 | 2 | 4 | 3 | 5 |
| | | 38000 | Numbers | ≤10 | 1-3 | | 3 | 2 | 2 | 4 | 4 | 5 | 1 | 1 | 3 | 3 | 4 |
| | | 8000 | Numbers | ≤10 | 1-3 | | 3 | 3 | 3 | 5 | 5 | 10 | 2 | 2 | 4 | 3 | 5 |
| number 4 | 4 | 1000 | Numbers | ≤10 | 1-4 | SOUND_TO_OBJECT | 4 | 3 | 3 | 5 | 5 | 10 | 2 | 2 | 4 | 3 | 5 |
| | | 1000 | Numbers | ≤10 | 1-4 | OBJECT_TO_NUM | 4 | 3 | 3 | 5 | 5 | 10 | 2 | 2 | 4 | 3 | 5 |
| | | 1000 | Numbers | ≤10 | 1-4 | SOUND_TO_NUM | 4 | 3 | 3 | 5 | 5 | 10 | 2 | 2 | 4 | 3 | 5 |
| | | 38000 | Numbers | ≤10 | 1-4 | | 4 | 2 | 2 | 4 | 4 | 5 | 1 | 1 | 3 | 3 | 4 |

Figure 24. Bubble structure for Uganda in Level 1.

Cascading information theory states that information should be released in the smallest possible pieces to convey the appropriate level of understanding at each point in a game's narrative. For example, at the beginning of the Maths Game, players take basic actions. As they become more competent, they can unlock more difficult actions and progress through levels. Therefore, they first gain mastery over simple tasks and then build on those accomplishments to complete more complex tasks. This staged process approach prevents information overload.

In the next section, we review parts of the curriculum and how these parts are integrated into the Maths Game.

mini-games, which refer to the numbers that are presented in each mini-game (e.g., 1–5, 1–10). The bubble structure sheet also shows the number of streaks the mini-game will have per bubble, as well as the number of questions per streak. The 73 games are divided into 100 curriculum bubbles or sections. A bubble contains one or more mini-games presented in random order. All mini-games must be completed before the player can continue to the next bubble.

Example of Curriculum Progression

An example is given to clarify the relationship between the bubble structure and mini-games. In a bubble, the same mini-game can have more streaks (up to five), with different amounts of questions in them. For instance, in a particular bubble there is a mini-game to recognise letters. On the curriculum sheet it says '2, 5, 5, 10, 10' and under fault tolerance it says '1, 3, 2, 5, 2'. The player experiences this as follows: the first time the game is played in the bubble, 2 questions are asked, and 1 can be answered incorrectly; the second time 5 questions are asked, 3 can be wrong, but 2 should be correct; the third time, there are 5 questions, with 1 mistake allowed; the fourth time, 10 questions are asked, with 5 mistakes allowed; and the fifth time, 10 questions are asked, with 2 mistakes allowed.

At the beginning of the game, the player is presented with a mini-game, called 'Trace'. The player traces the number 1 and clicks on the 'OK' button to indicate that the task has been completed. The game then presents feedback, with either a green smiley face or a yellow neutral face. The child has two chances to complete this mini-game. The first time, they must successfully complete one out of two possible chances. If they answer correctly, they begin to fill in part of a star. The game then closes, and the player has completed the first streak.

The child taps on the location to play the trace game again. For the second time, they have three chances to trace the number 1. The number of circles at the top of the mini-game screen again shows how many times they need to complete the game, which in this streak is three times. When the player has traced the number 1, the star fills up more. The game closes, and the child must complete one more streak in the tracing game before moving to another game.

Progress Database

The Maths Game product owner defines the progress database, which is closely linked to the curriculum. The progress database determines how many mini-games must be played to receive a full star in each location. In the beginning, players receive stars after two or three mini-games. As the player progresses, they must complete more mini-games to receive a full star. In total, each location has seven levels with seven stars each.

Once the player has received seven stars, the building is upgraded and a new empty star banner appears next to it. At the final stage, the star banner disappears and the building is fully upgraded. In each level, stars can be earned at the active location(s), represented by buildings. Players can identify these buildings by the particles coming out of them, which create a glow. They can also find the active location by selecting the Game Guide in the overworld, which causes the camera to pan to the active location.

Audio

Audio is another key element of game design, as the mini-games contain audio instructions. Audio instructions also allow the guide to provide support. Each mini-game has a script that was developed in accordance with the mini-game play and design. The audio was

recorded on location and sent to War Child's Amsterdam headquarters, where the team ensured that the recordings matched the gameplay. The game developers then implemented the audio into the game. When errors were discovered, the audio was re-recorded.

Video Production

Instructional videos are an important component of the Maths Game, as instructional videos provide players with an active learning component. Studies suggest that video-based education provides the same level of teaching and learning as face-to-face education (Zhang et al., 2006). Video education provides time and location flexibility, results in cost and time savings for educational institutions, fosters self-directed and self-paced learning by enabling learner-centered activities, creates a collaborative learning environment by linking each learner with physically dispersed experts and peers, allows unlimited access to electronic learning material, and allows

knowledge to be updated and maintained in a more timely and efficient manner (Baloian, 2000).

The Maths Game videos match the game's learning principles. There are 115 videos for Uganda Maths. The videos follow from the curriculum learning objectives, with each video starting with a learning objective. The educational specialist developed scripts, while War Child created resources for the scripts. The educational specialist decided how each topic could be explained in a clear and engaging manner. The videos were locally produced after selecting actors, locations, and props.

Game Design Assessment

Assessment is critical to ensure that games deliver positive learning processes and student outcomes. Appropriate and valid user feedback and performance assessments should therefore be available.

Assessments must consider individualisation and adaptability to ensure that the game meets the diverse needs of students (Bellotti et al., 2013). Assessment and evaluation must

consider the possibility that learning styles developed from games are different from those developed in the traditional classroom. For example, studies suggest that regular gamers are more creative, ambitious, and optimistic about their abilities and circumstances. Students who play video games have demonstrated improved visual memory and cognitive skills, especially regarding visualisation and mental maps.

Quality Assurance and Playtesting

Quality assurance and playtesting are essential steps in game design. Testing is conducted through all phases, including design, development, and post-production. This kind of testing is part of the iterative design process, in which prototypes are created and immediately tested with players. This process is also referred to as play-centric design (Fullerton et al., 2006).

Figure 25 describes the iterative aspect of play-centric design. This model illustrates that games work at several levels. The first level (from concept phase to pre-production phase) places an emphasis on games as formal systems of rules with objectives, mechanics,

and procedures. The next level illustrates how dramatic elements, such as premise, character, and story, create emotional experiences through goals and challenges. According to Fullerton et al. (2006), the combination of these two levels develops a dynamic system with emergent properties that creates unique play and interactive experiences for players. For this reason, they suggested formal playtesting throughout production.

Although we were not able to directly playtest with the children, we conducted playtesting and technical testing in all phases and at all levels.

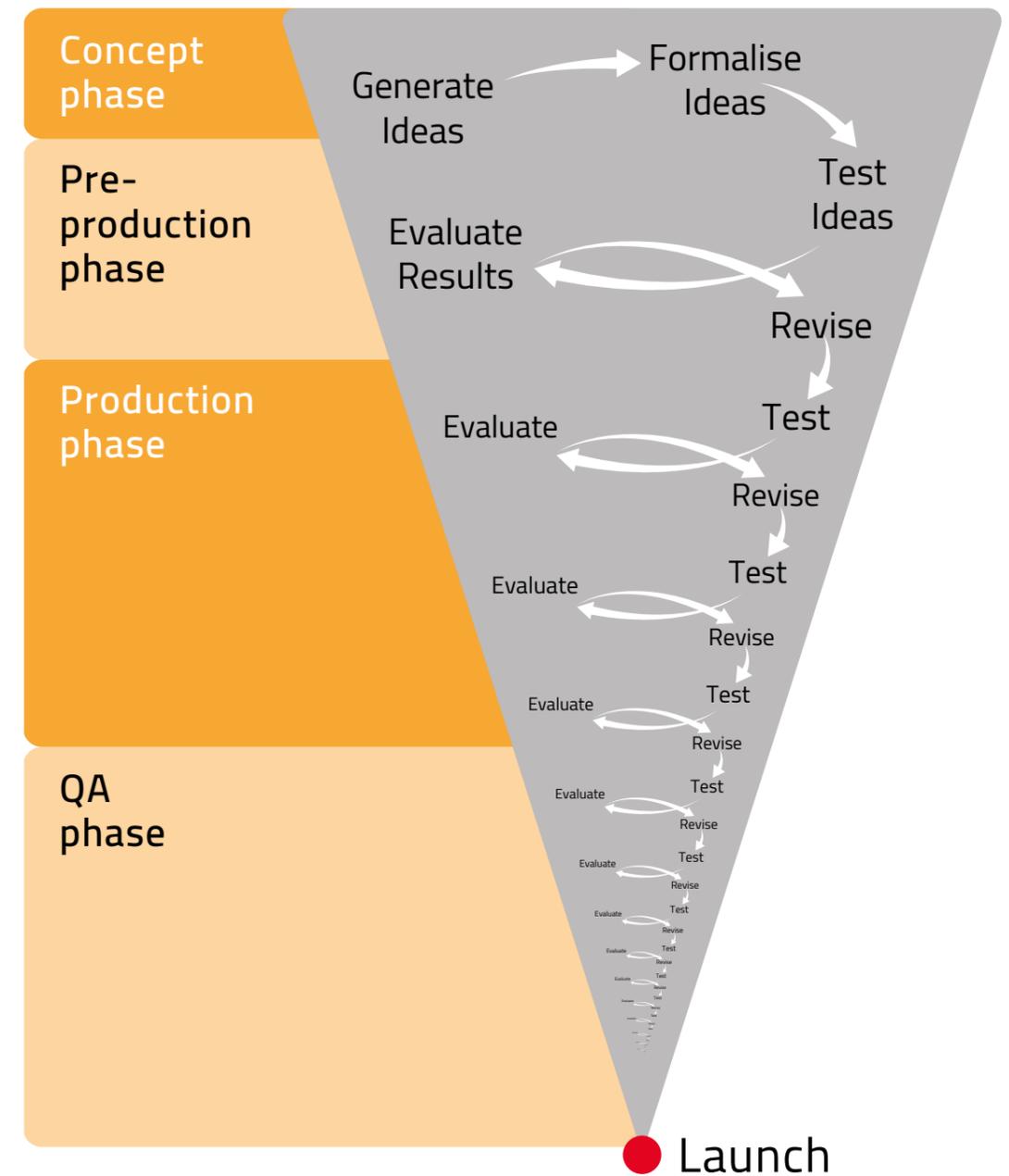


Figure 25. Model for iterative game design: playtest, evaluate, and revise. Reprinted from "That cloud game: Dreaming (and doing) innovative game design", by T. Fullerton, 2006, Proceedings of Sandbox '06 Proceedings of the 2006 ACM SIGGRAPH symposium on Video games, pp. 51–59

To support the quality of the education and functionality of the application, the Maths Game components, mini-games, and overall application were also tested. Table 9 describes the levels of testing conducted with the Maths Game, and by whom.

Table 9: Quality Assurance Testing for Uganda Maths Game

| Test On | Type of Test | Conducted By | Description of Test | Why is this done? |
|----------------------|--------------|---|---|--|
| Overall game | Technical | Game development company | The test is a technical test that automatically plays through the entire application. This test is run at least 20 times once the application is complete to avoid errors in progression. | To ensure that players can progress through the entire game and not get stuck by a technical malfunction or error in the code. |
| | Manual | Playtesters | Testers play the game from beginning to end. | To ensure building progression and rewards are working appropriately. |
| Mini-games | Manual | Product owner, educational specialist, play-testers | Mini-games are playtested manually from a specialised console. | To ensure mini-game design is intuitive, meets educational goals, and is bug-free. |
| Audio | Manual | Content manager, product owner, playtesters | After audio is recorded and implemented, audio is played within the mini-game or overworld. | To ensure the correct audio is implemented in the correct areas of the game. To ensure game design matches audio script. |
| Instructional videos | Manual | Content manager, product owner, playtesters | After video is recorded and implemented, video is played from the video space or the overworld. | To ensure the correct video is implemented in the correct areas of the game. To ensure the curriculum matches instructional videos and the timing of the instructional videos. |
| Aesthetics | Manual | Product owner, playtesters | After the art has been placed into the game, several spot checks are made from the specialised console and from playing in the overworld. | To ensure the latest artwork is included in the game. To ensure that the artwork is country-specific. |

Management Portal

A management portal supports every CWTL game. The portal tracks each child's attendance, time played, and progress. Teachers and facilitators can use the portal to monitor the progress of individual children and their whole

classes and to set the level or specific skills for individual children. On a global level, the management portal provides insight into attendance and performance trends, including demographic trends.

CWTL MATHS PROGRAMME UGANDA LAUNCHED: MAY 2018

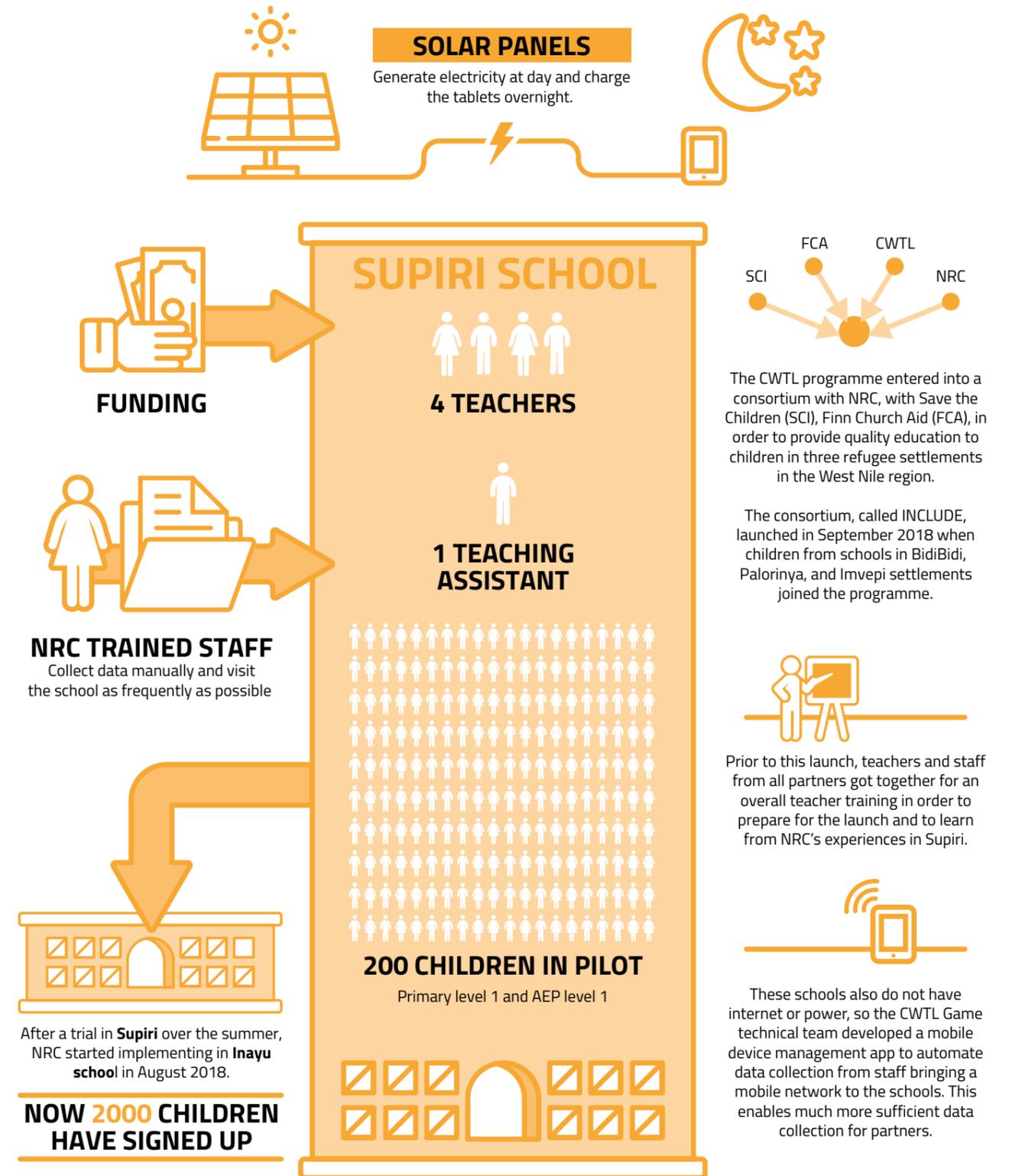


Figure 26. Pilot Implementation: Uganda Maths Game

Since the final quarter of 2017, significant investment has been made in the portal to increase and improve functionality. These improvements are listed below:

- Backend automation to improve loading time for visualisation and data;
- Improved functionality for teachers, providing better insight into student progress and attendance through more data and visual graphics;

- Additional student management tools for teachers, including the ability to search student IDs and download saved games;
- Based on feedback from the research teams, new data export files have been developed for easier data access;
- Country supervisor and location manager user profiles have been added for better programme management oversight; and

In the coming period, work will focus on monitoring dashboards and data analytics.



Figure 27. Can't Wait to Learn Management Portal

Implementation

The CWTL Maths game was launched with NRC in May 2018 and it was integrated into their Accelerated Education programming. The programme began in Supiri school located in the Imvepi refugee settlement in the West Nile region, where approximately 200 children in Primary Level 1 and AEP Level 1 were registered. Four teachers and one teaching assistant facilitated the CWTL Maths programme for the two classes. The teachers and staff from NRC were provided tools to manage the Maths Game as there were high numbers of students. As there is neither electricity nor internet in these schools, solar panels were used to charge the tablets overnight. Data was collected manually by trained staff from NRC, who visited the school often. In August 2018, after a trial in Supiri concluded, NRC

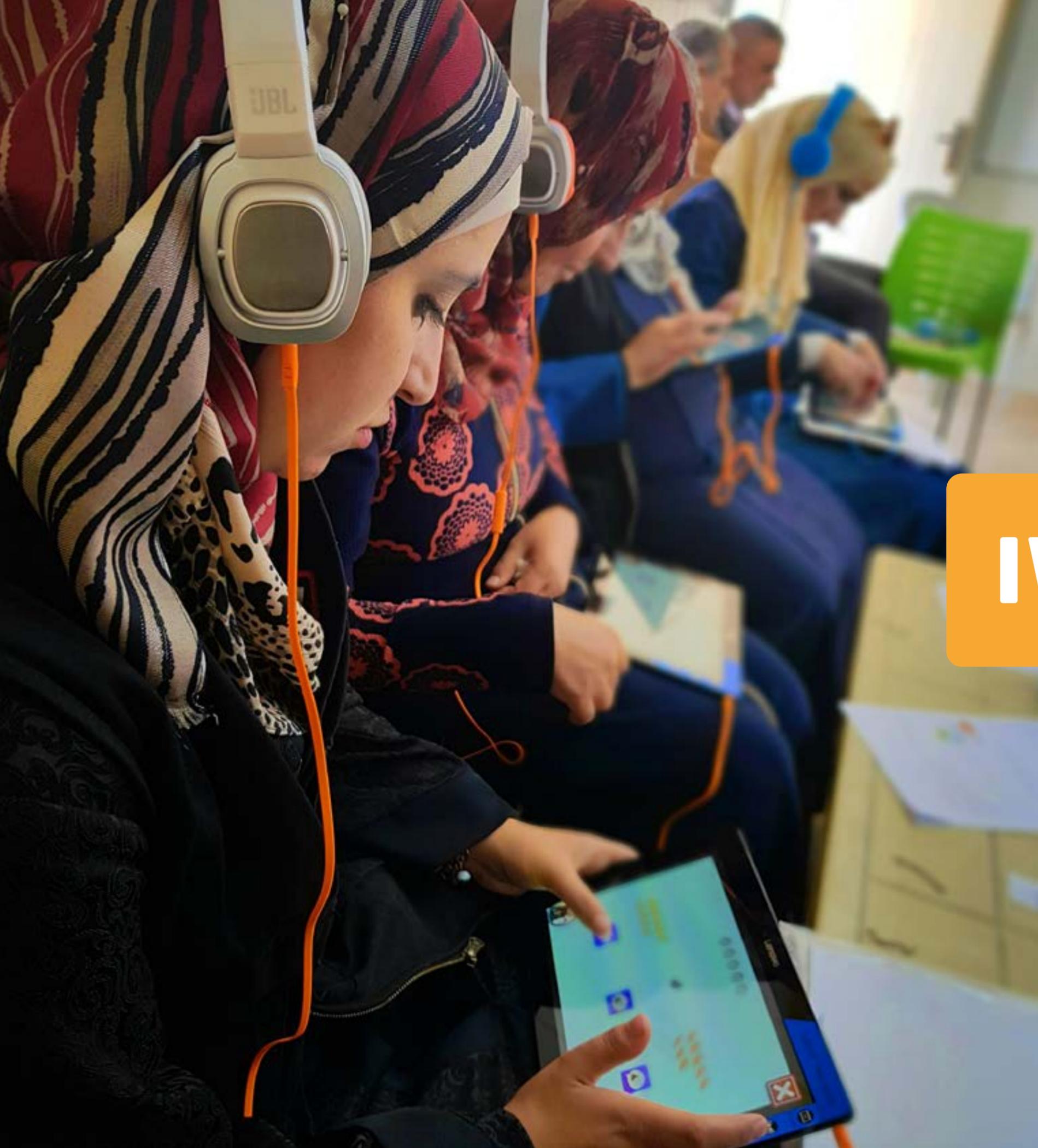
implemented the program in Inayu school. In addition to the partnership with NRC, the programme entered into a consortium with Save the Children (SCI) and Finn Church Aid (FCA), with the aim of providing quality education to children in three refugee settlements in the West Nile region. In September 2018, the consortium, named INCLUDE, launched in BidiBidi, Palorinya, and Imvepi settlements. Prior to the launch teachers and staff from all of the partners gathered for an overall teacher training to prepare and to learn from NRC's experiences in Supiri. As these schools have limited internet and electricity, the Maths Game technical team developed a mobile device management application including installing a mobile network in order to automate data collection by staff. This enabled efficient data collection for partners.

Summary

The CWTL Maths Game uses the de Freitas and Jarvis (2008) game design model to blend didactic elements with game design. The curriculum defines clear learning objectives, player goals, and learner content that is delivered through mini-games. The game engine programming defines the player's mastery level and provides feedback, allowing the player to proceed or to practise before proceeding. The game's progression is drawn from the themed progress database, which defines the player's rewards and building upgrades.

The CWTL Maths Game incorporates the self-knowledge principle (Gee, 2003) to create the correct level of difficulty. Players learn not only subject matter content, but also about their current and potential capacities. This self-knowledge acquisition increases student confidence, which is one of the key potential benefits of educational technology (Beck & Wade, 2004).

To ensure the game's efficacy, testing is conducted throughout the process (Fullerton et al., 2006).



**Can't Wait To
Learn - Jordan
Reading Game**

Game Design in Jordan

The Can't Wait To Learn Reading Game is designed to familiarise players with language and reading concepts, to help players complete challenges, and to provide players with opportunities to learn and grow in their reading skills.

Development of Arabic Content for the Reading Game

In order to inform the development of the Arabic component, a review was conducted to explore previously developed educative games in Arabic. No existing suitable games were identified. The same review also explored the elements necessary to include in an educative game designed to provide instruction in Arabic literacy, and suggestions for game design were formulated (TNO, 2016).

A review of literature on reading acquisition indicated that for all alphabetic languages, the process of learning to read is similar and comprises similar components. The following components were identified as important for literacy:

- Visual perception
- Concepts about print
- Phonological awareness
- Alphabetic knowledge
- Orthographic knowledge
- Fluency
- Vocabulary
- Comprehension
- Writing

The review suggested that all of these components should be addressed through tablet-based learning to support an effective and feasible educative game in Arabic. This approach should then be complemented with self-paced learning, with or without teachers.

Existing materials in both Arabic and other languages (mostly English) were reviewed. The availability of literacy games for English is quite comprehensive, but they mostly target only one or two components of learning to read and do not cover the entire curriculum. The availability of digital materials in Arabic is scarce, and no Arabic programmes were found to include the complete set of literacy components.

Concepts for instructional game activities were designed for all components of literacy. These concepts were based on a review of existing digital materials and best classroom practices. Thus, the game teaches skills in vocabulary, listening comprehension, phonological awareness, and visual perception; letters in names, sounds, shapes, and syllables; reading words with known letters; writing letters; writing words; and reading comprehension.

This section reviews the design of the CWTL Reading Game, including the game's goal, core activity, design, curriculum, and quality assurance testing.

Overview

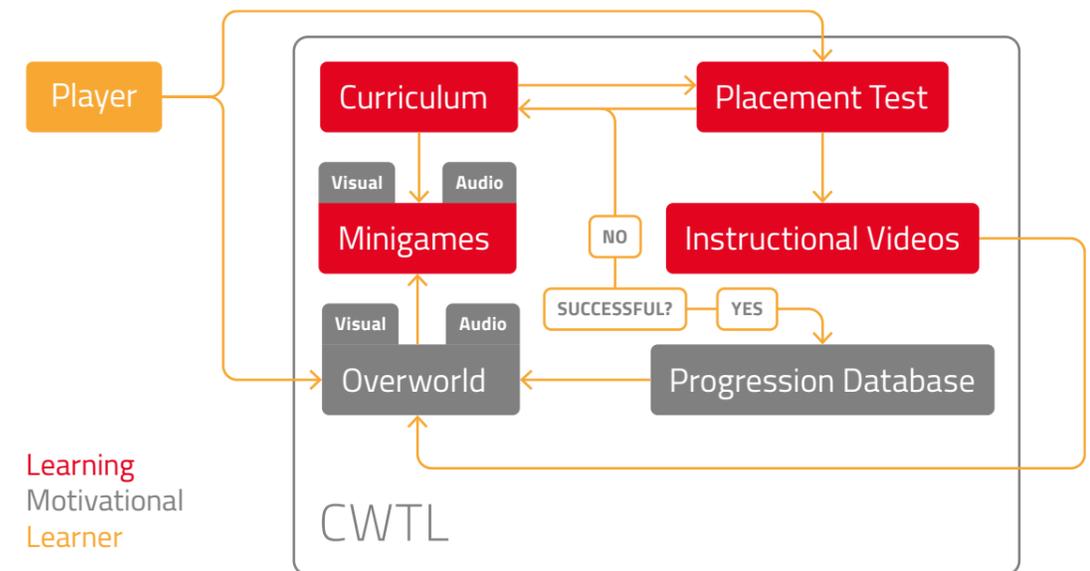


Figure 28. Summary of elements from the curriculum and game play functionality in the Jordanian Reading Game.

The CWTL Reading Game resembles social games (e.g., SimCity Social or Farmville). In social games, players build social relationships. Social games provide continuous positive reinforcement, allowing players to determine their progress by entering and exiting game sessions. They appeal to players' ambitions to connect and to collect trophies (Krom, 2012). Social games also include altruistic actions, private game spaces, and gaming capitals (trophies or prizes). In the CWTL Reading Game, players are motivated to help people in their neighbourhood,

either in a town, village, or city. The choice between a town, village, or city depends on the players' country. The map is contextualised to match the children's environment, ensuring a familiar setting. In Jordan, the map contains 15 locations within a neighbourhood, and each location exists as a room within a building. Halfway through the game, the player unlocks a second overworld with 15 locations. Players also have a separate private space in which they can draw and see the books they have unlocked, as well as their trophies.



Figure 29. Jordan Reading Game in the Neighborhood Mode.

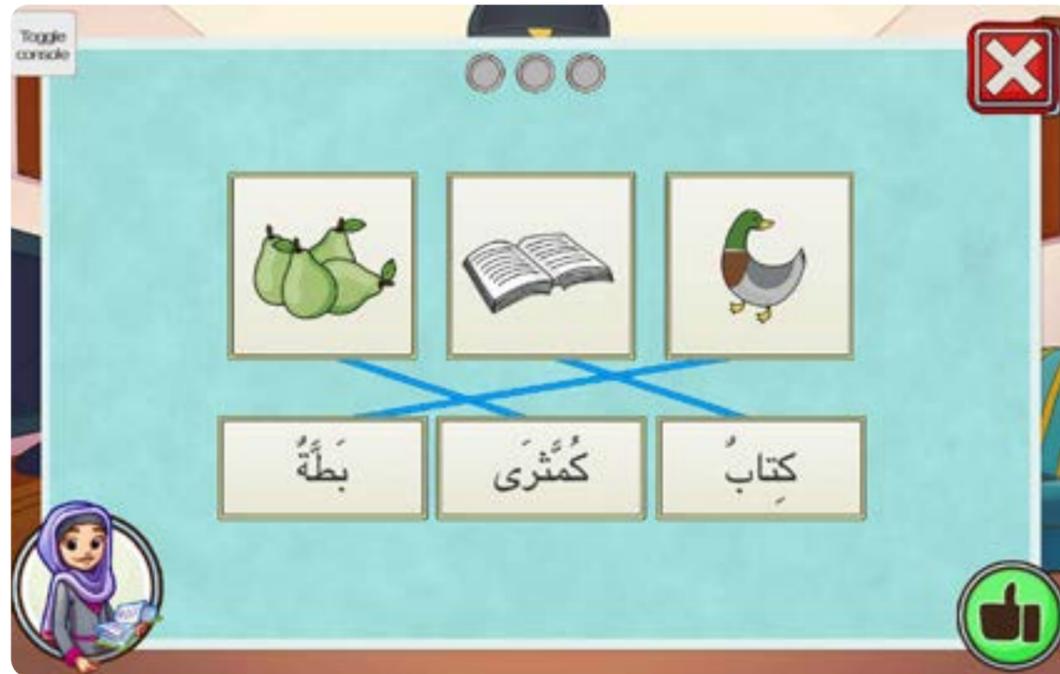


Figure 30. Sample minigame 40: Connect Word with Picture (learning principle: word and picture association).

The CWTL Reading Game differs from social games in that it is not a multiplayer game (a game in which many players play at the same time). Since connectivity is often difficult in

remote regions, the game's social aspect involves interaction between single players and game characters. There is also a social component in classroom interactions outside the game.

Game Walk-Through

Upon entering the game, the player sees a world in a neighbourhood with different buildings. Each building has rooms the player can enter. Each neighbourhood is linked to a different character, for a total of 30 neighbourhood characters. A guide explains the purpose of the game, orients the player, and describes next steps and required actions. The guide suggests certain characters for the player to help and offers recommendations for how to do this. To trigger and elicit the players' curiosity about this neighbourhood and its inhabitants,

characters are placed inside each room, and their location provides a meaningful link to the storyline. As players progress, they are introduced to each person in their neighbourhood.

If a location shows a bouncing wreath, it is open and available for play. When a location is initially open, the tutorial guides the player there. When the player clicks on a location, a small instructional video appears and introduces the player to a reading concept. After the video, a mini-game opens.

A mini-game is a didactic challenge or problem that consists of a number of questions. As each question is completed, a smiley face appears at the top of the screen. After successfully completing three mini-games, the player receives a smiley face. The player has several chances to

complete the mini-game. If those attempts fail, the player can begin again or review the instructional video. As the game progresses, the mini-games become more challenging and build on previous tasks.

For example, the player sees more letters, which makes the tasks more complex.

There are 64 types of mini-games in the curriculum for Grades 1 to 3. Once the player completes a full social meter (a wreath), a new location opens. By the end of the game, players will have completed all of the mini-games,

Game Goal

Cognitive psychologists discuss how goal setting supports consistent management of human action. All games have goals and winning conditions. In digital game-based learning, goals can be divided into three categories (de Freitas & Jarvis, 2008). First is the didactic goal. In the Reading Game, the didactic goal aims to have players successfully complete the reading curriculum for primary school Grades 1 to 3. The second goal is the one provided by the game experience. Establishing player experience goals at the outset allows game designers to focus on what players will find interesting and engaging (Fullerton, 2006).

Game Design

The CWTL Reading Game is designed as a single-player game in which one child plays in their own game world. There are several advantages to a single-player design. First, the player can pause or stop the game session without syncing the session to other players' sessions, facilitating a custom learning experience for the child. Second, a single-player design provides designers with more control over difficulty levels while simultaneously giving the player control over the pace of learning. Third, a single-player design allows teachers or facilitators to better observe a player's progress and to provide the right level of support when needed (Cassidy, 2004). Fourth, a single-player design allows for an incremental implementation of the curriculum. This design allows players to experience the transfer principle (Gee, 2003), where they can

received trophies, and helped the characters connect to one another.

In the following sections, we will focus on the game's goal, narrative, mechanics, visuals, and rewards. We will then review the design of learning elements and show how these elements contribute to the curriculum.

The game experience in the CWTL Reading Game provides players with the opportunity to be social, form relationships with the characters, and uncover each character's story. The game characters are an essential part of the narrative and help the player identify with the game and its storylines (Björk & Holopainen, 2005). This identification allows the player to become attached to game elements, including characters. The third goal is the assessment of mini-games and other activities related to learning goals. The game captures information on how long a player plays, what games they play, and which parts they complete.

apply knowledge from earlier mini-games to more complex mini-games. Players also experience the effects of the incremental principle (Gee, 2003), in which they have opportunities to slowly progress from novice to master (Zyda, 2005). Finally, the single-player design allows for ease of connectivity. Since the CWTL Reading Game is implemented in remote regions with limited connectivity and access to electricity, a multi-player design would not be possible.

The CWTL Reading Game was designed in collaboration with several partners. Table 10 summarises the elements of the game's development.

In the next section, we will review the game design in detail. We first discuss the game's overworld, followed by narrative, game activities, game mode, and visual design.

Table 10: Elements of the Reading Game's Development

| Domain | Team Composition | Process |
|--|---|---|
| Overall game design and development | Game development company and War Child product owner | The overall game design used the requirements for the Sudanese context such as full school curriculum for certification, accessibility through tablets (½ of children in Sudan are unlikely to attend school), long-lasting tablets (for remote regions), and design that does not require interconnectivity. |
| Mini-game design and development | War Child educational specialist, War Child product owner, game designer, interaction designer, game programmer | The War Child educational specialist develops the learning goals and education objectives. These are discussed with the product owner, who then discusses the objectives with the game designer, interaction designer, and game programmer. Based on what is technically feasible, the initial idea for the education objective may change. The game is then designed with the interaction designer and game designer, it is developed, and then tested by the game development team. Once the game is complete, the product owner reviews the game and approves it for integration into the larger application. |
| Visual game design | Butterflyworks researcher, future players and users, local visual designers | During the needs assessment and the co-creation process, the local children provide input into the characters and design. Local artists are selected, and their work is presented to the children for feedback and iterations. This includes art in the game world, character art, and art for the mini-games. For the Can't Wait To Learn Reading Game, this includes the design of the personal space, trophies, books, poems, the journal, and the drawing area. |
| Curriculum design | War child educational specialist, War Child product owner, Ministry of Education | The local curriculum is mapped, and the order of learning objectives is determined. Per learning objective, suitable mini-games are selected and placed into the curriculum. For the Can't Wait To Learn Reading Game, the educational specialist and product owner define the content, including words, books, songs, and poems. The Ministry of Education then decides which of these elements should be included in the game. |
| Educational Content Design | War child educational specialist, War Child product owner, War Child content manager, Ministry of Education | The content manager works with the Ministry of Education to define the type of Arabic font, the selection of poems (guided by the educational specialist), and the selection of traditional Arabic songs. The MoE also defines the grammar rules that will be used. The content manager ensures that the required Arabic material is available and presented accurately in the content database. The product owner reviews the content once it is implemented to ensure accuracy. |
| Instructional video design and recording | Ministry of Education, War Child educational specialist and on-location videographers, War Child content manager | The educational specialist develops the scripts, and War Child creates resources for the scripts. The scripts are developed in the game's language (Arabic). The video is scripted, and actors, locations, and props are defined and determined in consultation with the educational specialist. The MoE is present during the filming for immediate feedback. The War Child content manager and the educational specialist review the videos to ensure the content and educational goals are properly recorded. The videos are also reviewed for language proficiency and to ensure that they match the original scripts. After audio approval, video is shared with the game development team and incorporated into the game. |
| Audio recording | War Child content manager, War Child product owner, Arabic language specialist, internal language expert, and on location audio producers | The educational specialist develops scripts, and War Child creates resources for the scripts. The scripts are then translated to Arabic. The voiceover actor is selected, and audio is recorded on location. The War Child content manager and product owner review the audio recordings to ensure the content has been correctly recorded. The audio is also reviewed for language proficiency and to ensure that it matches the original scripts. After audio approval, audio is shared with the game development team and incorporated into the game. |

The Game World: Overworld

The overworld is the game world or the environment in which the gameplay or parts of the gameplay take place. The game world is also the space where the player interacts with various game elements. A game world limits the playing area and the players' movements and creates a basis for a consistent reality logic (Björk & Holopainen, 2005).



Play in the CWTL Reading Game begins with an open game world view, where the player sees the entire neighborhood at once. The Jordan game displays a front-back view, which means that the players see the neighbourhood houses and locations from a front-facing view. This allows players a zoomed-in view while enabling them to distinguish individual game elements.



Second Overworld

Later, the players' world switches to a top-down, high-level view, allowing players a commanding view while enabling them to distinguish individual game elements and to follow their progress.



Game Mode

A game mode is a configuration of the gameplay (Sicart, 2008), and a game can have different game modes. Each game mode can have different game mechanics or types of gameplay. In the CWTL Reading Game, the game world consists of five modes: neighbourhood mode, character mode, mini-game mode, personal space mode, and the second overworld mode. In neighbourhood mode, the player can monitor their social meters and can focus their efforts to help characters in one or two sites. This choice of sites is limited for two reasons. It limits complexity and allows players to master learning tasks while keeping the gameplay simple. It also enabled the developers to maintain a reasonably sized application for tablets with low processing power, as allowing for more variety would have required more complex code and a larger application size.

Figure 31. Three character rooms: kitchen, living room 1, and living room 2.

The character room mode begins when the player selects an active house and enters a character room. In character room mode, the player can see the corresponding character and a relationship status meter (a wreath) that indicates the current relationship level.

The third game mode includes the educational mini-games, which launch when the player clicks on the locations in the game world. Mini-games comprise the core activity and promote the game's educational goals. The mini-game window can include didactic reading exercises or exercises that require a child to listen to a song or read a poem or book.



Figure 32. Bird's-eye view of the overworld (world map) in Jordan. The arrow gives the player the option to return to the first over world.

The fourth mode is the player's personal space. Here, players can view the different items they received from their interactions with the characters, and they can view their progress. They can also read books they have unlocked and write or draw in a private journal.

Core Activities

Mini-Games

The core learning activity in CWTL is the completion of the mini-games. A mini-game is an educational task or challenge that must be completed in order for the player to progress in the game. Mini-games challenge players in several ways: through multiple-choice activities in which the player must choose the correct answer, by matching and arranging letters to images, and by writing letters correctly.

Mini-games are commonly associated with the game design concept of 'games within games' (Björk & Holopainen, 2005), which are games played completely within the framework of

another game. From a game design standpoint, this design principle keeps the players' experience of reality consistent within a game and does not interfere with the players' immersion. Mini-games facilitate intrinsic motivation by offering players the ability to demonstrate mastery of their skills and abilities, as dictated by Gee's (2003) achievement principle. Increasing mastery creates cognitive immersion (Björk & Holopainen, 2005), in which the player fully focuses on problem-solving within the game. Cognitive immersion in mini-games (and the rewards discussed later in this chapter) supports a player's competence and autonomy (Ryan & Deci, 2000).

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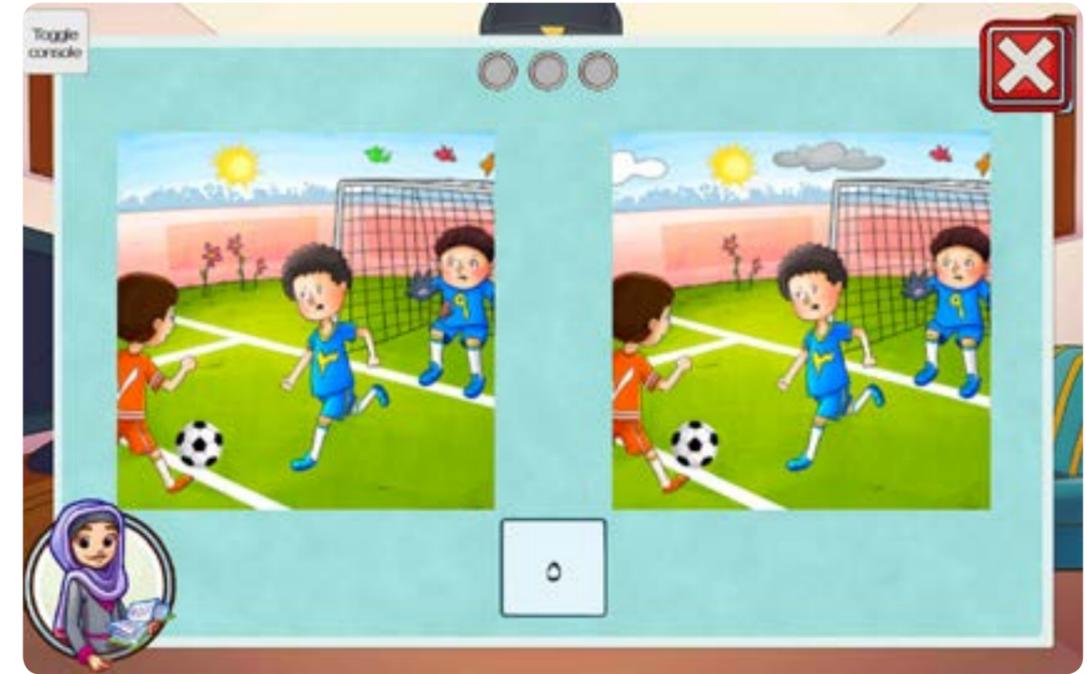


Figure 33. Mini-game in which the player is asked to compare the two pictures and select the differences.

Mini-game functionality includes these aspects:

- Every mini-game is fully explained with audio before it starts for the first time.
- Every task in a game is presented in audio. Players can always click the Guide button in the lower left corner to have the task repeated.
- When the player has performed the task, they need to click the Continue button at the lower right corner to continue.
- In tasks with multiple answers, a Confirm button appears to check the player's answers. After this check, the Continue button appears.
- A score is displayed at the top to show whether the player has performed the task correctly or incorrectly. If the player has made too many mistakes, he or she is directed to the Fail screen.
- After all tasks have been completed, the Continue button changes into the Finish button and/or leads the player to the End screen.
- On the End screen, the player can view the score bar to see how many mistakes they have made and the number of points they have received in this exercise. They can also see their player progression in the form of trophies or flowers.

Personal Space

The personal space allows for exploration and stimulates creativity. Players can access the personal journal through a menu button at the bottom of the screen, which is next to the Teacher button. This easy access makes the personal journey a central part of the game. In

the personal journal, the player sees their collection of unlocked videos, books, and progress rewards (trophies). They can access unlocked videos and books through buttons in the personal space. They also have the option to journal or draw in their diary.

Core Mechanics

Core mechanics refers to the actions players take in the game. The CWTL Reading Game uses four simple core mechanics: tap, tap + hold, tap + hold + drag, and scroll. By tapping, a player can select the direction of game play and select a location. A player can tap the correct answers within a mini-game and tap to move to the next mini-game. Tapping can also take the player to their personal space, to view the videos, to have the guide repeat instructions, or to exit out of areas. The tap + hold mechanic can be used in certain mini-games in which elements must be held for a few seconds (e.g., when a player is asked to record their voice after hearing the correct pronunciation of a word). The third core mechanic is the tap + hold + drag mechanic, or dragging. The child uses the tap + hold + drag in certain mini-games where elements within the mini-game need to be dragged in order to move letters or lines. A fourth mechanic is scrolling, in which the player swipes to access information in a mini-game window, such as when reading a book or poem.

Progression and Rewards

As mentioned in Chapter 1, progression can be divided into two parts: game progression and player progression (Bycer, 2013). In CWTL, these two types of progression are integrated. The player cannot progress without also mastering the mini-games as they are presented. According to Gee's (2003) achievement principle, players of all levels receive intrinsic rewards from the beginning, and the game should be customised to each learner's level, effort, and growing mastery while signalling ongoing achievements.

This learning principle is evident in the way accomplishments are displayed in the neighbourhood mode. There are four levels that let the player know how they are progressing: mini-game progression, social meter progression, level progression, and trophy progression.



Figure 34. Personal space in Jordan showing a shelf with a silhouette of trophies that will fill up as the player receives relationship points.

Mini-Game Progression

As mentioned above, a player begins by tapping on a room location within the neighbourhood mode. Once inside the room, the player taps on a character and a mini-game launches. Thus, the first level progression is the mini-game progression. Each mini-game contains a certain number of questions that must be answered in order to complete the learning goal. Together, these questions comprise a streak. The player can only get a certain amount of questions within a streak wrong before the mini-game is terminated and restarted. The number of incorrect questions was initially defaulted to 1 in the game design, but now this can be changed and is adjustable in the bubble structure.

For the first challenge, the player must complete one correct mini-game task out of three presented. Depending on the curriculum requirements for that mini-game, the player sees between one and ten questions and must get a certain number correct in order to pass. For example, in a five-question mini-game, the player sees three green circles and two yellow circles, indicating that three correct answers are required to complete the mini-game. When the player successfully answers the question, a smiley face appears on one of the green circles. If the player does not answer the question correctly, an upside-down face appears on one of the yellow circles. Completing one cycle of questions is called a 'mini-game streak', also known as a 'winning streak' in game design (Björk & Holopainen, 2005). Successful mini-game streaks provide the player with mastery points, which accumulate to eventually change the player's in-game mastery level.

Social Meter Progression

The player is now motivated to continue playing at two levels. The first is the social meter or wreath that shows their progress within a room; the second is the completion of trophies as a permanent reward in their personal space. If the player successfully completes the mini-game streak, they see a second level of progression called the social meter, which appears as a wreath. Once the streak is complete, the wreath partially fills with water. When a player completes enough streaks, the wreath fills to the top, and the player receives

The mini-game streaks foster intrinsic motivation and a sense of succeeding at increasingly difficult challenges. The challenging and repetitive work required in these streaks is called the game's 'grind' (Björk & Holopainen, 2005). Despite this grind, players continue playing because they are interested in the game. In the CWTL Reading Game the game's grind is set to low, then gradually increases throughout the game. Gee (2003) describes this phenomenon in his practice principle, which states that learners invest more time and effort in contexts and situations that interest them.

When players progress quickly, they do not necessarily experience this grind. If players are able to learn the didactic principles in each mini-game quickly, they progress easily and may not have to work hard. For those who find the mini-game questions more difficult, the mini-games repeat until the player achieves the required level of learning.

The mini-game streaks allow educational experts to design the difficulty level in accordance with the reading curriculum content. According to Gee's (2000) regime of competence principle, the streak mechanic allows the learner ample opportunity to operate within, but at the outer edge of, his or her skills and abilities. The game, therefore, feels challenging but not 'undoable' (Gee, 2003). This is most apparent when the player completes mini-game streaks to build and upgrade to the next level.

a flower. The player continues playing until the wreath is filled with flowers. When the wreath is completed, interaction with the related character ends. A new location opens, and the player meets another character, indicating to the player that they have reached a new level. When all the locations have been unlocked once, the player must return to the original locations in order to upgrade to new levels. A player will need to raise their social meter several times to collect all the items for room mode.

The social meter reflects Gee's (2003) multi-modal principle, in which players ascribe meaning to symbols or designs, and the meter progression symbolises progress and achievement. The social meter progression also supports engagement and continued motivation (Ryan & Deci, 2000).



Figure 35. Wreath: The social meter for the Jordanian Reading Game.

Trophy Progression

When the social meter (wreath) is full, the player gains a relationship point. When the player collects the correct number of relationship points, they earn a relationship upgrade, which occurs by earning a part of the trophy in the player's personal space and in the location. As the player continues to play, more of the trophy is earned until the trophy is complete and becomes displayed in their personal space. Reward mechanisms such as the completion of a trophy support intrinsic motivation while giving extrinsic rewards (Wang & Sun, 2011).

The goal of reward design is to construct a system that can detect and appropriately reward the players' actions. Since every game is different, every game needs a unique crafted reward system (Sylvester, 2013). Rewards such as visual meters create a reinforcement schedule that provide the player with blissful productivity, or a state in which players feel happy for working hard and doing meaningful and rewarding work (Schonfeld, 2010). The timing of when players anticipate and receive rewards is key to motivation and to the flow experience (Csikszentmihalyi, 1990).



Figure 36. Examples of trophies from the neighbourhood mode of the Jordanian Reading Game.

Level Progression

After players have completed the meter progression in each of the rooms in neighbourhood mode, they revisit the characters four times. This allows them to complete the curriculum of the first 50 educational bubbles (explained below). Each round of visits gives the player a

different coloured wreath to indicate that they have reached a new educational level. The first level is yellow, followed by blue, orange, and red. After completing the red level in all the rooms, players unlock and move up to the second overworld.

Can't Wait To Learn Narrative and Theme

The CWTL Reading Game takes a world narrative approach to support players' intrinsic motivation and autonomy (Ryan & Deci, 2000). In the tradition of Vygotsky (1978), learning is largely seen as a social activity. Learning should not simply be the assimilation of new knowledge; it should also be the process by which learners integrate into a knowledge community. Since learning is essentially a social phenomenon, learners are likely to be motivated by

rewards provided by the knowledge community in the game narrative (Cremin & Arthur, 2014).

In order to improve immersion and engagement with the game, the CWTL Reading Game has a consistent storyline that connects the locations and characters and creates a community. The social relationships the player develops supports player motivation by creating situated meaning (Gee, 2003).



Figure 37. Example of trophies from the second overworld mode of the Jordanian Reading Game.

All design decisions were made to support this relationship building. The characters resemble people that players might encounter in their daily lives. The neighbourhood mirrors the region in which they live. Players can associate their daily life experiences with their experiences in the game. As players complete more mini-games, they deepen their bond with the

Aesthetics

As mentioned in Chapter 1, aesthetics are the most important aspect of player experience. To ensure that CWTL players effectively connect with the game, and to empower player agency (Sun, 2012), all aesthetic elements, including art, audio, and video, are localised and support an immersive experience (Ryan & Deci, 2000).

Co-Creation

Participatory research is research conducted 'with those people whose life-world and meaningful actions are under study' (Bergold & Thomas, 2012, p. 2). This type of research is called co-creation or co-design (Sanders & Jan Stappers, 2008). In a classical user-centred process, the designer, researcher, and user work separately. The user is a passive contributor, contributing knowledge only through the researcher's inquiry rather than as an equal contributor. The researcher brings knowledge from observations and interviews. The

characters. Therefore, the CWTL Reading Game's narrative supports empathy (Marsh et al., 2016) and helps the player build a better bond by: (a) listening to the characters' stories; (b) helping the characters; (c) learning more about how the characters feel; (d) communicating regularly and positively; (e) doing things together; and (f) giving gifts.

Narrative and graphics must be accurately represented for cultural acceptance. Co-creation with local experts and the children can result in higher player engagement (Stubbé et al., 2017). For this reason, CWTL designers collaborated with children and local designers in Jordan on the visual design in the participatory research phase.

designer receives the researcher's report and designs the game. In participatory design (co-design), the research subjects are considered the experts and play a critical role in knowledge creation, idea development, and concept generation (Sanders & Jan Stappers, 2008). The designer and the researcher, who may be the same person, collaborate to gather users' insights (e.g., organising workshops). The designer plays a critical role in implementing the ideas. Figure 37 below portrays these two different approaches:

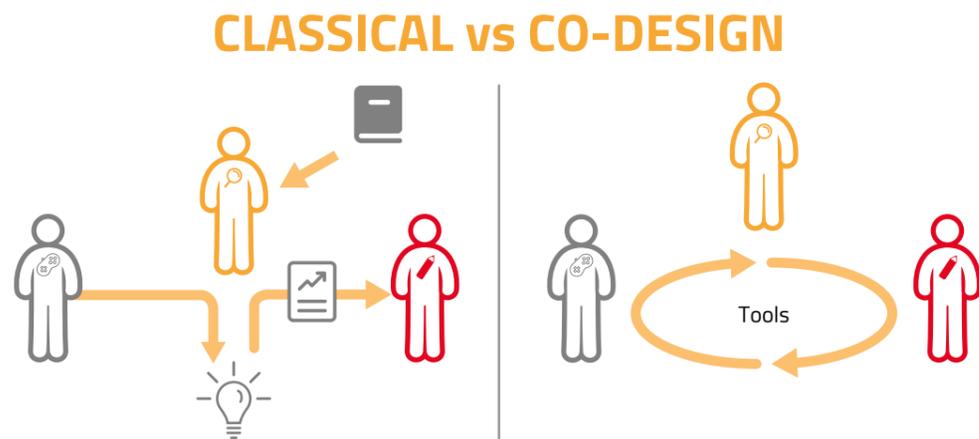


Figure 38. Classical roles of users, researchers, and designers in the design process (on the left) and how they are merging in the co-designing process (on the right). Reprinted from "Co-creation and the new landscapes of design" by E. B. N. Sanders and P. J. Stappers, 2008, CoDesign: International Journal of CoCreation in Design and the Arts, 4(1), pp. 5-18.

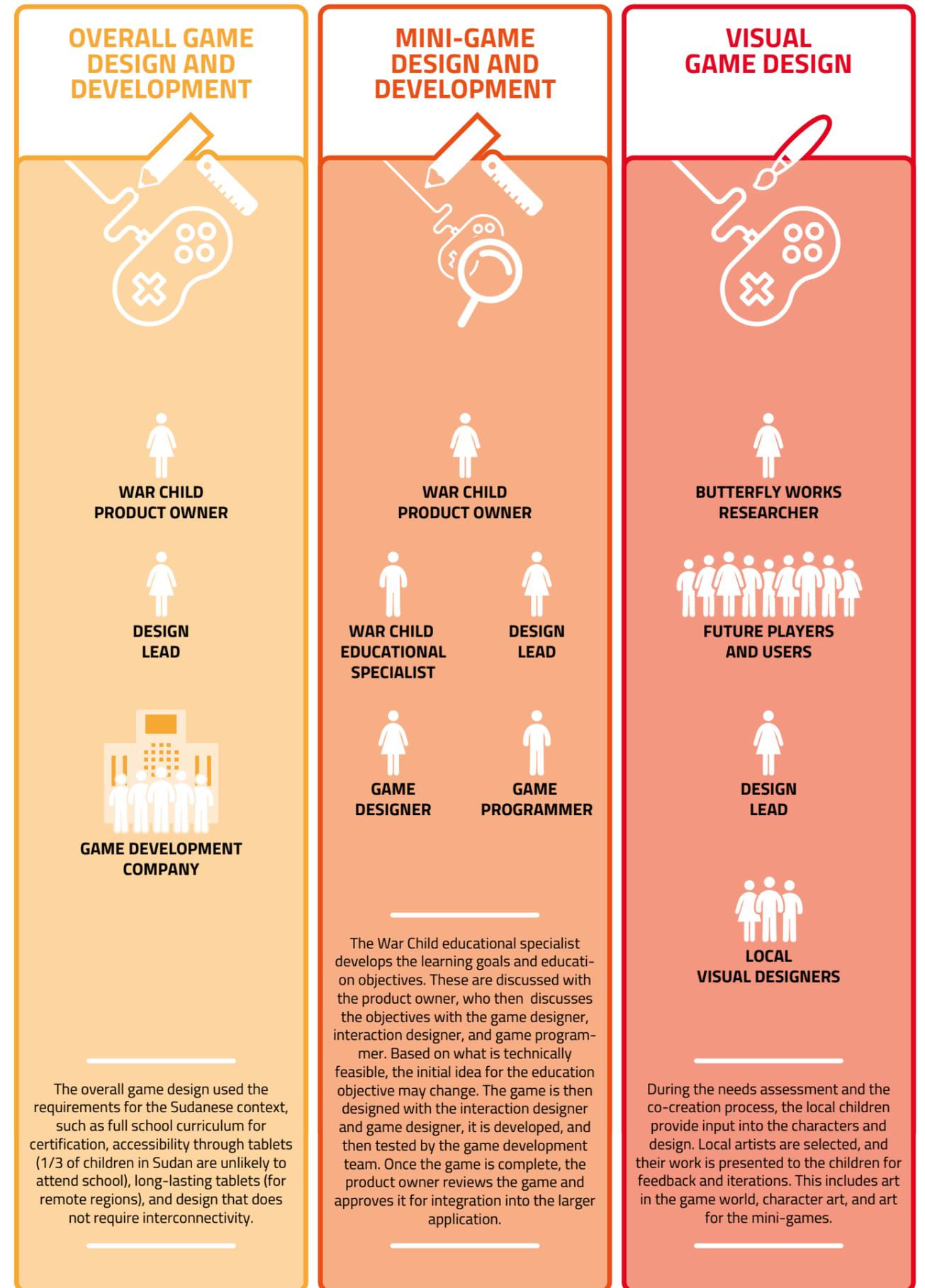


Figure 39. CWTL's Game Design Process.

CWTLs participatory research aimed to document users' lived realities, hopes, and dreams with sample narratives; identify visual artefacts relevant to users' lives; identify existing education challenges and opportunities relevant to the

The participatory design research conducted for CWTL by Butterflyworks included five activities: social mapping (mapping the children's social environment), communication mapping (an overview of how people in the region communicate), photo observation (using photographs to understand daily lived experiences), collaborative storytelling (understanding children's dreams, ideas of fun, and safety), and visual mapping (understanding children's visual culture) (see Figure 39 below).

CWTL has worked together with Butterfly Works to develop the visual style and game

CWTL programme; and identify existing MHPSS (Mental Health and Psychosocial Support) issues, practice resources, and opportunities relevant to CWTL. This research provided information about the game's ideal visual design.

story. This process started with creative research, where the children were asked for their input on illustration style and on social topics. The outcomes of this research were used in both a children's workshop and an artists' workshop.

In the children's workshop, the children were asked for their input in various creative ways. They were asked to draw objects and people from their environment, to visualise their dream job with Play-Doh, and to express social structures or working situations with Lego. They also did a group activity to describe their 'fictional' friend.

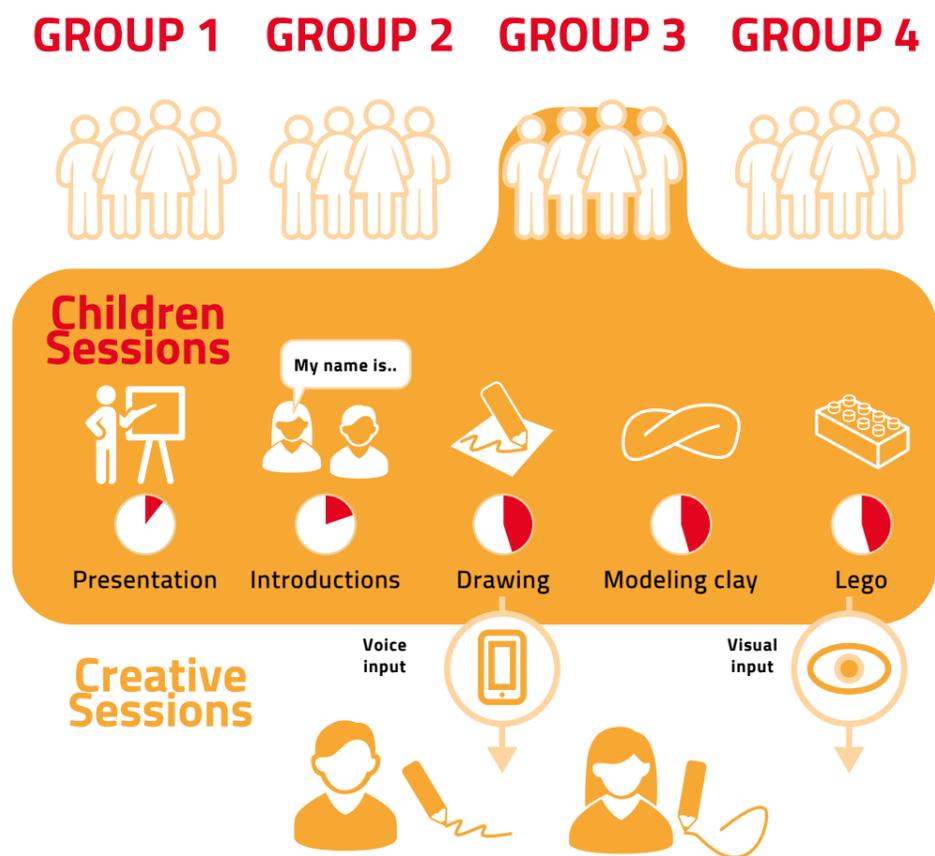


Figure 40. Co-creation process at Can't Wait To Learn conducted by Butterfly Works.

Simultaneously, the artist design workshop was held. Based on the stories and creative output of the children, the artists began defining the characters, drawing the world map, and building structures. These sketches were shared with the children again for feedback. This process resulted in a unique game story with local recognisable characters, including 15 characters along with their location and the game guide.

The co-creation process in the CWTL Reading Game resulted in a game world that includes familiar objects and appropriately dressed characters (e.g., the headscarf is worn the right way and the grandfather is wearing a local outfit). The buildings also represent familiar shapes, colours, and orientations (e.g., in Jordan the buildings are

Guide

A player's first exposure to narrative appears as a guide who invites them to play the game with the following text:

This is your place. You live here with your community. As you will start to see, there are many different types of people living here: neighbours, relatives, and children your own age. They all have things they really like to do. Find out what they enjoy and help them to solve any problems they have. This way you can make them happy and then they will reward you. The more people you meet and make happy, the more exciting the place will become. And you have a place where you can exhibit your own creations and achievements! It is a place that you can fill with things you like! The more you do, the more beautiful it will become.

The guide character guides players through instructions on how to play the game and where to start. She encourages them to discover which characters they resonate with, supporting Gee's (2003) telling and doing domain.

symmetrical to mirror the local architectural style). This is all presented in a Game Design Document.

After the workshop, the CWTL design lead worked with the artists from the Dutch game developer to finalise the game world. Its characters were based on the final sketches made by local designers and with the use of the Game Design Document. All the art that is used in the various mini-games, such as word illustrations (1400 illustrations), story book covers (220 illustrations), or find the difference mini-games (18 illustrations), is created by local designers guided by the design lead, who works remotely. Based on how well this process worked for the Jordan Literacy Game, all the game world illustrations were finalised by local artists, working remotely, after the co-creation workshop.

In Jordan, the guide's name is Eyman. She is a young female teacher who wears culturally representative clothing and a hijab (headscarf) and holds a book in her hand. She has a friendly smile and loves teaching many subjects.

As the game progresses, the guide character guides the player to different characters.



Figure 41. Jordanian guide, Eyman, in the Reading Game.

Characters

Localised, culturally appropriate characters help players identify with the narrative and support Gee's (2003) commitment learning principle. The characters are young adults with a mix of ages, as children look primarily to young people as role models. As players connect their real-world identity to their newly created virtual identity, they become more committed to the virtual world (Gee, 2003).

Like the people in the children's daily lives, every character has a skill. The game demonstrates that basic skills that can be learned at home, such as cooking or making bricks, can create income-generating opportunities. For example, cooking leads to owning a restaurant, and brickmaking leads to work as a builder. The role models for these characters are young adults.

Table 11: Characters and Locations in Overworld 1 Jordan Reading Game

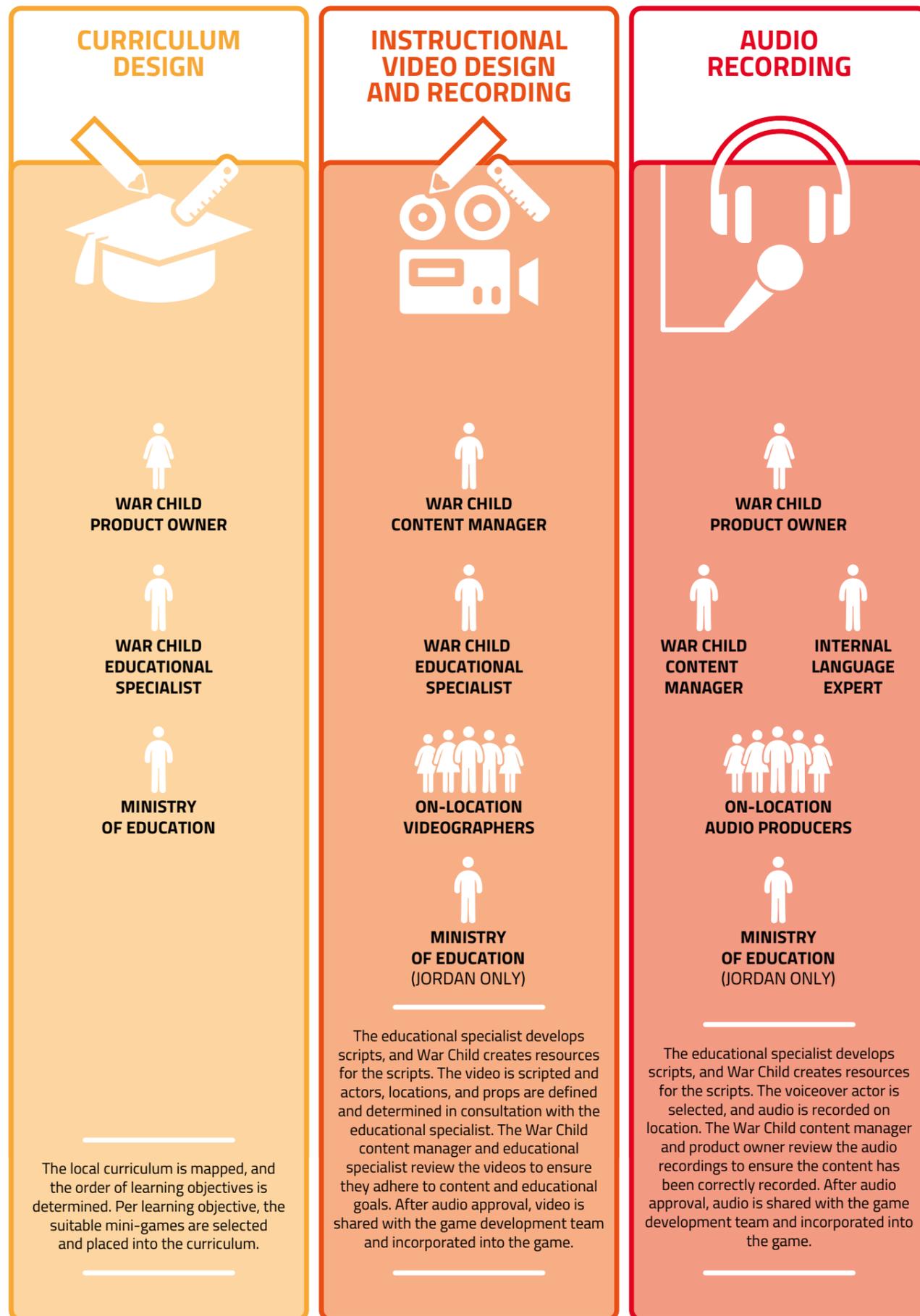
| Name of Character | Location | Vocation |
|-------------------|---|---|
| Haneen | Grandparents' house next door | Grandmother who wants to arrange a family meeting |
| Issam | Living room | Father who wants to refurbish the house |
| Rama | Doctor's office | Doctor |
| Rania | Neighbour's house - in front of door, in the stairway | Neighbour who graduated |
| Sawsan | Garden | Neighbour with garden |
| Houda | Kitchen | Mom has no idea what to cook and needs help |
| Enaas | traffic light in front of house | Traffic police |
| Elissa | salon (visitors' room) | Visitor who lives abroad |
| Wael | Rooftop | Uncle |
| Tamer | Grocery store | Shopkeeper |
| Rayan | Under a tree in street | Artist/Painter |
| Sondus | Balcony | Aunt (fashionable) |
| Muneer | On the rooftop at construction site | Construction worker |
| Wesam | Field next to the house | Football player |
| Fadi | Bedroom | Brother |



Figure 42. Jordanian characters from the first overworld.

Table 12: Characters and Locations in Overworld 2 Jordan Reading Game

| Name of Character | Location | Vocation |
|-------------------|---------------------------------|------------------------------|
| Omar | Park bench near Petra | Grandparent |
| Tasneem | Construction site | Electrician |
| Aisha | Hospital | Nurse |
| Anas | Event hall, graduation ceremony | Neighbour's husband (of OW1) |
| Fares | Farm | Farmer |
| Baker | Restaurant | Chef |
| Aws | Bus and taxi station | Driver |
| Shadi | School | Teacher |
| Ayah | Zoo | Animal keeper |
| Hiba | Market | Supermarket owner |
| Maha | Art studio | Artist (sculpture) |
| Yamen | Shop | Tailor |
| Yaraa | Office | Engineer/architect |
| Intisaar | Sports field | Basketball player |
| Ahlaam | Playground | Sister |



Educational Design

The curriculum was originally defined by our educational partner, TNO, and later by our internal educational specialist. The didactic framework was co-developed with the Ministry of Education in each location. The following reading topics are covered as part of the reading didactic framework: 1) visual processing, 2) writing, 3) phonemic awareness, 4) vocabulary, 5) letter knowledge, 6) listening, 7) reading comprehension, 8) pronunciation, and 9) grammar. The curriculum consists of 64 mini-games that cover the above domains of reading education.

The game's design also includes mechanisms that help players learn the game. CWTL employs cascading information theory (Schonfeld, 2010) to structure the complex

learning activities. Cascading information theory states that information should be released in the smallest possible pieces to convey the appropriate level of understanding at each point in a game's narrative. For example, at the beginning of CWTL, players take basic actions. As they become more competent, they can unlock more difficult actions and progress through levels. They, therefore, gain mastery over simple tasks first and then build on those accomplishments to complete more complex tasks. This staged process approach prevents information overload.

In the next section, we review parts of the curriculum and how these parts are integrated into the CWTL Reading Game.

Bubble Structure

Another game design domain within CWTL is the right level of difficulty (Björk & Holopainen, 2005), which refers to the intended level of difficulty the player experiences. 'Bubble' or 'bubble level' refers to the game's different levels, and the bubble structure dictates which mini-games need to be played in which bubble. The bubble structure also includes the ranges for mini-games, which refer to the letters that are introduced in each mini-game (e.g., 1-5, 1-10). The bubble structure sheet also shows

the number of streaks the mini-game will have per bubble, as well as the number of questions per streak. The 64 games are divided into 100 curriculum bubbles or sections. A bubble contains one or more mini-games presented in random order. All mini-games must be completed before the player can continue to the next bubble. In this way, mini-game challenges are controlled to create the right level of difficulty.

A sample bubble structure is shown below:

| Learning Objectives | Bubble | Mini-game | Mini-game description | Videos | Min | Max | Questions in streaks | | | | |
|---------------------|--------|-----------|-----------------------------------|--------|-----|-----|----------------------|-----|-----|-----|-----|
| | | | | | | | 1st | 2nd | 3rd | 4th | 5th |
| jiim | 22 | 40 | Connect Picture Word | 12,13 | | | 5 | 5 | | | |
| | | 110 | Easy Reading Book + Comprehension | 12,13 | | | 1 | | | | |
| | | 60 | Copy the Letter | 12,13 | | | 2 | 2 | | | |
| | | 220 | Letter name | 12,13 | | | 5 | 5 | 8 | 8 | |
| | | 240 | Letter sound + parrot | 12,13 | | | 3 | 3 | | | |
| | | 380 | Songs and Poems | 12,13 | | | 1 | 1 | | | |
| | | 390 | Sound Letter | 12,13 | | | 5 | 8 | 8 | 8 | |
| | | 420 | Syllable sound | 12,13 | | | 5 | 5 | 8 | 8 | |
| | | 460 | Trace the Letter | 12,13 | | | 3 | 3 | | | |

Figure 44. Level 1 Bubble structure for Jordan Can't Wait To Learn Reading Game.

Example of Curriculum Progression

At the beginning of the game, players see a mini-game called 'Trace the Shape'. They trace one of four shapes (a triangle, a circle, a cat, or a sailboat) and click the 'OK' button to indicate completion of the task. The game provides feedback showing whether the player has completed the task correctly, by displaying a green smiley face or a yellow neutral face.

The player has three chances to complete this mini-game. If they are correct at least once in each attempt, they begin filling up part of a wreath. The game then closes to end the first streak.

The player taps on the location again and plays the game three more times. After the final round, the wreath fills up completely with water.

Placement Test

As children may have different ability levels before beginning the game, they can take a placement test to determine their initial level, or a teacher can manually (without a test) determine their proficiency level by selecting a streaming-in point. In this placement test, they play a few selected mini-games that test their knowledge on specific learning objectives. If completed correctly, they move on to the next stage of mini-games. When a child reaches a level at which they no longer correctly complete the mini-games in the placement test, they enter the game at that level, or 'stream in'. This process ensures that children work at their own level.

The placement test has one screen per stage, with portraits and a trophy. Each portrait represents a mini-game, and the child taps the first portrait to unlock it and start the first mini-game. The other portraits remain locked until the child begins subsequent mini-games. The child can try five times to complete the streak and is allowed one error.

The figure below describes the first streaming-in points for the placement test:

Table 13: Placement Test Streaming-in Points per Bubble Level for Jordan Reading Game

| Streaming In Point | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|--------------------|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|
| | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| Bubble Level | 1 | 8 | 15 | 20 | 27 | 32 | 37 | 42 | 47 | 51 | 55 | 60 | 65 | 70 | 75 |

The first streaming-in point has 3 different mini-games. Later streaming-in points can contain up to five mini-games.

Mini-Bubbles

CWTL added a custom feature to the Jordan CWTL Reading Game. The Jordan Ministry of Education (MoE) requested mini-bubbles (specific educational objectives required by the MoE), which teachers can select and use to teach concepts to the entire class, depending on students' needs. For example, if the teacher notices

that children need more practise with the numbers 20–30, they can select that mini-bubble to be played in each tablet. In this way, the children receive a curated lesson for the day as the teacher deems necessary. Once the lesson is complete, the mini-bubble takes the child back to their most current location in the game.

Progress Database

The CWTL product owner defines the progress database, which is closely linked to the curriculum. The progress database determines how many mini-games must be played to receive a full star in each location. In the beginning, players receive stars after two or three mini-games. As the player progresses, they must complete more mini-games to receive a full star. In total, each location has seven levels with seven stars each.

Once the player has received seven stars, the building is upgraded and a new empty star banner appears next to it. At the final stage, the star banner disappears and the building is fully upgraded. In each level, stars can be earned at the active location(s), represented by buildings. Players can identify these buildings by the particles coming out of them, which create a glow. They can also find the active location by selecting the Game Guide in the overworld, causing the camera to pan to the active location.

Audio

Audio is another key element of game design, as the mini-games contain audio instructions. Audio instructions also allow the guide to provide support. Each mini-game has a script that was developed in accordance with the mini-game play and design. As the Jordanian game was in Arabic, the scripts were developed in Arabic by TNO. The audio was recorded on location (where a representative of the Ministry of Education was present) and sent to War Child's Amsterdam headquarters, where the team ensured that the recordings matched the gameplay. The game developers then implemented the audio into the game. When errors were discovered, the audio was re-recorded.

Video Production

Instructional videos are an important component of CWTL, as instructional videos provide players with an active learning component. Studies suggest that video-based education provides the same level of teaching and learning as face-to-face education (Zhang et al., 2006). Video education provides time and location flexibility, results in cost and time savings for educational institutions, fosters self-directed and self-paced learning by enabling learner-centred activities, creates a collaborative learning environment by linking each learner with physically dispersed experts and peers, allows unlimited access to electronic learning material, and allows knowledge to be updated and maintained in a more timely and efficient manner (Baloian, 2000).

There are 104 videos for the Jordan Reading application. The Arabic specialist from TNO (Netherlands Organisation for Applied Scientific Research) designed the video scripts, which the MoE reviewed and adapted to match the game's learning principles. War Child created additional resources for the videos. The scripts were written in Arabic to match the language of the Jordanian game. The videos follow the curriculum learning objectives and begin by addressing the first learning objective of the first bubble. The educational specialist decided how each topic should be explained.

Actors, locations, and props were determined before production, and the video production company was selected by a tender. The videos were shot locally, with a representative of the Ministry of Education present.



Figure 45. Image capture of a Jordan Reading Video.

Game Design Assessment

Assessment is critical to ensure that games deliver positive learning processes and student outcomes. Appropriate and valid user feedback and performance assessments should therefore be available.

Assessments must consider individualisation and adaptability to ensure that the game meets the diverse needs of students (Bellotti et al., 2013). Assessment and evaluation must

consider the possibility that learning styles developed from games are different from those developed in the traditional classroom. For example, studies suggest that regular gamers are more creative, ambitious, and optimistic about their abilities and circumstances. Students who play video games have demonstrated improved visual memory and cognitive skills, especially regarding visualisation and mental maps.

Quality Assurance and Playtesting

Quality assurance and playtesting are essential steps in game design. Testing is conducted through all phases, including design, development, and post-production. This kind of testing is part of the iterative design process, in which prototypes are created and immediately tested with players. This process is also referred to as play-centric design (Fullerton et al., 2006).

Figure 45 above describes the iterative aspect of play-centric design. This model illustrates that games work at several levels. The first level (from concept phase to pre-production phase) places an emphasis on games as formal systems of rules with objectives, mechanics, and procedures. The next level illustrates how dramatic elements, such as premise, character, and story, create emotional experiences through goals and challenges. According to Fullerton et al. (2006), the combination of these two levels develops a dynamic system with emergent properties that creates unique play and interactive experiences for players. For this reason, they suggested formal playtesting throughout production.

Although we were not able to directly playtest with the children, we conducted playtesting and technical testing in all phases and at all levels.

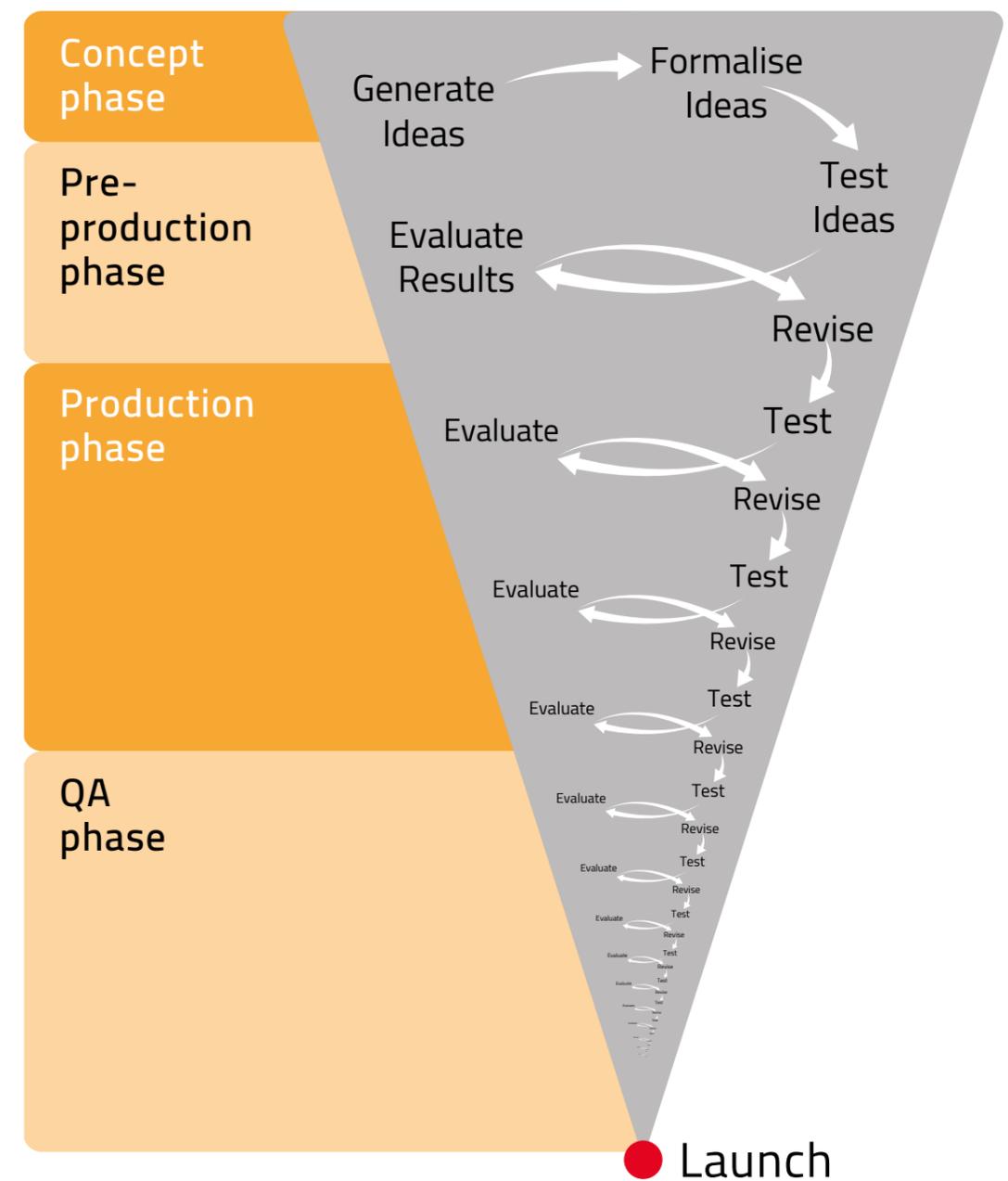


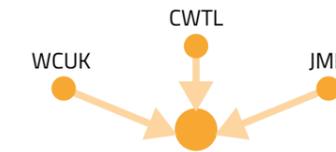
Figure 46. Model for iterative game design: playtest, evaluate, and revise. Reprinted from "That cloud game: Dreaming (and doing) innovative game design", by T. Fullerton, 2006, Proceedings of Sandbox '06 Proceedings of the 2006 ACM SIGGRAPH symposium on Video games, pp. 51–59.

To support the quality of the education and functionality of the application, the Reading Game components, mini-games, and overall application were also tested. The following chart describes the levels of testing conducted with the Reading Game, and by whom:

Table 14: Quality Assurance Testing Summary

| Test on | Type of test | Conducted by | Description of test | Why is this done? |
|----------------------|--------------|--|--|--|
| Overall game | Technical | Game development company | The is a technical test that automatically plays through the entire application. This test is run at least 20 times once the application is complete to avoid errors in progression. | To ensure that players can progress through the entire game and not get stuck by a technical malfunction or error in the code. |
| | Manual | Playtesters | Testers play the game from beginning to end. | To ensure progression and rewards are working appropriately. |
| Mini-games | Manual | Product owner, educational specialist, play- testers | Mini-games are playtested manually from a specialised console. | To ensure mini-game design is intuitive, meets educational goals, and is bug-free. |
| Audio | Manual | Content manager, product owner, playtesters | After audio is recorded and implemented, audio is played within the mini-game or overworld. | To ensure the correct audio is implemented in the correct areas of the game. To ensure game design matches audio script. |
| Instructional videos | Manual | Content manager, product owner, playtesters | After video is recorded and implemented, video is played from the video space or the overworld. | To ensure the correct video is implemented in the correct areas of the game. To ensure the curriculum matches instructional videos and the timing of the instructional videos. |
| Aesthetics | Manual | Product owner, playtesters | After the art has been placed into the game, several spot checks are made from the specialised console and from playing in the overworld. | To ensure the latest artwork is included in the game. To ensure that the artwork is country-specific. |
| Placement test | Technical | Game development team | A technical test is conducted, by playing through the placement test. | To ensure the placement test can be completed without errors in the code and that the player is at the correct level upon completing the game. |
| | Manual | Play testers and educational specialist | The testers and educational specialist take the placement test. | To ensure the placement test's mini-games are presented in the correct order and with the correct number ranges. To ensure the mini-games are educationally sound and appropriate. |

CWTL READING PROGRAMME JORDAN LAUNCHED: DEC 2017



The CWTL programme in Jordan is implemented through a partnership with War Child UK (WCUK) and the Jordan Ministry of Education (JME). The initial implementation started in December 2017 in UNICEF's Makani Centres in Azraq camp. This phase represented the pilot study before the Proof of Concept started in early 2018.



For this study, facilitators received training on how to use the game, classroom management, and how to support children without interfering in the research. Facilitators received game manuals, and programme staff provided assistance with the tablets, the game, and small issues as they arose



A French hardware supplier supplied the tablets after a procurement process in which 2500 tablets were purchased to prepare for the larger research study starting in September 2018

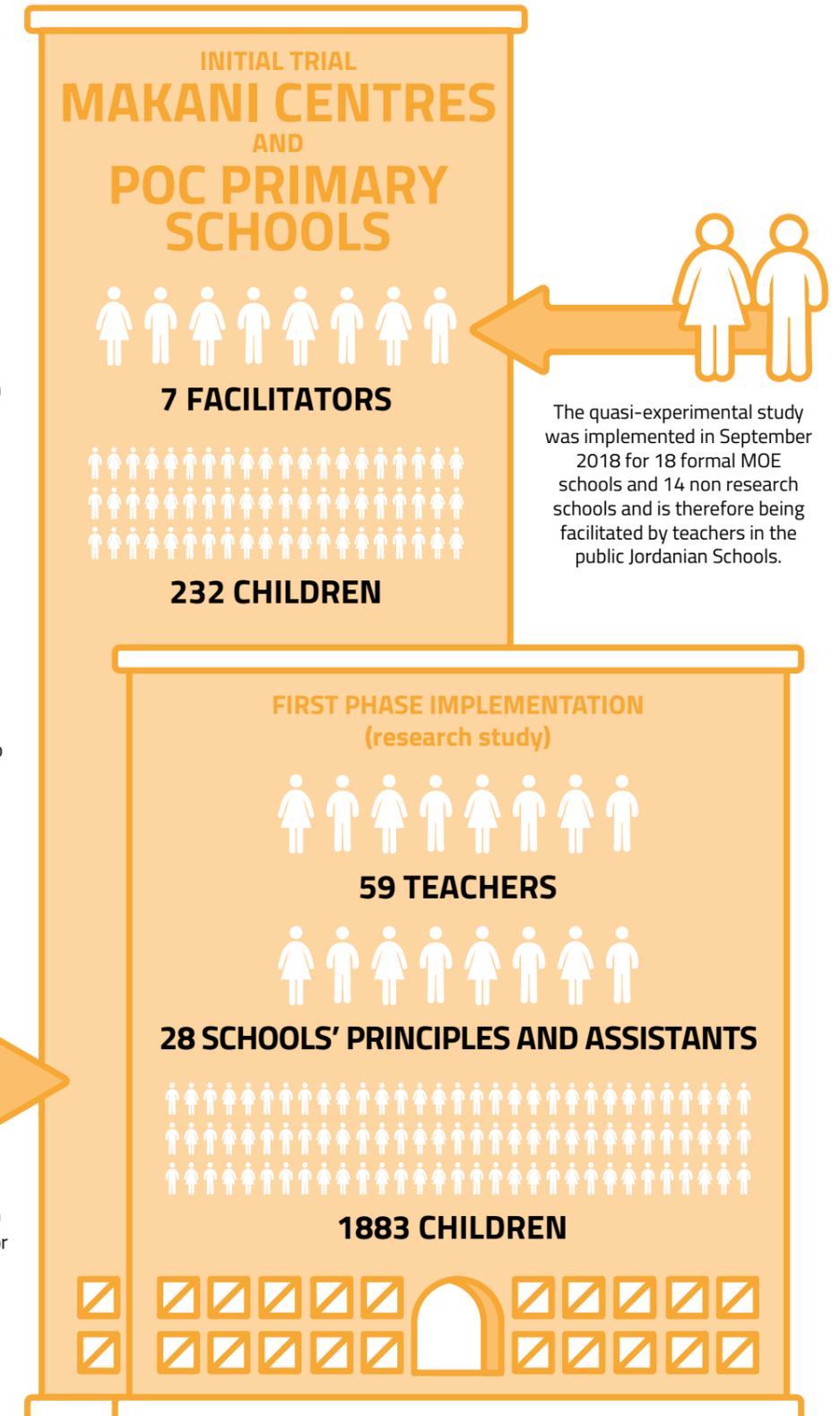


Figure 47. Pilot Implementation: Jordan Reading Game

Management Portal

A management portal supports every CWTL game. The portal tracks each child's attendance, time played, and progress. Teachers and facilitators can use the portal to monitor the progress of individual children and their whole classes and to set the level or specific skills for individual children. On a global level, the management portal provides insight into attendance and performance trends, including demographic trends.

Since the final quarter of 2017, significant investment has been made in the portal to increase and improve functionality. These improvements are listed below:

- Backend automation to improve loading time for visualisation and data;

- Improved functionality for teachers, providing better insight into student progress and attendance through more data and visual graphics;
- Additional student management tools for teachers, including the ability to search student IDs and download saved games;
- Based on feedback from the research teams, new data export files have been developed for easier data access;
- Country supervisor and location manager user profiles have been added for better programme management oversight; and

In the coming period, work will focus on monitoring dashboards and data analytics.



Figure 48. Screen capture of management portal and its functionality

Implementation

The CWTL programme in Jordan is implemented through a partnership with War Child UK and the Jordan Ministry of Education. The initial implementation started in December 2017 in UNICEF's Makani Centres in Azraq camp. This phase represented the pilot study before the Proof of Concept started in early 2018. For this study, facilitators received training on how to use the game, classroom management, and how to support children without interfering in the research. Facilitators received game manuals, and programme staff provided

assistance with the tablets, the game, and small issues as they arose. Archos supplied the tablets after a procurement process in which 2500 tablets were purchased to prepare for the larger research study starting in September 2018. This quasi-experimental research study is being implemented in 18 formal MoE Schools (1055 children) and is therefore being facilitated by teachers in public Jordanian Schools. In addition, CWTL is being implemented in 14 non-research schools (826 children).

Summary

The CWTL Reading Game uses the de Freitas and Jarvis (2008) game design model to blend didactic elements with game design. The curriculum defines clear learning objectives, player goals, and learner content. This content is delivered through mini-games. The game engine programming defines the player's mastery level and provides feedback, allowing the player to proceed to practise before proceeding. The game's progression is drawn from the themed progress database, which defines the player's rewards and building upgrades.

The CWTL Reading Game incorporates the self-knowledge principle (Gee, 2003) to create the correct level of difficulty. Players learn not only subject matter content, but also about their current and potential capacities. This self-knowledge acquisition increases student confidence, which is one of the key potential benefits of educational technology (Beck & Wade, 2004).

To ensure the game's efficacy, testing is conducted throughout the process (Fullerton et al., 2006).



Conclusions

Towards the Future

Considering the challenges in the Sudan Pilot (Phases I and II) as lessons learned, it is clear CWTL positively responded to a need: providing children access to quality education, through innovative education technology supported by strong partnerships. Whilst CWTL does not address all the education needs of out-of-school Sudanese children, the positive results are a 'large step in the right direction'.

In 2017, CWTL moved on to Phase III. The Maths Game was expanded to Jordan and Lebanon and the Sudanese Maths Game was updated. An Arabic literacy trial in Jordan expanded the programme's reach in terms of content. In 2018, a maths trial was started in Uganda, with an Arabic reading trial planned for Sudan and an English reading trial planned for Uganda (to be implemented in late 2018).

Table 15: Changes to the Reading Game

| Game Area | Current Design | New Design |
|-------------------|---|---|
| Overworld | There are two game modes: neighbourhood mode and town mode. | Only town mode will be available. |
| Story | Players receive trophies for helping characters. | A stronger story will be implemented. Players will continue to help characters, but the trophies will be illustrations related to each character in a location. Characters will introduce players to the next location and to the next character. For example, the bus driver might ask the player to go to the mechanic to get his tire fixed. |
| Personal space | The personal space offers journaling, reading, drawing, access to trophies, and videos. | The personal space will contain the new, story-based trophies. The design of the journal will be more like a scrapbook. |
| Curriculum | The curriculum and games encourage language learning. | New games will be offered. Curriculum will be added to support more gradual incremental language learning with a stronger focus on reading. |
| Playtesting | Playtesters support the quality of game play and confirm that the language is correct. | Playtesting sessions with children will be held before designing new overworld game components. Playtesting with children will support increased game design, game play, and engagement. Feedback from the sites will also be integrated into the design of the game. |
| Quality Assurance | A game development company conducts all quality assurance activities. | Can't Wait To Learn has begun a contract with a quality assurance advisor. |
| Game Process | Game development involves the use of sprints. | Designers will use a product road map and a more strict, agile methodology. |

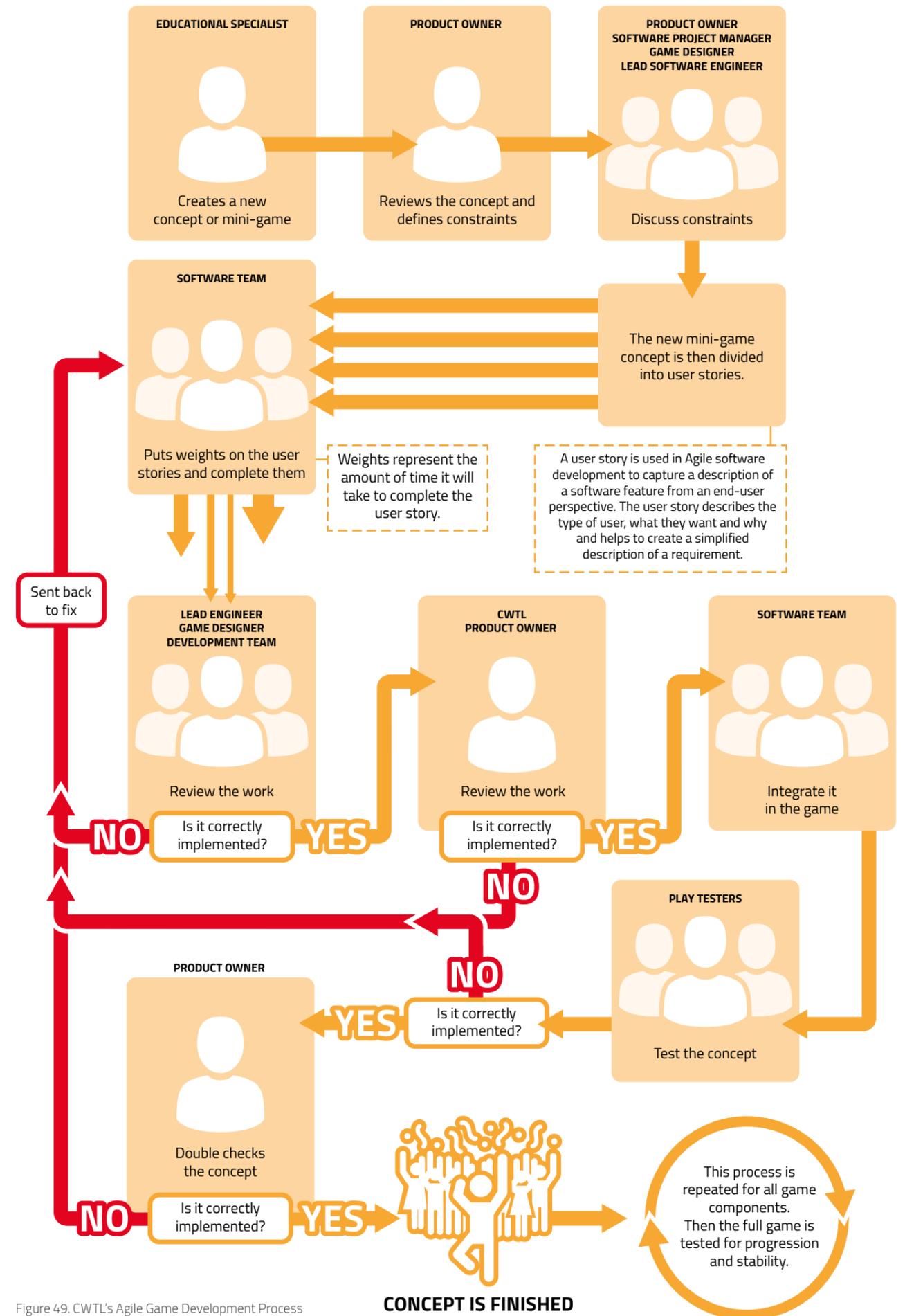


Figure 49. CWTL's Agile Game Development Process

Game Development

Reading Game

The Reading Game is currently being piloted in Jordan, with plans to implement it in Sudan in early 2019. As a result of what was learned from Jordan, changes have been made for future iterations of the game.

To support players in deeper engagement with the game, the Reading Game will be changed in the following ways:

Maths Game

In Sudan, Phase I successfully proved children can learn maths from the game. Phase II went further in understanding the impact on different children and the impact outside of learning outcomes. Other findings from Phase II are as follows:

- Children learn significantly from the game, with those who know the least learning the most;
- The game is gender neutral and promotes a more gender balanced learning experience, which stimulates and holds the attention of boys and girls equally; and
- Compared to the traditional education approaches in Sudan and selected countries, CWTL is more effective for learning outcomes than traditional education (when measured using EGMA as the standardised assessment).

Results of the research from the Maths Games (Jordan, Lebanon, and Uganda) and the Reading Game (Jordan) will be forthcoming in 2019.

For further information and the latest results, please refer to:

The Future of Can't Wait to Learn

The programme has plans for several improvements and changes in the future, including CWTLs iterative approach to improving the game build and learning outcomes. These improvements and changes will include generating a standard framework for the game that can be used as a template; using log/quantitative data and user feedback to improve/change the mini-games; infrastructure changes, including strategies for e-waste; using learning assessment to determine which areas of learning outcomes need to improve; and using artificial intelligence to improve software and communications (and making adjustments to the game to support that).

The ultimate goal of the CWTL programme is to provide significant numbers of out-of-school children with mathematics and literacy by 2020. Research into CWTL will continue to play an important role as the programme scales up. CWTL will continue to scale up to other contexts while applying lessons learned and adapting the model and methods to meet the urgent educational needs of children affected by conflict.



**Bibliography and
Annexes**

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Annex 1:

Uganda Maths Mini-Games

| Mini game | Description |
|-----------|--|
| 100 | Hundredsquare |
| 1000 | a SOUND_TO_OBJ MultipleChoice Standard |
| 1000 | b OBJ_TO_NUM MultipleChoice Standard |
| 1000 | c SOUND_TO_NUM MultipleChoice Standard |
| 1010 | MultipleChoice 1 Higher Lower |
| 1001 | MultipleChoice Standard Decimals (Jordan) |
| 1030 | MultipleChoice Object ThirdQuarter |
| 1020 | MultipleChoice Meters to Yards |
| 1040 | MultipleChoice Shapefind |
| 1060 | MultipleChoice ObjectLength |
| 1041 | MultipleChoice Shapefind More Shapes |
| 1050 | MultipleChoice Ruler |
| 1070 | MultipleChoice CountEggs |
| 1080 | MultipleChoice Input ThirdQuarter |
| 1085 | MultipleChoice Input Fracture |
| 1090 | MultipleChoice Multiplication Modification |
| 3000 | Word problem addition |
| 1100 | MultipleChoice Numberline Numbershift |
| 1110 | MultipleChoice Pattern Repitition |
| 1120 | Multiple Choice Standard: decimal - simple fraction |
| 2000 | Numberline 1-10 |
| 2010 | Numberline 10-100 |
| 2020 | Numberline 100-1000 |
| 2030 | Numberline 10, 20, 30 ... 100 |
| 2040 | Numberline X-X Add X |
| 2050 | Numberline X-X Subtract X |
| 2060 | Numberline X-X, Drag, X><Y |
| 2070 | Numberline X-X, Number, Add1 |
| 2080 | Numberline X-X Subtract 1 |
| 2090 | Place the decimal number on the number line (Jordan) |
| 3010 | Word problem subtraction |
| 3020 | Word problem division |
| 4000 | 2 HAND_TO_NUM FlashCard Standard |
| 4000 | 1 DICE_TO_NUM FlashCard Standard |
| 4000 | 3 NUM_TO_NUM FlashCard Standard |
| 4010 | FlashCard Friends of ten |
| 4020 | FlashCard Twins |
| 5010 | Grouping |
| 5000 | Grouping - explore |
| 6000 | FillEggbox |
| 7000 | Beads Standard 1 step |
| 7010 | Beads 2 step add/subtract 1 |
| 7020 | Beads 2 step add 2 numbers |
| 8000 | ClothesLine |
| 7030 | Beads 2 step subtract 2 numbers |
| 9000 | Abacus Standard |
| 10000 | PeopleOnBus More on |
| 9010 | Abacus Add X |
| 9020 | Abacus Subtract X |

| Mini game | Description |
|-----------|---|
| 10010 | PeopleOnBus Some off |
| 11000 | Sums Add |
| 11010 | Sums Subtract |
| 11001 | Solve the formula: Sum |
| 11002 | Solve the formula: Subtraction |
| 11003 | Solve the formula: Multiplication |
| 11004 | Solve the formula: Division |
| 11005 | Sums Add Decimals (Jordan) |
| 11020 | Sums Add with 10 |
| 11011 | Sums Subtract Decimals (Jordan) |
| 11030 | Sums Subtract with 10 |
| 11040 | Sums Multiplication |
| 11050 | Sums Division |
| 11041 | Sums Multiplication Decimals (Jordan) |
| 11042 | Sums Multiplication Fraction and Rational number |
| 11090 | Sums Equals |
| 11051 | Sums Division: Fraction by rational number |
| 11060 | Division conversion: Fractions to rational numbers |
| 11070 | Multiplication conversions: rational number to fraction |
| 11080 | Addition fractions with same denominator |
| 11085 | Subtraction fractions with same denominator |
| 12000 | FriendsOfTen |
| 14010 | Ordering EGGS AND MONEY |
| 13000 | Split Standard |
| 13010 | Split 1 option |
| 13020 | Split 2 options |
| 14000 | Ordering |
| 15000 | StackedArithmetic Add |
| 15010 | StackedArithmetic Subtract |
| 15020 | StackedArithmetic Multiply |
| 16000 | Visual Addition Add |
| 15021 | StackedArithmetic Multiply (3 by 2 and more) |
| 16010 | Visual Addition Subtract |
| 16020 | Visual Addition Multiply |
| 17000 | HowMany |
| 18000 | ShapeQuiz |
| 19000 | Sequence |
| 18010 | ShapeQuiz: More shapes |
| 21000 | Division |
| 19010 | Sequence Decimals (Jordan) |
| 20000 | Weights |
| 21040 | Division 2,3,4 |
| 21010 | Division round for 2 |
| 21020 | Division round for 3 |
| 21030 | Division round for 4 |
| 22000 | InARow Add |
| 22010 | InARow Subtract |
| 22020 | InARow Multiply |
| 22030 | InARow Divide |

| Mini game | Description |
|-----------|--|
| 25000 | PuzzlePie |
| 22040 | InARow Addition (4 in a row) |
| 22041 | InARow Addition (5 in a row) |
| 22050 | InARow Substraction (4 in a row) |
| 22051 | InARow Substraction (5 in a row) |
| 22060 | InARow Multiplication (4 in a row) |
| 22061 | InARow Multiplication (5 in a row) |
| 22070 | InARow Division (4 in a row) |
| 22071 | InARow Division (5 in a row) |
| 23000 | RepSub |
| 24000 | Sums with more sums in them 5 + 6 x 2 |
| 24010 | Sums with more sums in them 5 + 6 x 2 with writing |
| 27000 | Measuring Length of an object: How long is it? |
| 28000 | ShapeRecognition Rect |
| 27010 | Measure: Angles |
| 28010 | ShapeRecognition Triangle |
| 28020 | ShapeRecognition Circle |
| 28030 | ShapeRecognition Square |
| 28040 | ShapeRecognition Multiple |
| 29000 | Lengths |
| 32000 | The Scale |
| 30000 | Conversion Metric: Decimeters, Centimeters to Meters |
| 30010 | Conversion Metric to Imperial: Inch to centimeter |
| 30020 | Conversion Metric to Imperial: Centimeters to Feet |
| 30030 | Conversion Metric to Imperial: Yard to Meters |
| 30040 | Conversion Metric: Decimeter to Meter |
| 30041 | Conversion Metric: Decimeter Squared to Meter Squared |
| 30050 | Conversion Metric: Centimeter to Meter |
| 30051 | Conversion Metric: Centimeter Squared to Meter Squared |
| 30060 | Conversion Metric: Decimeter to Centimeter |
| 30061 | Conversion Metric: Decimeter squared to Centimeter Squared |
| 30070 | Conversion Imperial: Feet to Yard |
| 30080 | Conversions Imperial: Inches to Yard |
| 30090 | Conversions Imperial: Feet to Inch |
| 31000 | Ruler Conversion |
| 31010 | ConvertWeight |
| 31020 | ConvertWeight: Metric to Imperial |
| 31030 | Convert Weight: Metric (Kg to g and vice versa) |
| 36000 | Bar charts |
| 36000 | Calendar West |
| 36010 | Calendar Isl |
| 37000 | Clock |
| 37010 | Clock Move arms |
| 37020 | Clock Digital |
| 37030 | Clock Digital Input |
| 38000 | Writing Tracing |
| 38010 | Writing See number write |
| 38020 | Writing Hear number write |
| 40000 | Math Problems (Sums) with drawing input ADD |
| 40010 | Math Problems (Sums) with drawing input SUB |
| 40020 | Math Problems (Sums) with drawing input Add with 10 |
| 40030 | Math Problems (Sums) with drawing input Sub with 10 |
| 40040 | Math Problems (Sums) with drawing input Multiply |
| 40050 | Math Problems (Sums) with drawing input Divide |

| Mini game | Description |
|-----------|--|
| 40090 | Math Problems (Sums) with drawing input Equals |
| 41000 | Multiple Choice Estimate Your Answers (Objects) |
| 41010 | Multiple Choice Estimate Your Answers (Numbers) |
| 42000 | Round to the Nearest (ten) |
| 42010 | Round to the Nearest (one hundred) |
| 42020 | Round to the Nearest (thousand) |
| 43000 | Multiple Choice Prepositions |
| 44000 | What is the pattern? (Shapes) |
| 44010 | What is a pattern? (Numbers) |
| 45000 | Construct a chart |
| 45010 | Construct a table based on data |
| 45030 | Construct a circle diagram based on table |
| 46000 | How do you pay? (One Object) Jordan |
| 46010 | How do you pay? (Multiple Objects) Jordan |
| 46020 | How do you pay? (One Object) Lebanon |
| 46030 | How do you pay? (Multiple Objects) Lebanon |
| 47000 | Convert Coins to Paper Money (Jordan) |
| 47010 | Convert Coins to Paper Money (Lebanon) |
| 49000 | Long division |
| 50000 | This number can be divided by |
| 50010 | These numbers can be divided by (Pick the right answer) |
| 50020 | How many times does 1/8 go into 1? |
| 50030 | Pick the right answer: are these lines parallel? |
| 51000 | Simplify the numerical expression |
| 52000 | Colour the cells in the chart that represent decimal numbers |
| 53000 | Rewrite the addition with negative number into subtraction |
| 54000 | Find lowest common denominator prepare for addition |
| 55000 | Find greatest common divisor make a fraction more simple |
| 56000 | Draw the shape (does not exist?) |
| 56010 | Draw the shape: angles |
| 57000 | Draw the symmetry line |
| 57010 | Draw bisector of angle, Parallel line, Intersecting line |
| 58000 | Calculate perimeter |
| 58020 | Calculate volume |
| 59000 | Find the factors |
| 60000 | Describe route on map from A to B |
| 61000 | What is the shortest route? |
| 62000 | What do you see at point A on the map? |
| 63000 | Answer questions about a table/graph |
| 64000 | Draw a map based on picture/photo |
| 65000 | Identify the power when describing the area of a square |
| 65050 | Calculate area of square, rectangle or triangle |
| 65060 | new, = 65050 maar dan voor driehoeken |
| 66000 | Rewrite powers to repeated multiplication |
| 67000 | Calculate average of set of numbers |
| 68000 | Write numbers in words |
| 69000 | Can you construct a cube/rectangular prism with this model? |
| 70000 | Which one is the right angle? |
| 71000 | Where is the right angle |
| 72000 | Where is this point |
| 73000 | Calculate complementary angles |
| 73010 | Calculate supplementary angles |
| 74000 | Click parallel/perpendicular lines |
| 75000 | Metric Volume: Liter to deciliter, centiliter to milliliter |

Annex 2: Jordan Reading Mini-Games

| Level | Letter | Learning objective |
|-------|--------|---|
| 1 | | listening comprehension / phonological awareness / train fine motor skills / visual perception |
| 2 | | listening comprehension / phonological awareness / train fine motor skills / visual perception |
| 3 | | listening comprehension / phonological awareness / train fine motor skills / visual perception |
| 4 | ا | learn letter name / Learn letter sound / listening comprehension / visual perception / write letters |
| 5 | g | learn letter name / Learn letter sound / Listening comprehension / phonological awareness / visual perception / write letters |
| 6 | س | learn Letter name / learn letter shapes / learn letter sound / listening comprehension / visual perception / write letters |
| 7 | ب | learn letter name / Letter sound / phonological awareness / read easy books / visual perception / write letters |
| 8 | س | learn letter name / learn letter shapes / Learn letter sound / phonological awareness / read easy books / read syllables / write letters |
| 9 | م | learn letter name / Letter sound / phonological awareness / read easy books / segment words into syllables / visual perception / write letters |
| 10 | | Sukun / blend syllables into words / learn letter name / learn letter shapes / Learn letter sound / phonological awareness / read easy books / read syllables |
| 11 | ر | learn letter name / learn letter shapes / Letter sound / phonological awareness / read easy books / read words / visual perception / write letters |
| 12 | ف | blend syllables into words / learn letter name / learn letter shapes / Learn letter sound / listening comprehension / phonological awareness / read easy books / read syllables / read words / write letters |
| 13 | ش | learn letter name / learn letter shapes / Letter sound / phonological awareness / read easy books / read words / visual perception / write letters |
| 14 | ت | blend syllables into words / learn letter name / Learn letter sound / phonological awareness / read easy books / read syllables / segment words into syllables / write letters / Ta marbuta isolated and ta mabsutah final form |
| 15 | ن | learn letter name / learn letter shapes / letter pronunciation / Letter sound / phonological awareness / read easy books / read syllables / read words / write letters |
| 16 | د | learn letter name / learn letter shapes / Learn letter sound / listening comprehension / phonological awareness / read easy books / read syllables / read words / write letters |
| 17 | | blend syllables into words / learn letter name / Letter sound / phonological awareness / read easy books / read syllables / visual perception / Shaddah / Tips on recognizing shin vs. shin / Reading words |
| 18 | ح | learn letter name / learn letter shapes / Learn letter sound / letter pronunciation / Listening comprehension / phonological awareness / read easy books / read syllables / read words / segment words into syllables / write letters |
| 19 | ع | blend syllables into words / learn letter name / Letter sound / listening comprehension / phonological awareness / read easy books / read words / visual perception / write letters / write words |
| 20 | ل | blend syllables into words / learn letter name / learn letter shapes / Learn letter sound / phonological awareness / read easy books / read syllables / read words / write letters / write words |
| 21 | ز | learn letter name / learn letter shapes / Letter sound / phonological awareness / read easy books / read syllables / read words / visual perception / write letters |
| 22 | ج | blend syllables into words / learn letter name / Learn letter sound / letter pronunciation / phonological awareness / read easy books / read syllables / read words / visual perception / write letters |
| 23 | ث | learn letter name / learn letter shapes / Letter sound / phonological awareness / read easy books / read words / segment words into syllables / write letters / write words |

| Level | Letter | Learning objective |
|-------|--------|--|
| 24 | | blend syllables into words / learn letter name / Learn letter sound / listening comprehension / phonological awareness / read easy books / read syllables / read words / visual perception / Write the letter / write words / Tips on recognizing siin vs. thaa / Tips on recognizing baa vs. taa vs. thaa |
| 25 | ط | blend syllables into words / learn letter name / learn letter shapes / Letter sound / phonological awareness / read easy books / read syllables / read words / visual perception / write letters |
| 26 | ظ | building fluency / learn letter name / learn letter shapes / Learn letter sound / letter pronunciation / phonological awareness / read easy books / read words / visual perception / write letters |
| 27 | ك | blend syllables into words / learn letter name / learn letter shapes / Letter sound / phonological awareness / read syllables / read words / segment words into syllables / word pronunciation / write letters |
| 28 | ذ | learn letter name / Learn letter sound / phonological awareness / read easy books / read syllables / read words / write letters / write words |
| 29 | ق | blend syllables into words / learn letter name / learn letter shapes / letter pronunciation / Letter sound / listening comprehension / read syllables / read words / visual perception / write letters / write words |
| 30 | ا | building fluency / learn letter name / learn letter shapes / Learn letter sound / phonological awareness / read easy books / read syllables / read words / visual perception / word pronunciation / write letters / Write the letter |
| 31 | | learn letter name / learn letter shapes / letter pronunciation / Letter sound / Listening comprehension / read easy books / read words / segment words into syllables / write letters / write words |
| 32 | | Tips on recognizingf zaay vs thaa / Tips on recognizing jiim vs. haa vs. khaa / Isolated Hamza / learn letter name / Learn letter sound / listening comprehension / phonological awareness / read easy books / read syllables / read words / visual perception / word pronunciation / write words |
| 33 | ص | learn letter name / learn letter shapes / Letter sound / phonological awareness / read easy books / read syllables / read words / segment words into syllables / write letters |
| 34 | ض | learn letter name / learn letter shapes / Learn letter sound / read easy books / read syllables / read words / write letters / Write the letter / write words |
| 35 | ظ | building fluency / learn letter name / learn letter shapes / Letter sound / listening comprehension / read easy books / read syllables / read words / write letters / Write the letter / write words |
| 36 | غ | learn letter name / learn letter shapes / Learn letter sound / letter pronunciation / read easy books / read syllables / read words / Type words / visual perception / write letters / Write the letter / write words |
| 37 | | Tips on recognizing thah vs. daad / blend syllables into words / learn letter name / phonological awareness / read easy books / read syllables / read words / Type words / visual perception / Write the letter |
| 38 | | past tense with feminine sukūn t / blend syllables into words / learn letter shapes / read easy books / read syllables / read words / Write the letter / write words |
| 39 | | Adjunct preposition and majrūr noun / blend syllables into words / learn letter name / learn letter shapes / Listening comprehension / read easy books / read syllables / read words / Type words |
| 40 | | Present tense feminine / building fluency / read levelled books / read syllables / read words / Type words / Write the letter / write words |
| 41 | | Adverbs of place / learn letter shapes / phonological awareness / read levelled books / read words / visual perception / Write the letter |
| 42 | | masculine, and feminine with tā' marbū ah / learn letter shapes / read levelled books / read syllables / Write the letter / write words |
| 43 | | Sun and moon letters / learn letter name / read levelled books / read syllables / read words / Type words / Write the letter / write words |
| 44 | | infinitive/conjunctions ann and present tense / building fluency / listening comprehension / read levelled books / read syllables / read words / Type words |

| Level | Letter | Learning objective |
|-------|--------|--|
| 45 | | blend syllables into words / building fluency / learn letter shapes / Listening comprehension / read levelled books / visual perception / Write the letter / write words |
| 46 | | adverbs of time / learn letter names and / learn letter shapes / read levelled books / read syllables / read words / write words |
| 47 | | Learn letter sound / read levelled books / read words / Type words / word pronunciation / write words |
| 48 | | building fluency / listening comprehension / phonological awareness / read levelled books / read words / write words |
| 49 | | accusatives mansubat / learn letter name / read levelled books / read words / Type words / visual perception / write words |
| 50 | | standard exclamation / blend syllables into words / learn letter shapes / read levelled books / read words / writing words |
| 51 | | phonological awareness / read levelled books / read words / write words |
| 52 | | imperative mood using la / read levelled books / read words / Type words / write words |
| 53 | | building fluency / learn letter shapes / read levelled books / read syllables / read words / write words |
| 54 | | learn letter name / learn letter shapes / read levelled books / read words / Write the letter |
| 55 | | 1st person and subjective personal pronouns / listening comprehension / phonological awareness / read levelled books / read words / Type words / visual perception / writing words |
| 56 | | Dual, masculine and feminine / building fluency / phonological awareness / read levelled books / read words / reading comprehension |
| 57 | | listening comprehension / read levelled books / read words / Write the letter |
| 58 | | coordination prepositions / learn letter name / phonological awareness / read levelled books / Type words / word pronunciation |
| 59 | | building fluency / read levelled books / read sentences / read words |
| 60 | | listening comprehension / read levelled books / Type words / writing words |
| 61 | | Punctuation / Letter sound / listening comprehension / phonological awareness / read levelled books / visual perception |
| 62 | | Words ending with alif maqṣūrah ya' / Listening comprehension / phonological awareness / read levelled books / Type words / word pronunciation |
| 63 | | Isolated middle hamza form, above alif / listening comprehension / read levelled books / read sentences / read words / writing words |
| 64 | | Counting 1-10 / building fluency / learn letter name / read levelled books / Type words |
| 65 | | blend syllables into words / listening comprehension / read levelled books |
| 66 | | read levelled books / read sentences / read words / reading comprehension / write words |
| 67 | | listening comprehension / read levelled books / visual perception / writing words |
| 68 | | learn letter name / listening comprehension / phonological awareness / read levelled books / read sentences / Type words / write words |
| 69 | | building fluency / read levelled books / read sentences / reading comprehension / visual perception |
| 70 | | Hamza above ya / learn letter name / listening comprehension / read levelled books / read words / writing words |
| 71 | | hamza above a wāw, and Hamza alone / Listening comprehension / read levelled books / read sentences / write words |
| 72 | | read levelled books / read sentences / reading comprehension / Type words / visual perception / word pronunciation / write words |
| 73 | | building fluency / listening comprehension / read levelled books / segment words into syllables / visual perception / write words |
| 74 | | masculine sound plural / Listening comprehension / phonological awareness / read levelled books / read sentences / reading comprehension |
| 75 | | feminine sound plural / listening comprehension / read levelled books / read sentences / read words / writing words |

| Level | Letter | Learning objective |
|-------|--------|---|
| 76 | | past tense / Letter sound / Listening comprehension / read levelled books / reading comprehension |
| 77 | | present tense / Listening comprehension / phonological awareness / read levelled books / read sentences / reading comprehension |
| 78 | | learn letter name / listening comprehension / read levelled books / visual perception |
| 79 | | imperative mood verb / Listening comprehension / read levelled books / read sentences / read words / Type words / writing words |
| 80 | | kana and asbaha, with singular subject, and noun / phonological awareness / read levelled books / vocabulary |
| 81 | | adjective, singular masculine and feminine / listening comprehension / read levelled books / Type words / write sentences |
| 82 | | Absolute object / phonological awareness / read levelled books / read sentences / read words |
| 83 | | Vocative case, using ya / learn letter name / phonological awareness / read levelled books / read sentences / read words |
| 84 | | Listening comprehension / read levelled books / reading comprehension / vocabulary |
| 85 | | Personal pronouns, objective direct and indirect case / read levelled books / read sentences / Type words / visual perception / write sentences |
| 86 | | Hamzat waṣl / Listening comprehension / phonological awareness / read levelled books / read words / reading comprehension / visual perception |
| 87 | | Hamza on alif-madda / read levelled books / read sentences / read words |
| 88 | | Letters pronounced but cannot be drawn / learn letter name / read levelled books / read sentences / read words / writing words |
| 89 | | tā' marbūṭah / read levelled books / reading comprehension / write sentences |
| 90 | | read levelled books / read sentences / read words / vocabulary / writing words |
| 91 | | Nūn and tanwīn nunation / phonological awareness / read levelled books / read words / reading comprehension |
| 92 | | read levelled books / read sentences / read words / writing words |
| 93 | | Letter sound / phonological awareness / read levelled books / read sentences |
| 94 | | phonological awareness / read levelled books / read words / vocabulary / writing words |
| 95 | | read levelled books / read sentences / reading comprehension / writing words |
| 96 | | learn letter name / read levelled books / read sentences / read words / vocabulary / Write sentences |
| 97 | | read levelled books / read sentences / reading comprehension / writing words |
| 98 | | read levelled books / read sentences / type sentence / Write sentences |
| 99 | | read levelled books / read sentences / vocabulary |
| 100 | | phonological awareness / read levelled books / read sentences / read words / reading comprehension / writing words |
| 101 | | learn letter name / read levelled books / read sentences / type sentence / vocabulary |
| 102 | | phonological awareness / read levelled books / read sentences |
| 103 | | read levelled books / read sentences / reading comprehension / vocabulary / Write sentences |
| 104 | | Letter sound / phonological awareness / read levelled books / type sentence |
| 105 | | learn letter name / read levelled books / vocabulary / writing words from picture |
| 106 | | learn letter name / read levelled books / read sentences / reading comprehension / type sentence / writing words from picture |
| 107 | | read levelled books / read sentences / Type words / Write sentences |
| 108 | | phonological awareness / read levelled books / read sentences / vocabulary |
| 109 | | Listening comprehension / phonological awareness / read levelled books / read words / reading comprehension |
| 110 | | read levelled books / read sentences / vocabulary / writing words from picture |