OHANDA

A serious game for engaging young girls from a low-resource setting of Kenya in STEM education

Emma de Cocker
Masters Thesis • Design for Interaction

CHANUA

A serious game for engaging young girls from a low-resource setting of Kenya in STEM education

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This project was conducted partly in Lamu under the Kenya Red Cross institution and at Delft University of Technology.

CHANUA is a Kiswahili word which, directly translated means "enlighten". It implies elevating someone's mental state to become curious about a certain topic. Often associated to technological advancements, that someone goes through a learning journey at the end of which they will master the related knowledge and skills.

Preface and acknowledgements

This graduation project marks the end of my Master's at the TU Delft. Graduated with a Master's degree in Mechanical Engineering, I decided to pursue my studies with the objectives to merge design thinking with my technical background. I wanted to have a more human-oriented approach in my working processes while ensuring innovation and technology are well implemented. This is the reason that pushed me to look for such a project and led me to embark on this memorable and insightful journey. I would not have done it so well if it was not for the support and guidance of some people.

I would like to first thank my graduation committee for their support and feedback which have guided my decisions and challenged me to do better every time. JC, thank you for proposing this project when I first approached you. You allowed me to combine everything I wanted in a graduation project and for that I am very grateful. Even short, it was nice to share part of the Lamu adventure with you. Mathieu, thank you for sharing your knowledge and giving your advice on researching with children and the world of play. Your expertise for these topics has inspired me. To both of you, I enjoyed and learnt a lot from our meetings which also allowed to bring me back to Earth when I needed to.

In parallel, I want to share my gratitude to the IOMe and Kenya Red Cross teams who made this project possible. Derrick, thank you for taking me under your wing for the duration of the project. Thank you Nassor and Emmanuel for your wisdom, time and contagious enthusiasm which made this co-creation process a success in my eyes. Many thanks to Abbu, Omar and Kennedy for showing me how to use the machines at the IOMe. Thank you Asya, Imran, Hachim and Sham for accompanying me to the schools and showing me the Lamu culture. Many thanks to Abdulhakim for welcoming me to Lamu and making sure the stay went flawless.
I am very thankful to the teachers and their adorable pupils who so kindly agreed to participate in the many activities during the field trip, but also after. Many thanks to the members of the Lamu Women Alliance who helped me start my field research, to Nooran who I consider a role model of Lamu and to all the locals I met there who, in one way or another, made the trip a rich and meaningful experience which I will never forget.

Dorrit, I am extremely grateful for having spent the most meaningful part of this project with you. Thank you for your mental support, your joie de vivre and inspiring insights. I keep our evening discussions on the terrace of our house a sweet memory. Wessel, you were such a nice addition to the Lamu crew. Thanks for your relaxing mood.

Thousands thanks to the sponsors FAST fund, Students4Sustainability and Delft Global without whom I would not have been able to undertake this journey. Many thanks to my family sponsors who also chipped in.

Besides, I would like to thank my family who supported me in not only this project, but throughout this extension of studies. Merci Papa et Maman d'avoir cru en moi comme vous le faîtes si bien.
Charlotte, Omar, Hotong and Gabriele, thank you very much for your feedback on my report. Djemie, your help with making the final prototype was a blessing. I also feel very lucky to have incredible flatmates who were there in the fun moments as well as in the serious times, and never hesitated to offer their hand. Thank you Joep for your contribution.

Last but not least, I would like to give a warm thanks to my boyfriend. Tristan, during this whole time you have shown me how caring and intelligent of a person you are. Thank you for believing in me through your adorable supportive words.

I sincerely hope that this project can contribute to women's empowerment in Lamu.

Executive summary

The island of Lamu is a part of an archipelago in Kenya's southeast. In comparison to other parts of Kenya and the rest of the globe, it is a remote and rural area where residents do not have the same access to contemporary educational materials. The Kenya Red Cross Society's IOMe005 Innovation Hub attempts to combat these disparities by providing STEM (Science, Technology, Engineering, and Mathematics) toolkits to the Lamu children. Generally speaking, STEM fields are frequently associated with stigmas and preconceptions that steer girls away from these disciplines. This phenomena also exists in Lamu, which may make it difficult for girls to respond to STEM toolkits provided in schools.

The design goal of this project was therefore defined to design a serious board game which sparks the interest of the young girls of Lamu and help them feel confident when engaging in STEM education. The intervention should create positive interactions on which girls can fall back when facing stereotypes or other alike incidents.

The report first presents the IOMe as the client of this project and Lamu as the area of study. The assignment of developing both the game and the method to design this game is then clarified, along with the approach adopted to carry out this project.

The information needed to comprehend the design choices is provided by a review of the pertinent literature combined with observations and insights gathered from the research and design activities during the field trip. These insights concern the context of Lamu, the current situation regarding STEM education, the potential of playful learning, and especially serious games, for the solution space and finally existing methods for designing games.

These methods inspired the development of a canvas which consists of two tools that guide the designers at the IOMe in generating concepts for serious games and evaluating them, respectively. This canvas is regarded as the method which supported the elaboration of the final game concept for this project.

The findings of the field research also allowed to understand the needs and wishes of the end-users of the game, depict the current interactions they have with STEM and illustrate the desired situation to be achieved by this design intervention. Besides, they indicated the important requirements to be met by the final design.

Next, the chosen concept for this project is then revealed. It is a board game which mirrors the environment of Lamu. Players start "at home" and must arrive "at school", by moving their pawn on a path on the board, but encounter challenges on their way. These challenges are embedded in cards with questions that the players must answer to win points. The game encourages the girls to observe their surroundings critically and from a scientific point of view.

A final prototype was tested with ten girls at a school of Lamu. The insights collected from the test enabled to make a preliminary evaluation of how well the final design performs with regards to the specified requirements. Furthermore, the design iterations which led to developing this final prototype are introduced.

To conclude, the outcomes of this project have shown that CHANUA is well designed to not only meet the end user's needs but also contribute to amplifying the client's exposure to the community and empower secondary stakeholders. The game fits well in the context as it brings innovation with a new energy to a low-resource setting. Besides, the canvas serves as the first example of brainstorming tool specifically developed for the IOMe to keep on developing serious games. Finally, recommendations for future work, such as involving the outer social circles of the end users in such a project, are listed.

Reading guide

This is the reading guide which explains how the report is structured.

This report contains eight chapters which all start with an introduction (red pages) making a link with the previous chapter and explaining what the chapter discusses. They end with takeaways (dark grey pages). These are sometimes further developed into design requirements or recommendations, or show a bottleneck or indicate a (extra) value or impact. This is illustrated on the right.

Besides, every section of chapters start with a short explanation of what the content is which helps the reading flow. An example is shown below.

Reading the introduction, section explanation and chapter takeaways gives a quick glance at the entire project if reading time is limited.

The chapters are read as:

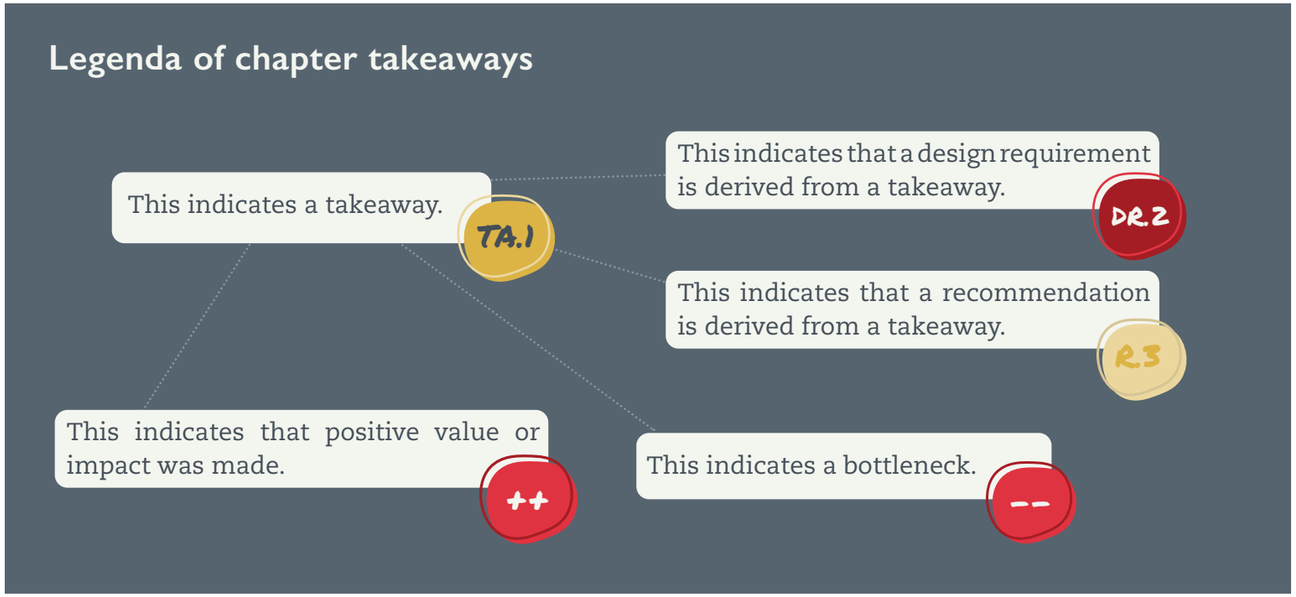
X.X Title of sub-chapter

sub-chapter explanation

Sub sub chapters

Aspect discussed

Quotes



Abbreviations

IOMe: IOMe005 Innovation Hub
KRCS: Kenya Red Cross Society
STEM: Science, Technology, Engineering and Mathematics
LWA: Lamu Women Alliance
MBF: Mahmoud Bin Fadhil

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game

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key information	the place and initial client brief the chosen users and goals the approach and assignment	the context STEM in Lamu playful learning and game design	the users the method development the method	the users the design goal and interaction vision the design requirements	an iterative process the concept to achieve the goals the final design	feasibility desirability viability	3 initial concepts prototype testing selection of the best concept	impact of the designs limitations recommendations

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research session to get to know the girls

co-creation session with children

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Chapter 1

INTRODUCTION

This first chapter provides background information on the area of study, the client and the reason for initiating this project. The context and relevant stakeholders from the given client brief are then illustrated. With the initial problem and picture of the current situation clarified, the chosen problem, assignment and approach to conduct this research-through-design project are defined.

1.1. Project background

First, a simplified map showing Lamu as the area of study is illustrated. Secondly, the client and their vision are presented.

The area of study

This project was proposed by the IOMe005 Innovation Hub, a Kenya Red Cross Society (KRCS) initiative based in Hindi, in the Lamu County of Kenya. The Lamu County is a coastal region located in the Southeast of Kenya and comprises an archipelago with Lamu as the main island. Figure 1 illustrates the geographical situation of the area of study.

In Lamu, locals live off fishery, agriculture and tourism activities. Besides, boat carpentry is an old traditional activity from which some people make a living off. The main mean of transport for on-land activities is donkeys. Except for mobiles phones, Lamu people have little access to digital devices such as computers and laptops. As a result, locals, including children, are barely exposed to technology.

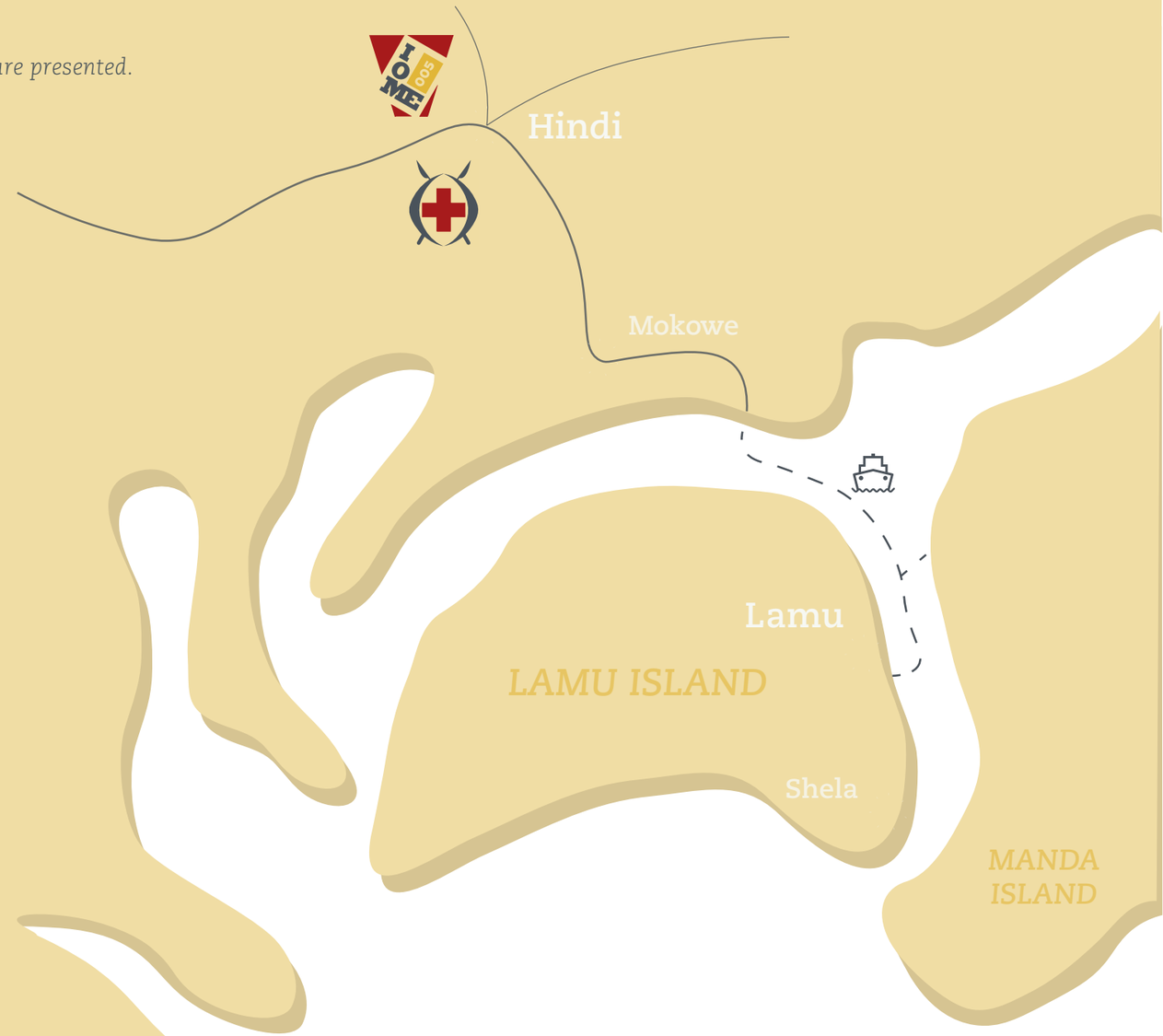


Figure 1. Illustration of the area of study

The client

The IOMe005 Innovation Hub, or simply IOMe, is a maker space (Figure 3) with a global vision to promote innovation in Lamu through problem-solving and critical thinking approaches. IOMe comes from “I owe me” meaning “I owe it to myself to get empowered”.
This maker space is run by facilitators who train eager students, often the local youth of Hindi (see map 1), to acquire practical skills revolving around Science, Technology, Engineering and Mathematics, often referred to as STEM. This innovation hub houses production facilities such as 3D printers, a laser cutting machine, a CNC machine, as well as other tools and space to design and tinker, as shown in Figure 2. Students therefore get to develop their digital literacy and are encouraged to pursue innovative projects.
This project originates from the client wanting to reach out beyond the local youth of Hindi, to the youth of the islands of the archipelago living remotely, starting by the city of Lamu in the Lamu island. Their given assignment was to design STEM toolkits which should be producible using the available production facilities and materials. These toolkits should also be transportable over land and sea to be brought to the schools of Lamu.

Figure 2. Pictures of the production machines at the IOMe

Figure 3. The IOMe005 Innovation Hub

1.2. Project brief

The project started with an initial project brief with a given, rather broad, problem. From this, the decision to focus on girls as target users was made. The following section clarifies this scope and what it entails. The complete project brief is in Appendix A.

Given problem

The relevance of STEM is such that, in order to tackle the increasingly complex challenges of the 21st century, the future workforce is required to be equipped with a certain set of skills, commonly found in Science, Engineering, Technology and Mathematics (Njoki Karanja, 2021). However, these disciplines play little or no role in the daily life of Lamu children as they grow in a low-resource environment. Education of STEM is, in turn, limited due to the lack of new and modern material. This trend is different in other, more connected parts of Kenya which have access to better know-how and resources. Inequalities are therefore observed whereby Lamu children do not have the same chances as other kids to receive relevant education and take control of their own future.
The initial assignment given by the client was therefore to design and make toolkits which support and improve STEM education in schools of Lamu.

Chosen problem

Scope

STEM fields are generally male dominated and associated with strong stereotypes conveying ideas that girls lack the right capacities to engage with such topics (Hill, Corbett, & St. Rose, 2010). These biases tend to push girls away from this type of education leading to their under representation in STEM. This phenomenon occurs in Lamu as well, also due to the traditional and rather conservative lifestyle. An intermediate step was therefore deemed essential before bringing STEM toolkits to all children of Lamu. From the given problem, the project was scoped to focus on the young girls of Lamu and ensure they know that they can engage in STEM education.

Target users and general objectives

The target users are the young girls of Lamu, currently in Grade 5 and 6 (which ranges from 9 to 16 years old in Lamu) which corresponds to the age when interests towards certain topics start to be shaped. The general objectives of this project are to challenge the current status quo regarding gender roles and empower these girls in building a strong future for themselves through education. Ultimately, the goal is to enhance female community resilience.

The use of serious games

The virtues of play have been flaunted by many theorists who argue that children's cognition mainly develop through play (Wallace & Rogers, 2013). One widely chosen form of play are games. Beyond the fun that playing games can provide, there is a whole other potential in using this form of play to educate, sensitise and share on serious issues. Games with a purpose, also categorised as serious games, have been developed to reach such objectives. This project therefore aims to utilise the power of serious games to sensitise and educate the young girls of Lamu in a fun way.

Stakeholders

Several actors are involved in this project. They are illustrated in Figure 4 which is a simplified map showing Lamu island with respect to the mainland and indicating where each stakeholder is located.

On the island, live the children who go to a local school as shown by the Kenyan flag. These schools can be gender-separated or mixed. Like other children in the world, school makes up a large proportion of their day and they enjoy learning. The teachers enjoy their job and appreciate the impact they have on pupils. However, they also recognise flaws in the current educational system which limits the extent to which they can teach STEM in class. In this research, learners from Wiyoni Primary (mixed school) and Mahmoud Bin Fadhil (MBF) Girls (girls' school) were involved. Besides, teachers from MBF Boys participated in feedback and co-creation activities.

The Kenya Red Cross Society (KRCS) deploys volunteers who support the organisation's activities, as shown by the KRCS flag. They travel within the region of Lamu, depending on the activities. The KRCS sends them to schools to run sensitisation campaigns about drug usage, violence and health issues. For this project, the volunteers got involved as a focal person between the researcher (foreigner) and the locals of Lamu.

Finally, the lab facilitators from the IOMe005 Innovation Hub train and facilitate workshops to educate the local youth and promote innovation and STEM. They are young students who come to develop their digital literacy and are called the innovators.
As being a recent initiative, their current scope is limited to targetting the youth from the mainland, especially from Hindi. The IOMe recognises the importance of offering the same opportunities to all the children from the region.

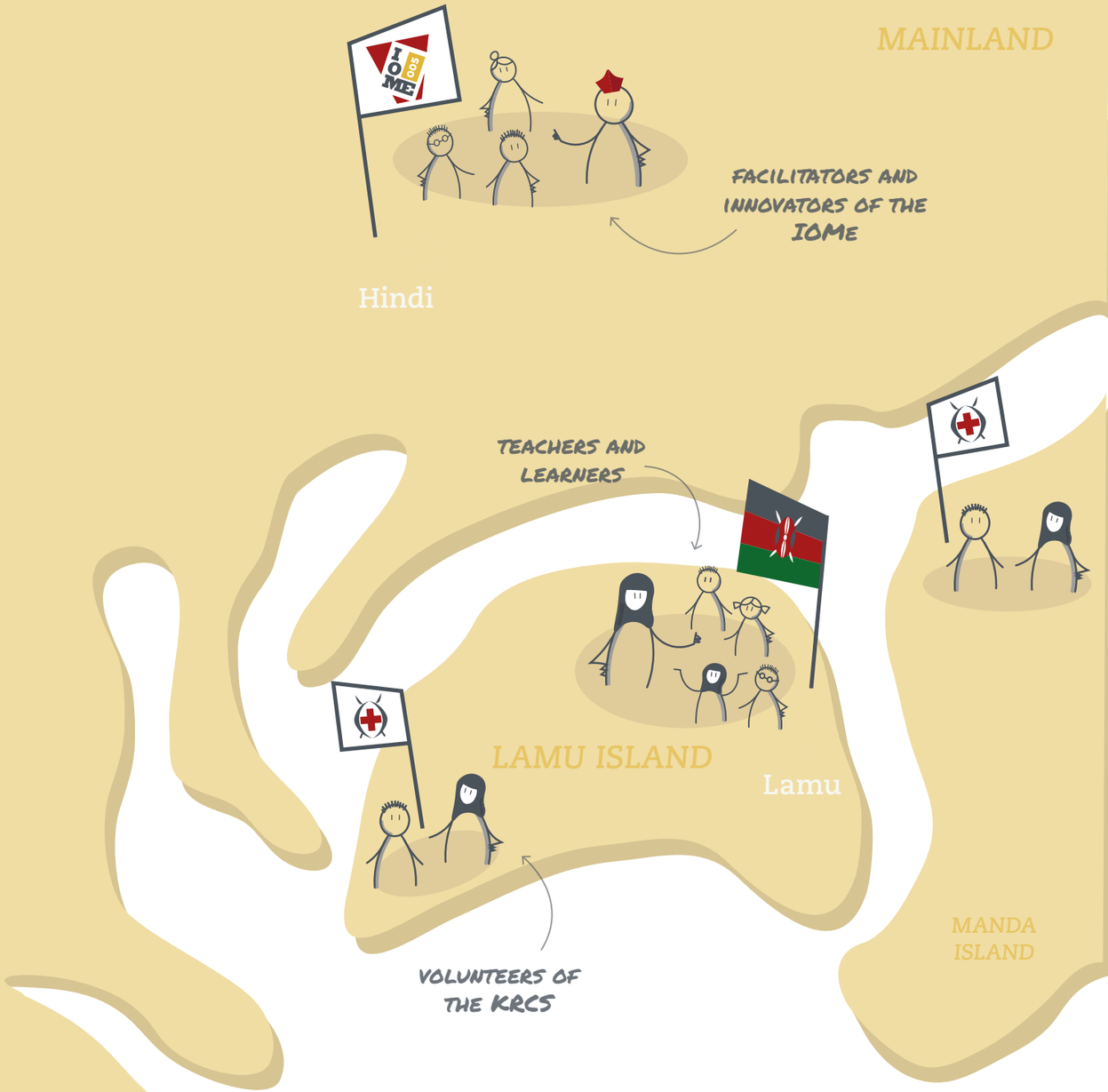


Figure 4. Map of the stakeholders in the area of study

Assignment

First, a method was elaborated in the form of a canvas (a template) during the project to design the serious game (second part of the assignment). This canvas was deemed useful by the client as a brainstorming tool for the innovators, and was therefore included in the assignment.

> **Develop a canvas to guide the design of serious games at the IOMe005 Innovation Hub.**

The second part of the assignment was initially formulated as:

> **Design a serious board game which changes the current views about girls in STEM that the girls themselves have, to ensure they know they can engage in such education.**

The exploring phase of the project led to redefining the objectives and reformulating the project assignment. This is explained in Chapter 4.

Approach

The existing literature was first reviewed and complemented with insights obtained through field research. This field research was undertaken in the area of study, by spending five weeks in Lamu. There, regular research activities were conducted with the several involved parties. These are the first target group (the players so the girls) the second target group (the innovators of the IOMe), as well as other key stakeholders like the teachers and the KRCS volunteers. Two different schools participated in these sessions, namely Wiyoni Primary and Mahmoud Bin Fadhil Girls. Besides, teachers from Mahmoud Bin Fadhil Boys were involved in feedback and co-creation activities. Prototypes for the game were regularly developed with the support of the IOMe facilities to test concepts and ideas, and engage the users and stakeholders in an iterative design process. This project followed a research-through-design process.

When back in Delft, a few iterations on the chosen concept were done to design the final product. A final prototype was tested at a distance, with the support of volunteers to evaluate the performance of the concept. In parallel, prototypes of the canvas were developed and one prototype was tested through an online workshop with IOMe designers to suggest the final version.

Chapter takeaways

Being a low-resource setting, the Lamu island cannot provide the opportunities for the residing children to access relevant and empowering education. TA.1

For the sake of equality, the IOMe005 Innovation Hub (project's client) wants to design toolkits to educate children of the island about science and innovation. TA.2

These toolkits should be producible at the IOMe, with locally available materials and be carried from the maker space to the island of Lamu easily. DR.1

It is important to ensure that all children are included and targetted by this initiative. Within the given problem, it was therefore decided to focus on girls. TA.3

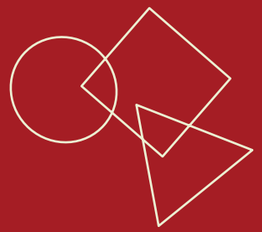
This project aims to empower the young girls of Lamu for them to engage in STEM education by the use of a serious game. TA.4

Besides, the general vision of the client to promote problem-solving and critical thinking is essential to consider. DR.2

The next chapter will now present the findings from the desk and field research, carried out according to thie chosen problem. These are necessary to understand the decisions regarding the design of the game and canvas.

Chapter 2

LITERATURE REVIEW & EXPERIENTIAL OBSERVATIONS



The definition of the project scope as described in the previous chapter requires to conduct relevant research to support the design process. This chapter summarises the findings of the literature review annotated with the observations and insights collected during field research in Lamu. The general context of the area of study is first portrayed through different lenses, together with the educational system in place. Secondly, the benefits and gender issues associated with the disciplines of STEM are discussed. Besides, this chapter reviews the relevance of learning-by-playing and use of serious games for this project, and reports on the play culture in Lamu. Finally, approaches for designing serious games are examined which are relevant to understand the chapter coming after.

2.1. General context

Lamu represents a specific context which is important to visualise in order to understand the final design of both the canvas and the game. This context is now portrayed with text and images. The educational system in place is also described.

Lamu through different lenses

The next page presents a collage of images that visually support the following explanation of the Lamu context.

Geographical context

The Lamu archipelago plays a significant role in the country's ecosystem with 75% of Kenya's mangrove forests located there (Muthaura, 2020). The marine and mangrove ecosystems give life to a flourishing fauna and flora that support a lucrative fishing industry. However, increasing settlement in Lamu accelerates the pollution and destruction of these sensitive ecosystems. Plastic detritus lying on the coast of Lamu are becoming part of the visual landscape.

Historical and cultural context

The historical identity of Lamu originates from the mixing of Arabian and Persian traders with local people. Compared to nearby regions, Lamu is characterised by its cultural heritage, recognised by the UNESCO, making it the oldest Swahili settlement in East Africa ('A Glimpse of Lamu County', 2022). The local traditions are celebrated every year at the Lamu Cultural Festival during which are organised dhow (traditional boat) and donkey races, music and dance performances, as well as henna painting and cooking classes.

Lamu brings together Kiswahili, the main spoken language with Arabic, used for religious practices, and English, taught at school. Lamu is also famous for hosting the Maulidi Islamic celebrations for the birth of the Prophet Mohammed, which gathers thousands of Muslim people from across the world (Communication, 2019).

Social and economic context

Fishing is the main economic activity, followed by tourism with coastal tourism accounting for 60% of Kenya's GDP from touristic activities (Muthaura, 2020). Secondary income sources are agriculture, craftwork and carpentry. The latter two come from old traditions and expertise whereby locals make their own boats with wood. These are used to transport people and merchandises from the mainland or other island to Lamu. Locals use donkeys and wheelbarrows for on-land transport. The construction sector also provides a lot of jobs to men. Most women do not work but stay at home to take care of the house and the children.

Drug consumption affects locals, often from a young age, which prevents them from attending university, and even high school in some cases. They often end up taking on small, irregular jobs as they come. The lifestyle in Lamu is dominated by conservative customs whereby traditional gender roles shape the dynamics between people. There are still cases of early marriages pushing young girls, as early as 9 years old, out of school for marriage (according to the founder of Lamu Women Alliance).

Figure 5. Typical Lamu architecture

GEOGRAPHICAL CONTEXT

ECONOMIC ACTIVITIES

LOCAL CUSTOMS

CULTURAL HERITAGE

The educational system in Kenya and Lamu

The old educational system, the so-called Content-Based Curriculum, was in place until 2017 and was exam-based, promoted corruption and diploma faking. This led to incompetent students entering universities and eventually becoming unprofessional academics (Amutabi, 2021).
In response to these flaws, a new system was introduced which aimed at empowering young citizens by making them independent and curious through the acquisition of practical knowledge and skills. It is the Competency-Based Curriculum, shortened as "CBC" (Njeng'ere Kabita & Lili, 2017).

As great as the principles and values conveyed by the CBC are on paper, the actual implementation of such a system presents challenges for low-resource settings like Lamu. First, to implement this new system, the Government has called teachers for trainings which happen during school holidays leading to a large proportion of staff not turning up (Mwang'ombe, 2021). Textbooks instruct teachers to conduct practical classes where children team up. However, these activities require supporting materials that are often hardly found in Lamu, for which the schools do not have the budget (Mwang'ombe, 2021), and have to ask parents to provide.

Besides, a greater parental engagement is one of the guiding principles of the CBC. However, *"there are a number of parents who are illiterate"* (- according to a Grade 5 teacher from Mahmoud Bin Fadhil Boys) and cannot help the kids to complete their homework. Besides, most of them cannot financially support the practical classes. For instance, for the subject *Home Science*, it was asked to bring a chicken from home. Parents could not provide that, and the activity could not be done. This leads to teachers having to fall back on the old way of teaching, i.e. theory-based.

The CBC also promotes the integration of ICT classes and tools, like tablets. However, teachers are often not digitally literate themselves and claim that this integration is time consuming. *"The girls find coding difficult"* (according to a Grade 6 teacher from Mahmoud Bin Fadhil Girls) because they have to learn how to program without any digital devices. Moreover, schools sometimes do receive digital tools like tablets from the Ministry of Education but these end up in a shelf, unused because of the unfamiliarity teachers have with technology.

In general, the teaching system is very linear and theoretical. Problem-solving is very limited as pupils are not pushed to think critically. A practical activity for the subject *Science and Technology* was observed in Grade 6 (Figure 7). It aimed to demonstrate the advantages of using slopes for doing work. It was noticed that the teacher makes the pupils repeat definitions of physics principles by heart and tends to ask leading questions, which altogether does not push pupils to reason and criticlaly think.

Figure 6. Typical class setting with on average 50 pupils for one teacher

Figure 7. Demonstration of physics principle in a Grade 6 class

2.2. Science, Technology, Engineering and Mathematics (STEM)

The general benefits of STEM and their relevance for Lamu are now discussed, together with the gender issues associated with these fields.

Why STEM?

Benefits of STEM

Today's world is in increasing demand for a workforce with multidisciplinary skills. To address the complex and dynamic issues, the current and future generations will need to show abilities for creative problem solving and critical thinking, and come up with innovative solutions using technologies such as computing, artificial intelligence, robotics and data analytics (Njoki Karanja, 2021). These various competencies are found in Science, Technology, Engineering and Mathematics fields, commonly referred to as STEM. The benefits of STEM are numerous. This education fosters the learners' creativity and ingenuity, encourages progressive ways of working like teamwork and experimentation, triggers users' problem-solving mindset and invites them to make use of new technologies (Njoki Karanja, 2021). Ultimately, STEM education can build resilience.

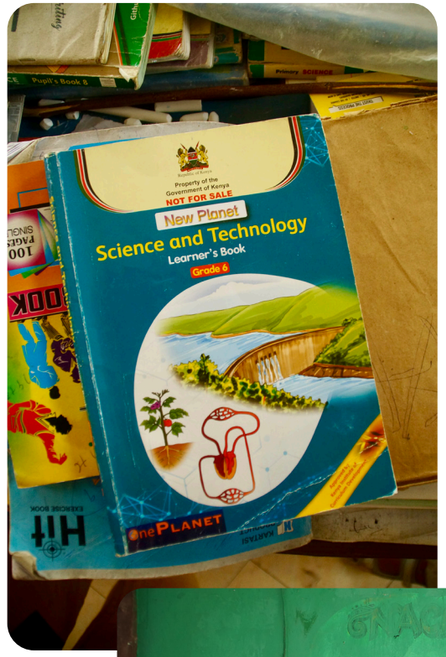


Figure 8. Science and technology textbook for Grade 6

Figure 9. Shop facade with m-pesa details

Potential of the Lamu youth in STEM

The African demographic accounts for 17% of the world's population with 60% aged under 25 (El Habti, 2022). Africa's youth therefore plays a major role in the future development of the continent. The opportunity lies in exploiting the youth's inherent ability for manipulating technology and equiping them with the skills of tomorrow. In the Kenyan school syllabus, the only school subject related to STEM is *Science and technology*. Pupils get lessons on physics (force, energy), chemistry (state of matter and properties), biology (organ systems, ecosystems) and technology (computer devices, programming). Teachers follow the textbooks provided by the Ministry of Education which instruct them to conduct some ground theory classes followed by practical activities (picture of textbook in Figure 8).

In Lamu, a significant proportion of locals own a phone. The main payment method is through m-pesa, a digital service that allows people to pay for goods and services using their phone. Everyone uses it! Nonetheless, mobile phones are the only devices accessible to the majority of locals which prevents the local youth from developing their digital literacy and comply with the new global trends.

There is no university in Lamu but a college where students can follow various degrees. It is therefore difficult for the youth of Lamu to attend university as they would need to go to larger cities which incurs costs to support their life. There are only two engineers in Lamu and one of them is one of the IOMe facilitators.

Girls in STEM

In general, an under-representation of women in STEM disciplines can be observed (Njoki Karanja, 2021). This phenomenon can be explained by several factors, as illustrated in Figure 10; namely the influence played by the environment, the problem of attracting women and the implicit biases people often experience (Hill et al., 2010).

Factors explaining the under-representation

Influence of the environment

The environment plays a significant role in attracting and retaining female students in STEM education and professions (Hill et al., 2010). In general, the stereotypes of girls not being as good in maths and science as boys, and scientific jobs not being suited for women are dominant.

Growth vs fixed mindset

A growth mindset is different from a fixed mindset in the way people deal with difficult situations (Hill et al., 2010). Pupils with a growth mindset tend to embrace challenges and are more likely to maintain their confidence in comparison to pupils with a fixed mindset. Girls manifesting a fixed mindset are more likely to succumb to these stereotypes.

Stereotype threat

Additionally, some girls and women say they are not interested in STEM topics or actively avoid engaging in these fields. They often do so to reduce the possibility of these stereotypes being confirmed. This phenomenon is called stereotype threat (Steele & Aronson, 1995).

Self-assessment

The simple fact that STEM fields are associated to the masculine gender tends to increase men's beliefs of their ability, and decrease women's. Hill et al. conducted a study to measure this phenomenon and found that for the same results to a calculus exam, boys would assess their ability higher than their female peers. This also leads to girls and women holding higher standards for success, therefore assessing themselves lower than boys and men tend to do.

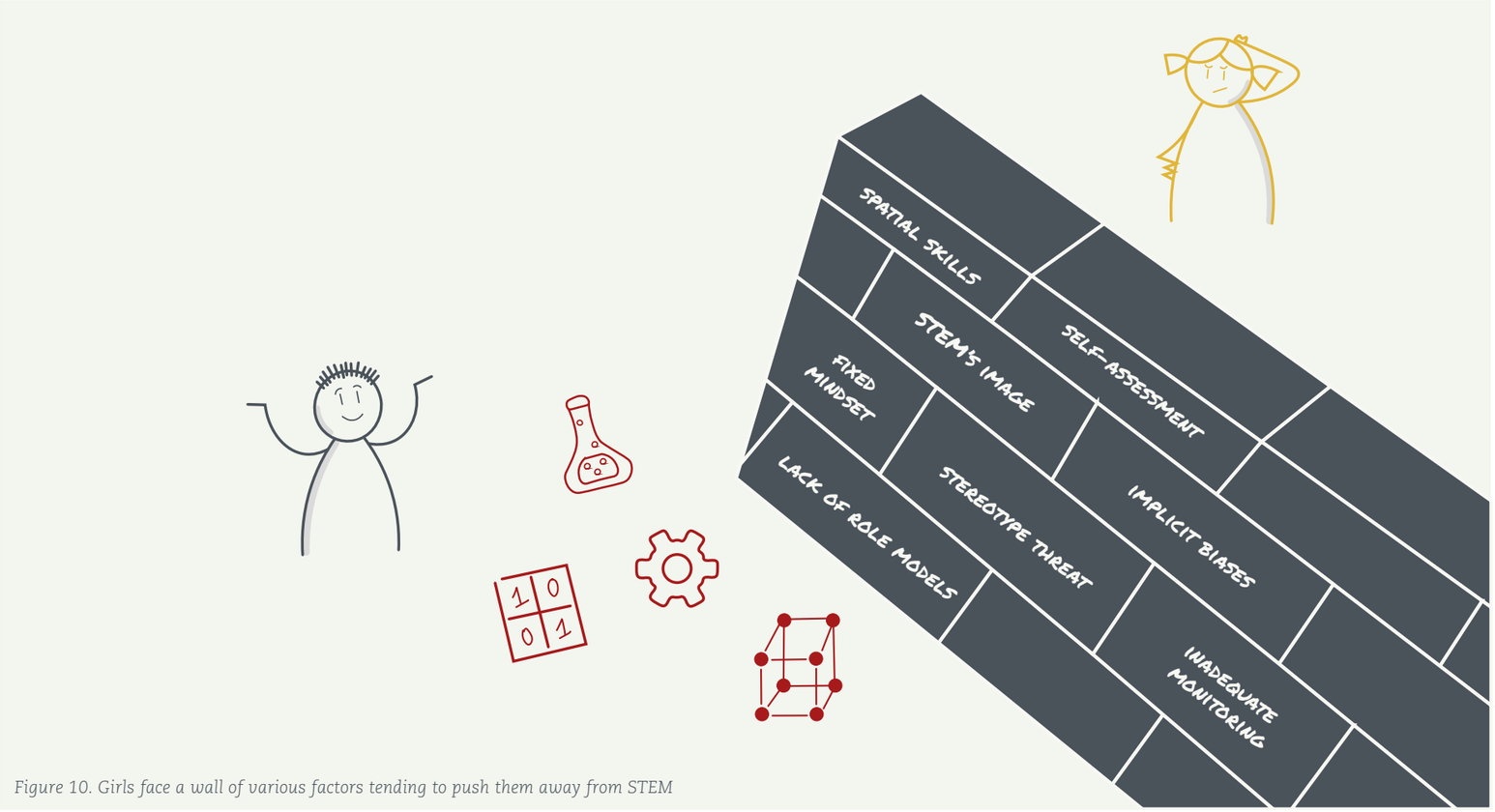


Figure 10. Girls face a wall of various factors tending to push them away from STEM

STEM reputation

Besides, STEM disciplines often have the reputation of attracting 'geeks'. However, current technologies ought to be used for creativity and innovation, things girls are often sensitive to. Women are also less likely to have female role models and mentors which can limit their career development in these, often competitive, fields.

Implicit biases

Finally, implicit biases have a great influence, especially due to the fact that they are innate, which makes people act through them without realising the impact of their actions or words.

The situation in Lamu

Insights were collected on the general gender situation in Lamu from a meeting with members of the Lamu Women Alliance (LWA), a woman-led organisation for young women's empowerement in Lamu. Even though mentalities are changing, gender roles in Lamu are still very much defined whereby men undertake physical tasks and jobs to feed their families while women stay home to take care of the children and run the house. In general, mentalities have an impact on young women's empowerment since they discourage their aspirations to continue their education and gain independence. A female member of the LWA wanted to pursue higher studies after having received a grant but was confronted to her mom's refusal: *"you cannot be an engineer, you are a woman"*. Besides, early marriages also come in the way of women's empowerement. They can happen as soon as girls reach their puberty, so as early as nine years old (according to the LWA leader).

Two research sessions at two different schools were conducted at the beginning of the field trip to map the current context. Four girls and three boys participated in the session at Wiyoni Primary (Figures 13, 14, 15), and eight girls were involved in the second session at Mahmoud Bin Fadhil Girls (Figures 11, 12). The session was built with a few exercises to map the general context of children's home, typical school day, subject preferences and future aspirations. The research material are in Appendix B. It was found that girls tend to prefer social subjects while boys prefer STEM-related topics. Within STEM, girls tend to be more interested in biology and are less likely to engage in technology and engineering. These findings were confirmed by interviewing teachers. A Grade 6 teacher from MBF Boys confirmed the gap existing between girls and STEM: *"when they [girls] hear maths and science, it's a no go"*. A Grade 5 teacher from MBF Girls said that her pupils are more interested in *Home Science* and *Agriculture* subjects because they get to do practicals. *Science and Technology*, especially coding, lacks practical activities and the right resources like computers, which makes it difficult and not interesting for girls. Finally, all children aspire to attend university. Girls dream to become doctors, pilots or teachers mainly. The findings of these sessions are gathered in Appendix B.

The resource situation is different for boys. Mahmoud Bin Fadhil Girls used to be one school with the neighbouring Mahmoud Bin Fadhil Boys. They are now separate; an only-girls' and only-boys'. For the same number of children, the boys' school has three to four times more space and benefits from computers and tablets which the girls' school does not.

Figure 11. Session at Mahmoud Bin Fadhil Girls

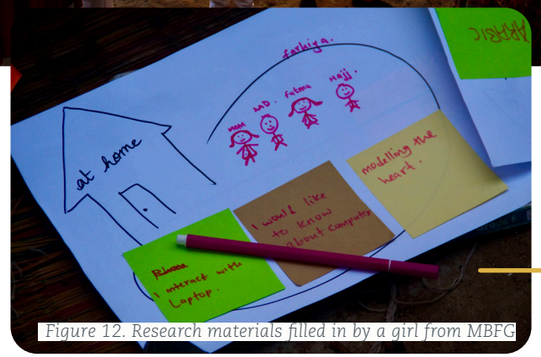


Figure 12. Research materials filled in by a girl from MBFG

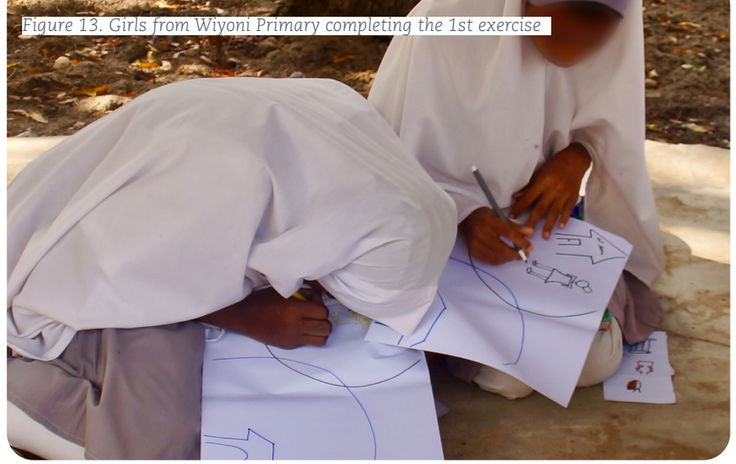


Figure 13. Girls from Wiyoni Primary completing the 1st exercise

Figure 14. The participants and researcher at Wiyoni Primary

Figure 15. A boy from Wiyoni Primary completing the 1st exercise

2.3. Playful learning

As defined in the previous chapter, this project aims to utilise games as the mean to realise the objectives. This section therefore discusses the relevant findings regarding play and games, and elaborates on the serious purpose which can be given to games.

Games as a common form of play

Benefits of play

The virtues of play have been flaunted by many theorists who argue that children's cognition mainly develop through play (Wallace & Rogers, 2013). Through play, children engage in activities with cognitive and educational objectives such as learning new information, learning and practicing skills, extending their thinking and co-operating with others (Piaget, 1952). Play can manifest itself in various ways and have been categorised into stages or forms of play (Parten, 1932; Piaget, 1952).

Every child, regardless of their background, engage in play from their early age which makes play a universal phenomenon (Jaipaul, Michael, & James, 2015). Nevertheless, play is influenced by the culture and the context in which the child evolves. This explains why a child from Kenya will play different games with different toys compared to a toddler livin in France. Besides, the design of play (of toys for instance) can be subject to subtil expression of stereotypes and stigmas. Indeed, kids are sensitive to the messages they receive from toys and games which affect their perception of their environment, and ultimately of the world (Mader, 2022). It is therefore essential to carefully design positive interactions with play so children have a good experience on which they can fall back when facing stereotypes and stigmas.

Board games

Amongst others, play takes form through the combination of rules and scenarios which together make up games (Wallace & Rogers, 2013). Games are often played using materials or probes, and a large subset of this play form are board games, also called tabletop games. This is the play form of focus for this project.

There is no official taxonomy to differentiate types of games but an informal one arose from experience and discussions in gaming communities who have suggested their own way of categorising them (Castle, 2021; Hillary, 2022). These communities consider board games to be any game played on a flat surface with any type of probes, not only a board. Some types have a specific format associated to them, like the *deck-builder* type of game which is solely based on cards, or the *roll-and-move* which requires a die, a board and possibly other elements. Some might not need a lot of materials such as *storytelling*. Others can be designed from any type of elements like the *engine-builder* type or *dexterity* games. These five types of board games are relevant to understand the canvas that was part of the assignment for this thesis. The relevance of each is further explained in Appendix C and the canvas is presented in the next chapter.

The situation in Lamu

As the games Lamu children interact with are influenced by the culture and the context, it is important to understand the play situation in Lamu. There, children spend their free time playing with their friends, siblings and other family members. They play as soon as they are done with class, whether it is during breaks or after school, as shown in Figure 16. Due to the lack of resources, the children are used to play with whatever they find around them, like washing plastic bottles as displayed in Figure 17. Their toys are rather simple, and they often have a rope or a ball with which they play skipping rope and collective sports like football or netball. The kids show their ingenuity by making their own toys, like the vehicle in Figure 18.
Analog games are often played by the elderly who enjoy gathering around a DIY board of Chess or a game of Bao, carved in wood with the traditional expertise (Figure 19). In contrast, the younger generations spend some time playing digital games when they own a phone. Ludo and Templerun are by far their favourite ones (Figure 20).


Figure 16


Figure 17


Figure 18

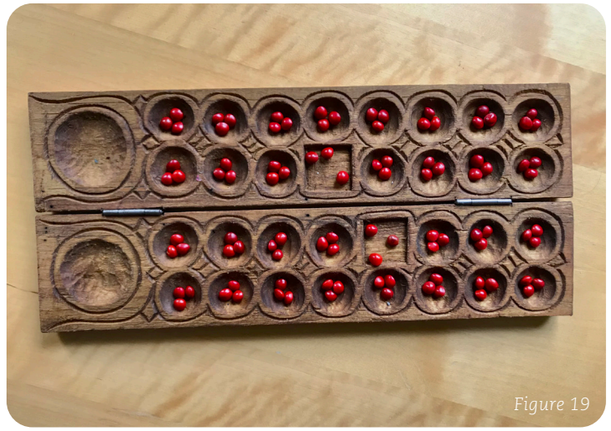


Figure 19

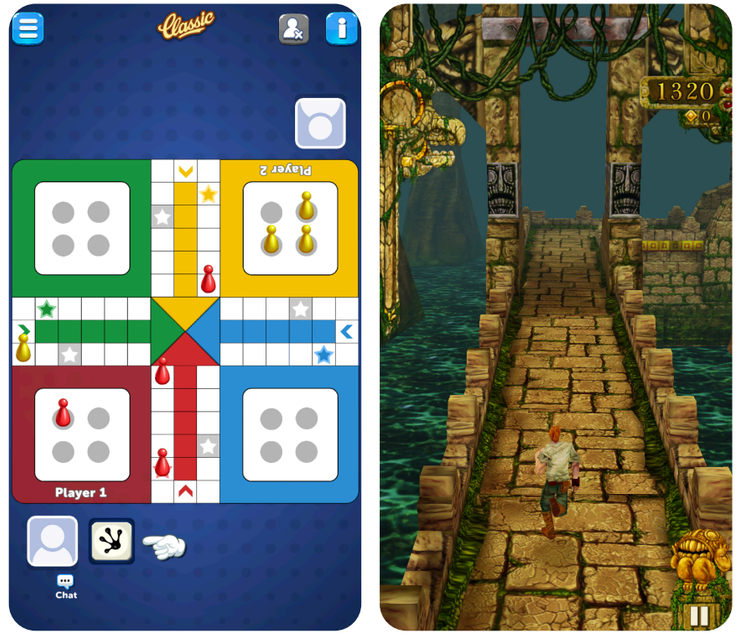


Figure 20. Ludo (left) and Templerun (right) widely played on the phone

Figure 16. Kids of Matondoni playing after school
Figure 17. Kids of Matondoni washing plastic bottles
Figure 18. DIY toy made by a boy at Matondoni
Figure 19. Hand-carved game of Bao

Giving a purpose to games

Games with a purpose

This project seeks to stimulate certain cognitive processes amongst the users. From the educational objectives which can be achieved through play, the relevant goals are for players to learn something new and for them to extend their way of thinking. Apart from the fun (whether games are engaging and trigger enthusiasm amongst players) and the physical dimensions (whether the game is built with a board, or cards only for instance), games also have a cognitive dimension, as discussed previously. This aspect can become central to the design of a game when a specific, rather serious purpose is sought to be achieved. These are referred to as *games with a purpose*. Figure 21 presents a categorisation of the sub-forms of games which was made from the findings of this literature review and experiential observations. As illustrated, games with a purpose can be further categorised into:

- *Educational games* - games with a purely educational objective whereby players learn something (by acquiring knowledge or skills)
- *Persuasive games* - games with the purpose of changing the behaviour of players
- *Serious games* - games with the purpose to teach but also to actively engage players in discussions to tackle serious issues

The use of games with a purpose, especially for education, has increased through the 20th century with applications going from training employees about supply chain management (de Sousa & Barbosa, 2020) to supporting rehabilitation, prevention and physiotherapy of patients (Smeddinck, 2016). Companies and organisations are developing games to sensitise people about critical topics like the game about the Darfur war designed by the United Nations (Barbosa, Pereira, Dias, & Silva, 2014).

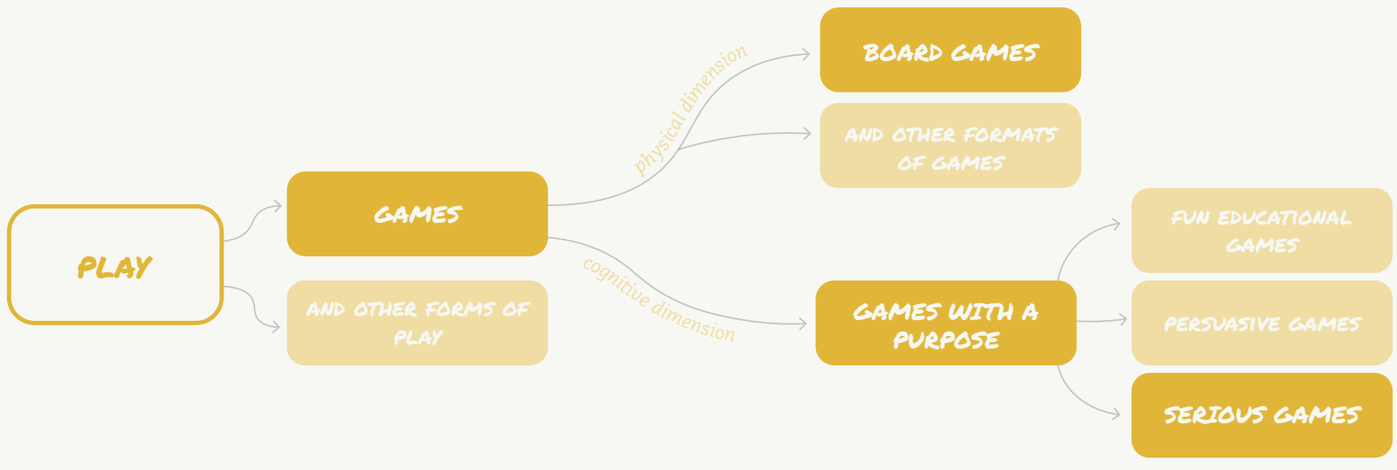


Figure 21. Categorisation of forms of games

Serious games

Since serious games would enable the achievement of the initially outlined objectives, they were chosen as the type of games with a purpose for this project. Indeed, they can have the positive effect of stimulating cognitive processes like problem-solving and reasoning whilst engaging users in a fun activity. They also offer the opportunity to the players to participate in discussions about relevant serious issues. An example is the game *Electric City* which aims at triggering community behaviours amongst players who must work together to generate ideas for a shared energy system in their neighbourhood (Singh, et al., 2015). Another example is *Get* H_2O, a serious board game which was developed for the Kenyan youth (Dormans, 2010). With the use of real-life scenarios, the users are stimulated to discuss peace building and access to resources (Figure 22). Because serious topics are being tackled, the execution and outcomes of playing serious games should be carefully monitor. This type of game is therefore often facilitated by a game master who ensures the objectives are achieved and the rules are respected.

Figure 22. Get H_2O serious game

2.4. Game design

Methods, approaches and frameworks have been elaborated to guide the design of serious games. The relevant ones are reviewed in this sub-chapter which will be referred to in the next chapter that presents the method developed for this project.

Several approaches for game design

It is important to note that the following approaches use different nominations to games. These are categorised according to Figure 21.

Mechanics, Dynamics and Aesthetics approach

This approach argues that the way a game is designed has consequences on the way players will make use of it, which, in turn, will affect how they experience the game (Hunicke, LeBlanc, & Zubek, 2004). The *mechanics* are the various actions afforded to the players. They are the building blocks of the game design and the visible elements like rules and points. They produce the *dynamics* which are the response players give in return. These can translate in certain behaviours that the players adopt like experiencing difficulty or bluffing. These, in turn, trigger emotions and feelings amongst the players. They produce the "fun" and are called the *aesthetics*. This approach suggests eight aesthetics from which five were throught to be pertinent for this project, namely narrative, challenge, fellowship, discovery and expression. Figure 23 illustrates the relationships between the mechanics, dynamics and aesthetics.

For example, with the game Jungle Speed, players have to recognise similar shapes to be able to win (mechanics), which produces pressure and competition (dynamics), which produces challenge and sensation (aesthetics).

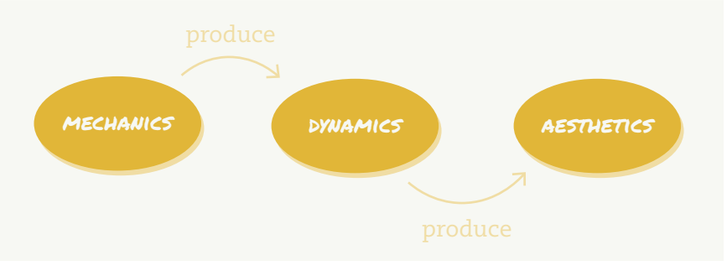


Figure 23. MDA process (adapted from Hunicke et al., 2004)

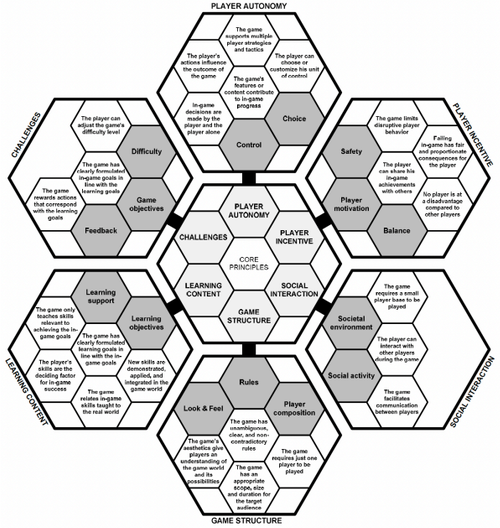


Figure 24. Conceptual framework for designing educational games (van Staalduinen, 2012)

Conceptual framework for designing educational games

Van Staalduinen developed a conceptual framework for designing educational games (van Staalduinen, 2012) for which they drew six core principles (located in the middle of Figure 24). These are the most important areas to address when designing a serious game:

- *Player autonomy* - giving players control and options
- *Challenges* - all the actions the players do, what constitutes the fun
- *Learning content* - essential element to make the game educational
- *Game structure* - consisting of the rules, the players, the aesthetics
- *Social interaction* - players like to interact with one another
- *Player incentive* - players should feel motivated when engaging in the learning process

With each of these principles, specifications, located inside the outer hexagons, are associated. Finally, the framework provides guidelines for understanding and applying these principles and specifications in the design of a game with a purpose.

Persuasive Game Design model

This is a model to design a persuasive game, i.e. a game which immerses users in a game world to change their behaviour in the real world (Visch, Vegt, & Anderiesen, 2013). The method is like a cookbook and is illustrated in Figure 25. It lists the essential "dishes" or steps and their respective "ingredients" or elements with suggested "utensils" or methods to "cook" a persuasive game.

There are five steps:

1. Define the transfer effect
2. Investigate the user's world
3. Design the concept
4. Design the game
5. Evaluate the effects

The first step is essential to formulate the purpose of the game, the so-called *transfer effect*. It is the behavioural change in players that the game aims to achieve. Steps 2 to 4 consist of the research and design phases for conceptualising a persuasive game where it is important to first design a *concept* (idea) before developing the game (product). The last step provides guidance for evaluating the realisation of the intended transfer effect(s).

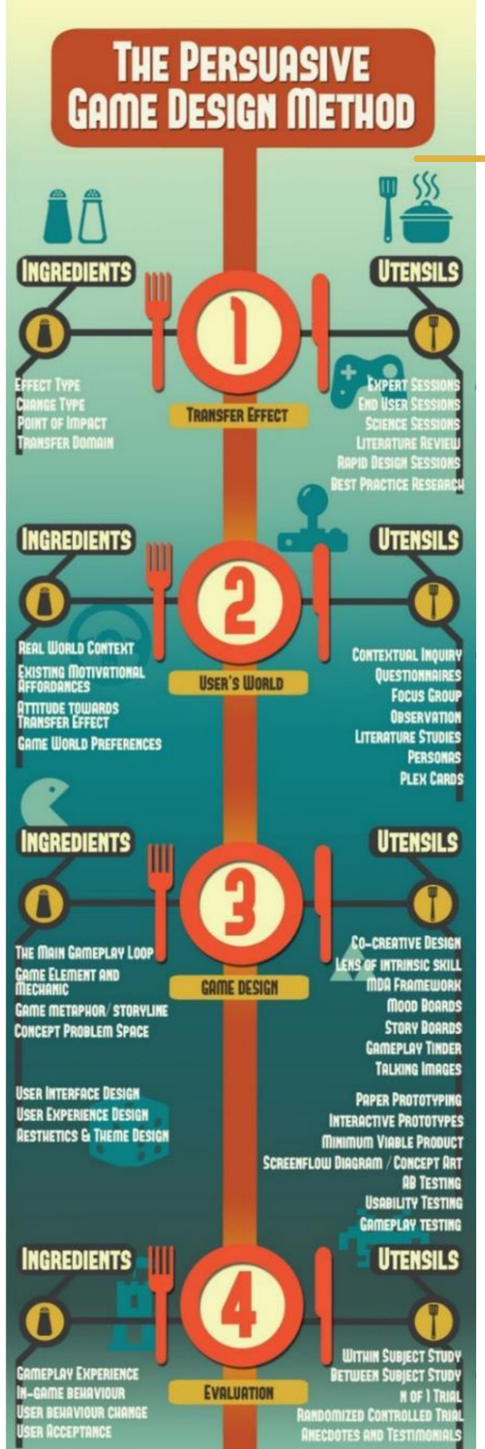


Figure 25. Persuasive Game Design method

Chapter takeaways

TA.1 At school, pupils are used to work in groups.

TA.2 Teachers cannot do a lot of practical activities due to the lack of resources which leads to keeping the traditional way of teaching where problem-solving and critical thinking do not have a place.

TA.3 There is a need for an intervention bringing educational tools to schools that are better adapted to the current and future needs of the young girls of Lamu.

TA.4 A positive interaction with games can help children go through negative events. Within this play area, the potential serious games have to positively affect users' learning experiences and personal views while having fun makes it a suitable design form for the given assignment.

DR.1 The design intervention should focus on promoting teamwork, problem-solving and critical thinking.

DR.2 The design intervention should fit in the users' context, respecting the norms and traditions.

DR.3 The transfer of this design intervention needs to be carefully thought in order to ensure its viability.

DR.4 The serious purpose should be well defined, and can be formulated as transfer effect(s).

DR.5 The fun aspect and players' engagement are essential to achieve the transfer effects.

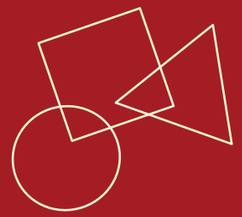
NB: the term *serious game* is only used in this report. The terms *game* or *game with a purpose* are used to communicate with the client. The reason for this is elaborated in the next chapter, on page 31.

The findings of the literature review on game design allowed to develop a method guiding the ideation and selection of the final game concept. This method is explained in the next chapter. It is also possible to continue reading from Chapter 5 which presents this final concept.

Chapter 3

CANVAS

This chapter presents the canvas which can be regarded as the method developed and used throughout the project to guide the ideation, selection and evaluation of serious board games. This canvas will be referred to when describing the final game design, in the next chapters. First, the needs and values of the users of this tool, who are the innovators of the IOMe, are illustrated. This allows to understand the structure of this canvas which was designed as two tools embedded in a toolkit.



3.1. Users of the canvas

First, the typical profile of the user of the canvas is portrayed through a persona. This allows to understand the needs and values of the these users who are the innovators of the IOMe.

Persona

This persona portrays a student, also called “innovator” of the IOMe who is interested in design approaches when conducting projects.

This is Abdu

Abdu comes from Hindi, on the mainland of the Lamu county. From a catholic confession, he was raised by his mom with his two sisters. He is now 21, dropped from high school and recently joined the IOMe005 Innovation Hub. There, he is developing his digital literacy and is being trained to use production machines like 3D printers and laser cutting machines.

Abdu recently participated in a training given by the IOMe005 about new and innovative approaches for developing solutions. In particular, he found design thinking interesting and wants to implement this set of methods in his future working processes.

Abdu is

***curious** and **eager to learn**, **grateful**, **creative** and **slightly dreamy**.*

Abdu likes

- drawing
- cooking with his mom
- woodworking
- facetiming with his friends.

His needs, values, beliefs and concerns

His family and community are important to Abdu. Even if he wanted to, he could not have attended university because of the lack of resources his family has. However, he is grateful he found a structure through which he can grow after dropping from high school. He still aspires to build a future for himself and sees the advantages of what he is learning at the IOMe for that. He dreams to become an engineer or a designer and conduct meaningful projects for the good of his community.

Figure 26. Illustration of the persona of Abdu

3.2. Final canvas design

The canvas was therefore designed for young IOMe students who are just starting their engineering and design career. The canvas and its development are first briefly explained. The two tools are presented in their core and the full toolkit can be found in Appendix D.

This canvas is a tool elaborated to guide the IOMe students in the first steps of a design process for developing serious games (or games with a purpose for the client). The canvas is divided in two tools: a *generator tool* and an *evaluation tool*. As shown in Figure 27, the first tool consists of seven rectangles which are called “blocks”. These blocks are each named with a key game “pillar” which were derived from the literature review (Chapter 2) and experience with using and iterating on this tool. This process of selecting the relevant game pillars is explained in Appendix E. By choosing game elements for each of the blocks, the users create one game concept. After generating a few game concepts, innovators can evaluate them with the second tool (Figure 28) according to their feasibility, desirability and viability. These are general evaluation criteria which are further translated into more tangible design requirements. The use of these tools is intended to be quick and low-key.

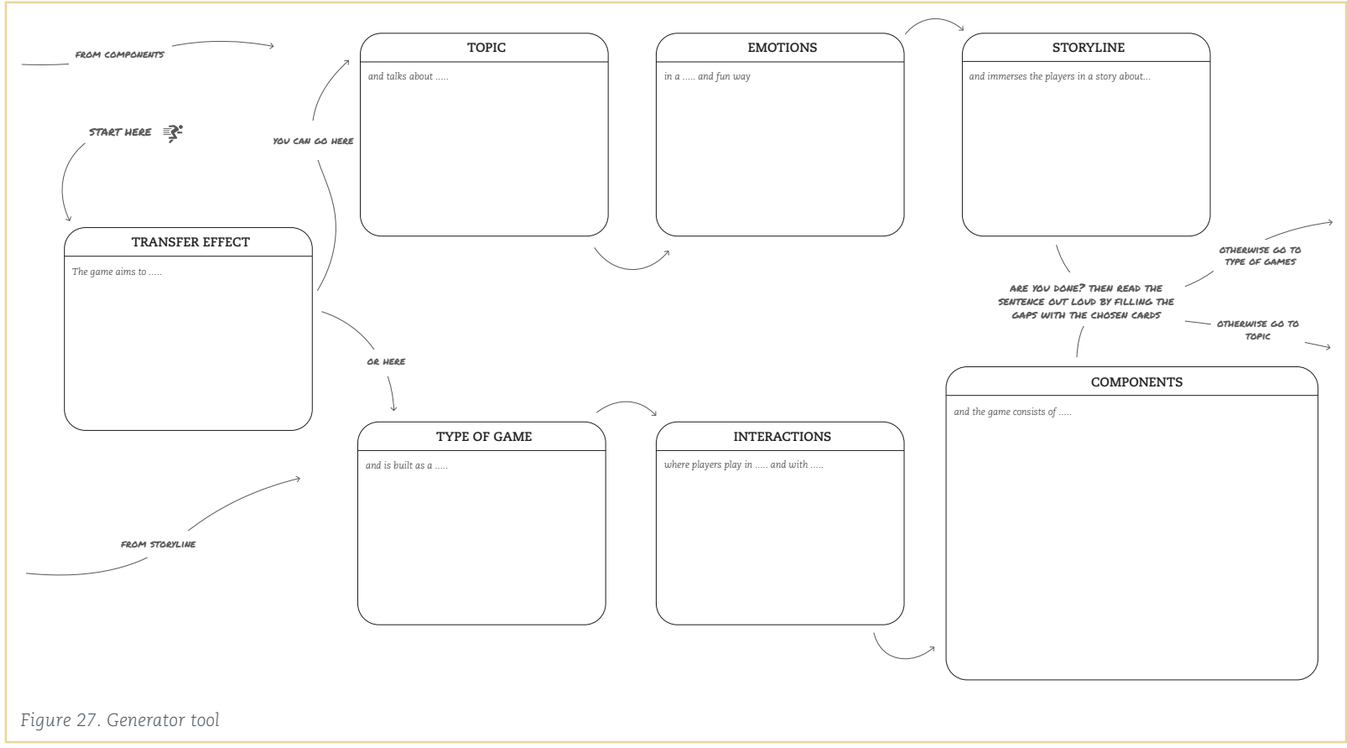


Figure 27. Generator tool

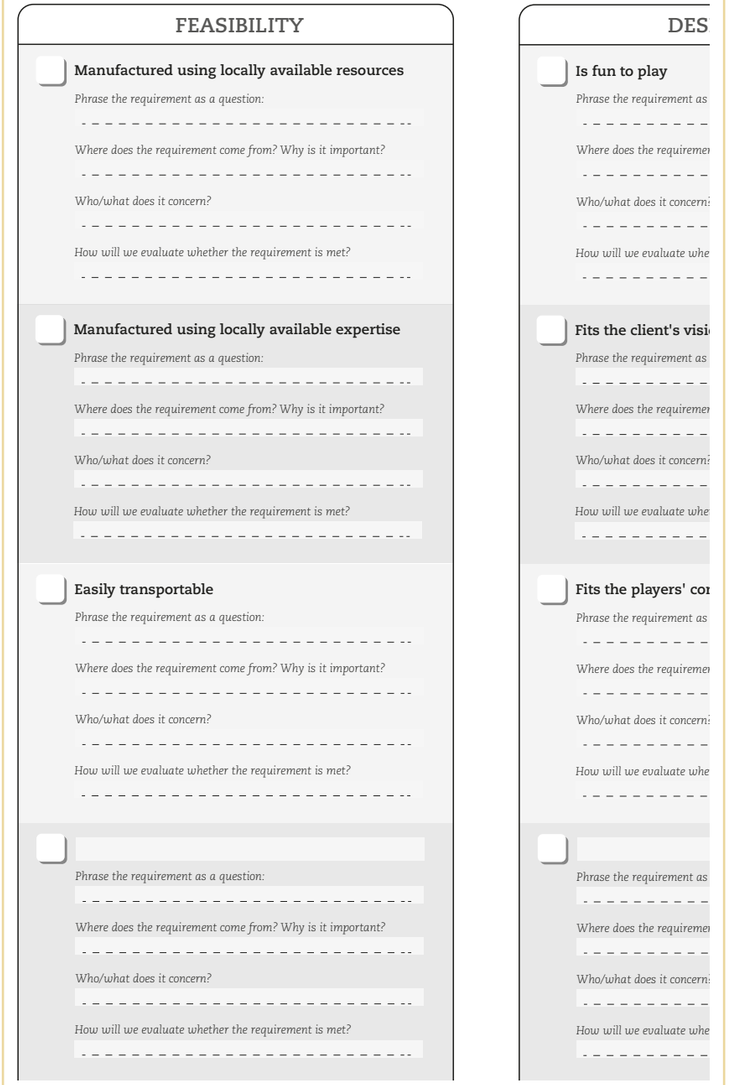


Figure 28. Evaluation tool

Development of the canvas

The process for developing the canvas, as part of the project, will now be briefly described. It was first elaborated during the initial ideation phase based on the findings from the literature review (Chapter 2). The exact source for each element of the canvas is explained in Appendix E. The experience with using this canvas led to iterative changes and improvements to make it relevant for designing serious games in a context like Lamu.
A high-fidelity prototype was eventually made and tested with users to assess the relevance of the tool for the target group and evaluate its usability. This user test was organised as an online workshop supported by a Miro board. The researcher of this project facilitated the session with two facilitators and one innovator of the IOMe as participants. A fake but realistic project brief was invented and the participants had to create concepts for a game to solve the given problem. The details of the user test including the Miro board are found in Appendix E.
The feedback obtained from the workshop led to designing a new version. The usability of that last design was evaluated with a fellow design student.

Main insights from user test

From these two tests, four main insights were obtained which indicated issues regarding the use and understanding of the tool. These issues and subsequent solution to make the final version, presented in the next pages, are now discussed.

Usability

A few issues regarding the usability of the tools were pointed out by both the end users and the fellow design student. Technical words were hardly understood which required to give extra information and made it difficult to fill in the templates. For instance, for the block *types of games*, the words *dungeon-crawler* and *engine-builder* were not understood by the participants. Besides, the amount of instructions, which is necessary to understand the tools, impeded the reading flow of the instructions.
The language was reviewed, some technical words were removed, explanation texts were added to further clarify other technical words and guidance was improved to make the reading flow better for the users.

Offline vs online setting

The workshop had to be conducted online because of the physical distance between the researcher and participants. This showed that online brainstorming session is not suited for teamwork settings and tend to lower the energy level that designers would otherwise have when working in-person. The users said they would rather do such an activity offline but find the preparation of the material quite time consuming (users would have to write down all game elements on seperate post-its, see next page).
It was decided to make the final version of the canvas as a toolkit which can be downloaded and printed to keep the physical dimension and ensure minimum preparation time.

Intention behind the generator tool

The intention for considering the generator tool as a low-key, quick-to-use tool was not understood by the participants which had an impact on the outcome of the workshop. They took a long time to create one game idea because they got stuck on the feasibility of this potential concept. However, the feasibility or any other details should not be considered at this moment of the design process. This is partly due to the fact that the participants were not familiar with the tool yet. However, this behaviour is also explained by understanding the socio-cultural norms. At school, Kenyans are taught in a “failure is not an option” mindset which leads to people attempting to produce “perfect” work, and not “quick and dirty”. This tool therefore comes clashing with the way Kenyans are used to work.
As a result, emphasis was put on the intention for using this tool when making the final design. This intention is now clearly defined in the toolkit as “3 golden rules” that the users must respect when using it (see Appendix D for the full toolkit).

The use of the term *serious*

The lead of the IOMe found that the term *serious* in *serious games* is an oxymora. He advised to refer to it as *games* or *board games* because the term *serious* might give the impression that the activity of designing oand playing the game is too serious.
Thus, it was decided to keep the term *serious game* in this report but refer to it as *game* or *game with a purpose* in the communication with the client.

Finally, the IOMe does not have official tools to support their research and development activities. This tool was therefore well accepted by the target users who see it as an example to develop more tools.

The design iterations as well as the detailed insights obtained from testing the several versions of the canvas are further described in Appendix E.

The solutions to the issues found during the workshop and usability test were implemented to design the final version of the two tools as described below.

A tool for generating concepts

The tool in a nutshell

The first tool consists of seven blocks corresponding to the key "pillars" which were thought to be pertinent to build a game concept for a context like Lamu. These blocks are organised in a certain user flow, on a template sheet as illustrated by Figure 29 on the next page. They are to be filled in game elements. This template also comes with seven pages, one for each block (Figure 30), which explain what each block means and which have cards with words on them, corresponding to game elements. These game elements were chosen according to the context of use, and to match with the innovators' needs and values, such as giving back to their community. By combining game elements, the innovators generate a concept for a game. The cards are used with the template sheet (they should be cut to size). For each block, the innovators can pick any suggested card and place them within the corresponding block. Users can also write their own elements on empty cards. The example of a filled in template for this project's game is shown on page 49.

The user flow

Users should follow the arrows which indicate where to start and where to go from that. In general, users start by defining the purpose, i.e. the *transfer effect(s)* they want the game to achieve. This is the serious element of the concept which is further defined by the *topic*. Users contrast these blocks with the fun by choosing how the *emotions* of the players should be triggered and imagining the *storyline* (the game world). They also think of the physical look of the game by choosing the *type of game* and its *components* and what the kind of *interactions* the players should have.

The golden rules for using the tool

The instructions of the toolkit come with three golden rules to make sure the innovators use the generator tool as intended:

- allow yourself to combine elements that you think are hardly combinable
- do not think of how you will actually make the game, and whether it is even possible to make such a game
- when working in teams, postpone judgement

NB: the canvas does not include decisions on the facilitation but games should be facilitated by a game master to ensure that the purpose of the game is achieved and that the rules are respected.

Appendix F shows examples of the generator tool filled in for the three initial concepts that were generated during the first ideation phase of the project. This is also explained in Chapter 7.

A tool for evaluating concepts

The tool in a nutshell

Once the innovators have generated a few game concepts for the same given assignment, they can continue to the next phase of the design process. This is when design requirements should be defined to select the most suitable concepts to solve the given problem. The second tool was designed to guide this phase. By defining design requirements, the innovators make sure they select and further develop the most suitable game concept for the given problem. The requirements are categorised under the three general evaluation criteria: feasibility, desirability and viability. They are translated into more tangible requirements that the users can choose if they find them relevant. They can also add their own.

The user flow

As shown in Figure 31, users can pick from the suggested requirements under the feasibility, desirability and viability columns. They can also formulate their own requirement to be specific to the project in question. For each requirement, there are four questions the innovators should address. These allow the users to put in words what their game should achieve and why, who is affected by these criteria and how these will be evaluated.

The golden rule for using the tool

The generator tool (first tool) is best use as part of a creative process. The innovators should not have in mind the design requirements when creating concepts. Therefore, the evaluation tool must be used after the generator tool.

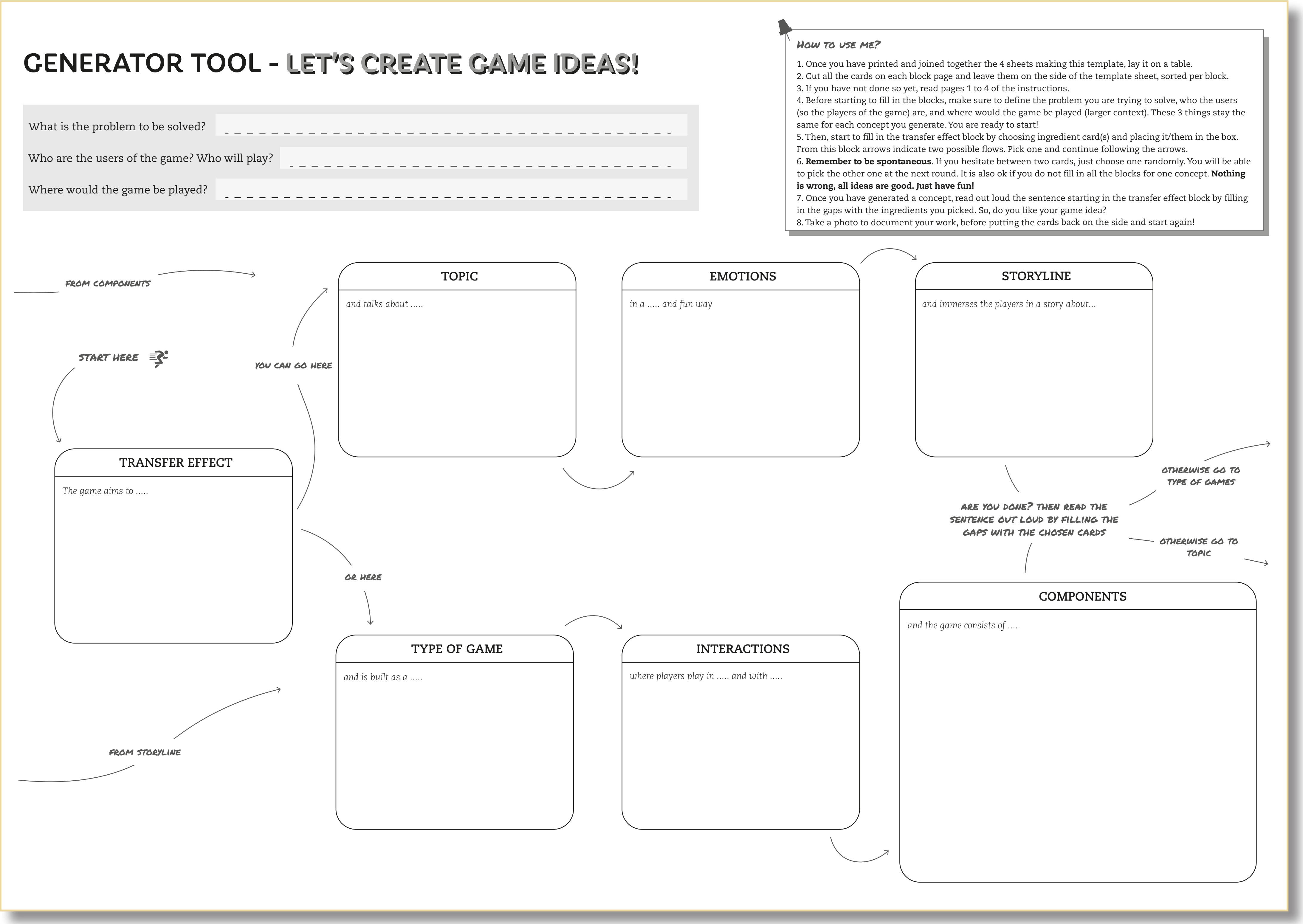


Figure 29. Template of the generator tool

TRANSFER EFFECT

BLOCK PAGE

Print this page so you keep the explanation about this block with you when you use the template.

WHAT IS THIS BLOCK ABOUT?

Next to having fun, what is the intention behind playing this game?

This block is the most important one. It helps you define the purpose you want to give to the game.

You should select 3 transfer effects maximum for one concept.

WHAT ARE THE POSSIBLE INGREDIENTS?

Cut the following cards and use them to fill in the template sheet (generator tool).

ACQUIRE KNOWLEDGE	ACQUIRE SKILLS	SPARK INTEREST
GET INSPIRED	CHANGE MENTALITIES	CHANGE BEHAVIOURS
BOOST SELF-CONFIDENCE		

EMPTY CARDS THAT YOU CAN FILL IN

WHAT IS THIS BLOCK ABOUT?

What is the game about? Which topic(s) are important to talk about?

This block helps you define what the purpose of the game should be about. It gives the content to the *transfer effect*. It can be addressed after the *transfer effect* or the *components*.

You can select up to 3 topic cards for one concept.

WHAT ARE THE POSSIBLE INGREDIENTS?

Cut the following cards and use them to fill in the template sheet (generator tool).

STEM	DRUG CONSUMPTION	VIOLENCE & CRIME
HEALTH	ENVIRONMENT CONSERVATION	POLLUTION & WASTE
IOMe MAKER SPACE	CARPENTRY	
BOAT DESIGN	ANIMALS	

EMPTY CARDS THAT YOU CAN FILL IN

TYPE OF GAME

BLOCK PAGE

Print this page so you keep the explanation about this block with you when you use the template.

WHAT IS THIS BLOCK ABOUT?

What kind of game fits for achieving the purpose?

With this block you select the type of game that helps you achieve the *transfer effect(s)* you picked. It can be addressed after *transfer effect* or *storyline*.

Select only 1 type of game.

WHAT ARE THE POSSIBLE INGREDIENTS?

Deck-builder: players start the game with an identical set of cards and change their own card set to keep the best ones only (which ones are the best cards is for you to decide but later in the process!)

Dexterity: players make use of their physical abilities (with that type of game you can make players practice manual skills for instance. Google Twister if you are not sure what "dexterity" means)

Role-playing: players use their imagination and storytelling to role-play a certain character (maybe this character has certain powers which are skills or knowledge the players can acquire?)

Engine-builder: players win by increasing and enlarging their resources (maybe these resources represent knowledge and skills for the players to acquire in order to win?)

Role-and-move: often played on a board, the players roll a die and move accordingly. This triggers actions players have to do in order to continue playing. (Ludo is a simplified version of role-and-move. You can also look at the UDADISI board game designed for girls!)

Cut the following cards and use them to fill in the template sheet (generator tool).

DECK-BUILDER	DEXTERITY	ROLE-PLAYING
ENGINE-BUILDER	ROLE-AND-MOVE	

COMPONENTS

Print this page so you keep the explanation about this block with you when yo

WHAT IS THIS BLOCK ABOUT?

What components other than the main one (game have? Are the look and feel important?

By filling in this block, you embody the game and add a characteristic (indicated with a ") should be addressed once the *type of game* an

An infinite number of components can be co you choose, the more complex your concept

WHAT ARE THE POSSIBLE INGREDIENTS?

Cut the following cards and use them to fill in the template sheet (generator too

CARDS	DICE	
PAWNS	COINS	
BELL	PUZZLE PIECES	
HOURGLASS (or other type of timing system)	ROPE	

EMOTIONS

BLOCK PAGE

Print this page so you keep the explanation about this block with you when you use the template.

WHAT IS THIS BLOCK ABOUT?

How can I make the game fun? Which emotions and feelings should the players have?

This block guides you in choosing what kind of emotions you want the players to feel and how the fun should take place.It complements the purpose so it should be addressed after the *topic*.

You can select 3 emotion cards maximum for one concept.

WHAT ARE THE POSSIBLE INGREDIENTS?

Fellowship: the players feel emotions for the other players as the game and the fun is all about encouragement, solidarity and help

Narrative: the players get immersed in a game which has a strong narrated story (to choose after this block) which triggers related emotions

Discovery: the players have fun by exploring a new world presented by the game which can trigger emotions like suspense and excitement

STORYLINE

BLOCK PAGE

Print this page so you keep the explanation about this block with you when you use the template.

WHAT IS THIS BLOCK ABOUT?

How does the game world look like? What is the story of the game?

This block helps you imagine the game world in which players are immersed. The relevance of the storyline directly affects how good the *transfer effect(s)* are achieved. The story can be more or less strong based on the chosen *emotions* (narrative will have a strong story compared to fellowship).

Several ingredients can be combined to create one story.

WHAT ARE THE POSSIBLE INGREDIENTS?

Cut the following cards and use them to fill in the template sheet (generator tool).

AFRICA	LAMU	CHINA
CULTURAL FESTIVAL	OCEAN	BEACH
DONKEYS	DHOWS	HENNA

INTERACTIONS

BLOCK PAGE

Print this page so you keep the explanation about this block with you when you use the template.

WHAT IS THIS BLOCK ABOUT?

Who are the players playing with? Is there competition? Are the players playing in teams?

This block helps you define the interactions with the players. You choose whether the users are in teams, if there is competition and with whom are the users playing? It comes after *type of game*.

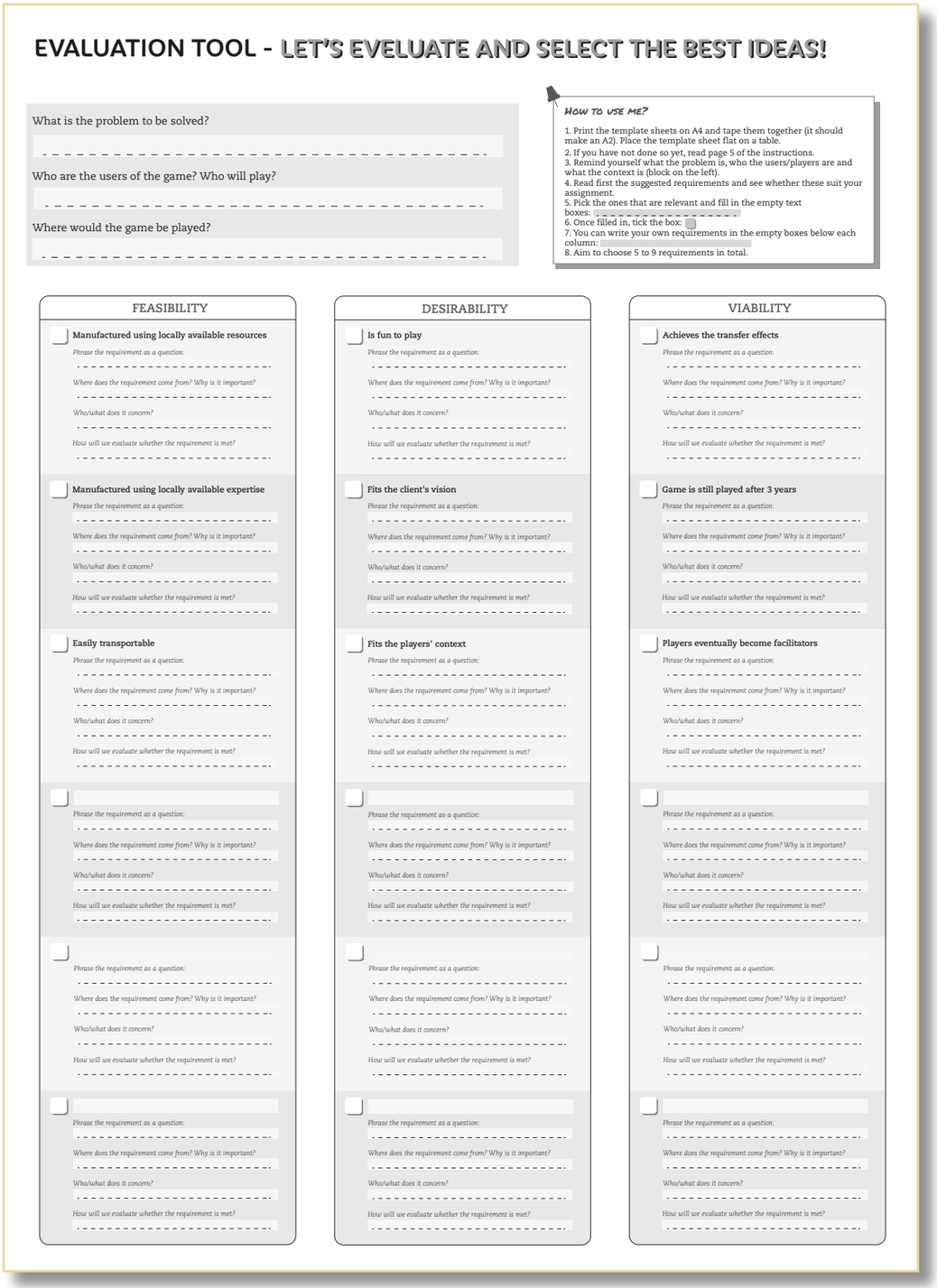
One of the two cards about teams and competition should be selected. From the other cards, you can select a maximum number of 3.

WHAT ARE THE POSSIBLE INGREDIENTS?

Cut the following cards and use them to fill in the template sheet (generator tool).

teams? PLAYED INDIVIDUALLY	*teams?* PLAYED IN TEAMS	WITH OTHER TARGET USERS
competition?	*competition?*	WITH PLAYERS

Figure 30. Seven pages, one for each block



EVALUATION TOOL - LET'S EVELUATE AND SELECT THE BEST IDEAS!

What is the problem to be solved?

Who are the users of the game? Who will play?

Where would the game be played?

How to use me?

1. Print the template sheets on A4 and tape them together (it should make an A2). Place the template sheet flat on a table.
2. If you have not done so yet, read page 5 of the instructions.
3. Remind yourself what the problem is, who the users/players are and what the context is (block on the left).
4. Read first the suggested requirements and see whether these suit your assignment.
5. Pick the ones that are relevant and fill in the empty text boxes:
6. Once filled in, tick the box:
7. You can write your own requirements in the empty boxes below each column:
8. Aim to choose 5 to 9 requirements in total.

FEASIBILITY

Manufactured using locally available resources

Phrase the requirement as a question:

Where does the requirement come from? Why is it important?

Who/what does it concern?

How will we evaluate whether the requirement is met?

Manufactured using locally available expertise

Phrase the requirement as a question:

Where does the requirement come from? Why is it important?

Who/what does it concern?

How will we evaluate whether the requirement is met?

Easily transportable

Phrase the requirement as a question:

Where does the requirement come from? Why is it important?

Who/what does it concern?

How will we evaluate whether the requirement is met?

Phrase the requirement as a question:

Where does the requirement come from? Why is it important?

Who/what does it concern?

How will we evaluate whether the requirement is met?

Phrase the requirement as a question:

Where does the requirement come from? Why is it important?

Who/what does it concern?

How will we evaluate whether the requirement is met?

Phrase the requirement as a question:

Where does the requirement come from? Why is it important?

Who/what does it concern?

How will we evaluate whether the requirement is met?

DESIRABILITY

Is fun to play

Phrase the requirement as a question:

Where does the requirement come from? Why is it important?

Who/what does it concern?

How will we evaluate whether the requirement is met?

Fits the client's vision

Phrase the requirement as a question:

Where does the requirement come from? Why is it important?

Who/what does it concern?

How will we evaluate whether the requirement is met?

Fits the players' context

Phrase the requirement as a question:

Where does the requirement come from? Why is it important?

Who/what does it concern?

How will we evaluate whether the requirement is met?

Phrase the requirement as a question:

Where does the requirement come from? Why is it important?

Who/what does it concern?

How will we evaluate whether the requirement is met?

Phrase the requirement as a question:

Where does the requirement come from? Why is it important?

Who/what does it concern?

How will we evaluate whether the requirement is met?

Phrase the requirement as a question:

Where does the requirement come from? Why is it important?

Who/what does it concern?

How will we evaluate whether the requirement is met?

VIABILITY

Achieves the transfer effects

Phrase the requirement as a question:

Where does the requirement come from? Why is it important?

Who/what does it concern?

How will we evaluate whether the requirement is met?

Game is still played after 3 years

Phrase the requirement as a question:

Where does the requirement come from? Why is it important?

Who/what does it concern?

How will we evaluate whether the requirement is met?

Players eventually become facilitators

Phrase the requirement as a question:

Where does the requirement come from? Why is it important?

Who/what does it concern?

How will we evaluate whether the requirement is met?

Phrase the requirement as a question:

Where does the requirement come from? Why is it important?

Who/what does it concern?

How will we evaluate whether the requirement is met?

Phrase the requirement as a question:

Where does the requirement come from? Why is it important?

Who/what does it concern?

How will we evaluate whether the requirement is met?

Phrase the requirement as a question:

Where does the requirement come from? Why is it important?

Who/what does it concern?

How will we evaluate whether the requirement is met?

Figure 31. Template for the evaluation tool

Chapter takeaways

Issues regarding usability and the online teamwork setting were found by testing two high-fidelity prototypes of the canvas. These were addressed to design the final version as a ready-to-use toolkit which can be downloaded and printed.

TA.1

This final design consists of two tools to guide the innovators of the IOMe in, first, generating as many concepts for games as possible (given a project brief) and, secondly, evaluating these to select the most suitable ideas.

TA.2

Besides, another issue was discovered hindering the proper use of the tool by the innovators. This was found to come from the users' education where "failure is not an option" which clashes with the intention to see the canvas as low-key, quick-to-use templates.

TA.3

The literacy level between the designer of this canvas and the innovators causes an issue when writing the instructions with a language that is adapted to the users. It is recommended to review the usability once again and/or make a video to better give the instructions with visual support.

R.1

The client is enthusiastic by the canvas as it is the first brainstorming tool developed for the needs of the IOMe which has the potential to support the empowerment of the innovators.

++

Even though emphasis on this intention was put in the final canvas design, this culture clash might still persist. This therefore requires to conduct specific tests or interviews to potentially find a solution which is better suited for the users.

R.2

This method will now be put in practice for the game that was developed for this project. This is shown in Chapter 5 where the chosen concept is described and in Chapter 7 where the generation of initial ideas and the selection of one is illustrated. But, first, the scope for the solution space to design the game is defined in the next chapter.

Chapter 4

SCOPE

The canvas used to develop the game for this project has been explained. Before presenting this game, this chapter details the solution space which was defined to design the end product. First, the girls who are the target users, i.e. the players of the game, are portrayed by means of a persona. The interactions they have with the current context are illustrated and further translated into desired interactions. This ideal scenario supports the formulation of the interaction vision and design goal which guided the design and evaluation of the final product. Finally, the design requirements important to achieve these goals are listed.

4.1. The users of the game

First, the typical profile of a user of the game is portrayed with her needs and values which are used to visualise the interactions she currently has with STEM. These are then translated into an ideal scenario to achieve guided by an interaction vision and design goal.

Persona

This persona portrays a young girl living on the island of Lamu, currently in Grade 5 or 6.

This is Nour

Nour is now 11, in Grade 6 at a mixed school on Lamu island. She was born and raised in Lamu in a muslim traditional family. Her dad works to bring food to the family and her mom stays home to take care of the house and children. In fact, Nour helps her mom with the house chores everyday.

She does well at school, mostly in the *Arabic* and *Kiswahili*. They are actually her favourite subjects at the moment. She is curious and interested in *Science and technology* but finds it hard to understand because the classes are quite theoretical. She would like to have more practical activities. Either way, these subjects are for men, she believes, so why would she have to understand them?

Nour is

hard working *and* ***enthusiastic about school***, ***caring***, ***creative*** *and* ***slightly competitive***.

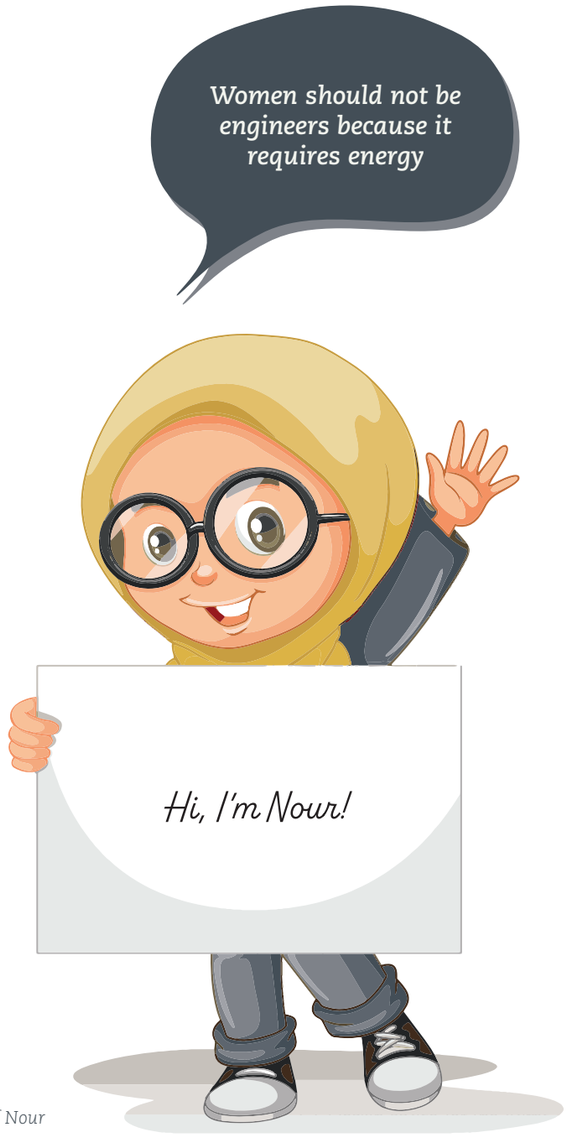


Figure 32. Illustration of the persona of Nour

Nour likes

- reading
- playing skipping rope with her friends
- playing netball at school
- playing Ludo on her phone.

Her needs, values, beliefs and concerns

Nour likes to work with her friends in class, she enjoys learning new things and appreciates the support from her teacher and classmates. She sees the advantages of science and technology for finding solutions that help others but she does not believe that girls can become engineers.

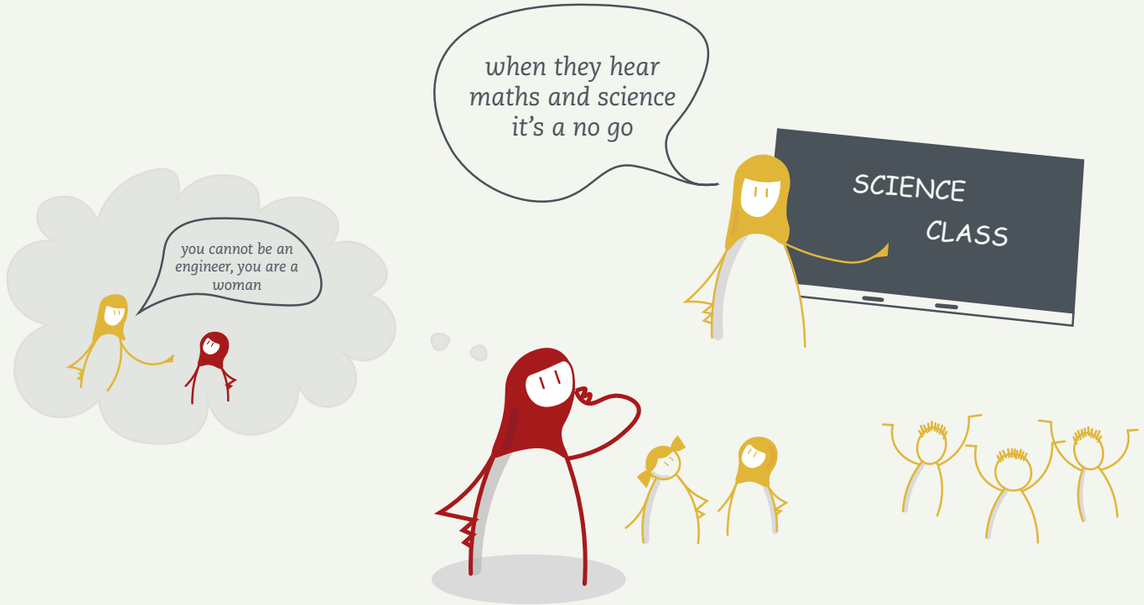
After she is done with high school, Nour would like to attend university and knows she needs to work hard for it. She dreams of becoming a doctor or a pilot but, in general, she wants to give back to her community and

Current interactions

The literature review as well as the observations and insights obtained during field research in Lamu have allowed to draw the current picture regarding interactions between the girls and STEM. This current situation will help define the design goal and interaction vision.
Currently, the young girls of Lamu engage with STEM at school, during *Science and technology* classes. This subject is often amongst the girls' least favourite and *"when they hear about it, it's a no go"*, according to a teacher. Some girls also lack self confidence towards these subjects and tend to assess themselves not as well as other subjects like *English* or *Kiswahili*.

This current situation can be explained by the fact that these girls face stigmas, stereotypes and biases conveying ideas that STEM is not for them. Some even face their parents' refusal to pursue higher studies in STEM: *"you cannot be an engineer, you are a woman"* (-Lamu Women Alliance member's mother).

Figure 33. Visualisation of the current interactions



Beyond the school sphere, the activities where STEM disciplines mainly take place are in construction (buildings and roads) and business (transport of merchandises). These activities are perceived to be solely for men because *"they require a lot of energy"*, according to a Grade 6 girl from Wiyoni Primary.

From the observations collected during field research, it was concluded that, in general, the young girls of Lamu avoid to take part and/or lack interest in STEM fields. This, in turn, can affect their self-confidence when engaging in the relevant school subjects or close the door to pursue related studies in the future. All these factors make the interactions between girls and STEM **distant**, rather **unfamiliar** and often **undesirable**.

Desired interactions

The need for an intervention which re-designs these current undesirable interactions between the young girls of Lamu and STEM disciplines was identified. By changing these into positive, desired interactions, an empowering and meaningful experience will be created on which girls can fall when they face the stigmas, stereotypes and biases in the future.

Ideally, the interactions between the girls and STEM trigger **curiosity** for topics revolving around science, engineering, technology and mathematics. The girls should also feel **encouraged** to **confidently** engage in STEM education in a **constructive**, **collective**, and **fun** way.

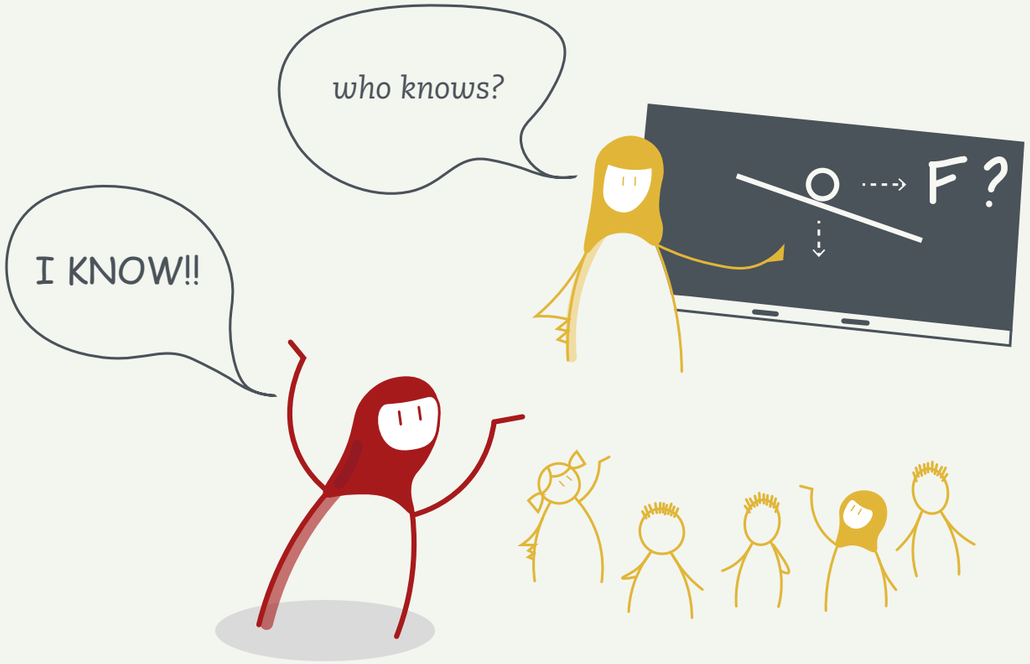


Figure 34. Visualisation of the desired interactions

These desired interactions will now support the visualisation of the interaction vision and the formulation of the design goal.

4.2. Project vision and goal

Interaction vision

As discussed in Chapters 1 and 2, a serious game was selected as the product format to achieve the desired purpose and interactions. Regarding the interactions, a metaphor is introduced to envision how they should take place when the users are exposed to the final product. The vision is formulated as:

The interactions with the game should feel like hiking in the mountains with friends.

curious, encouraging, collective and constructive

As the players walk together through the hiking path, they grow interest and become **curious** about their surroundings. When they encounter challenges, they might feel stuck at first but they **encourage** each other and work **collectively** to solve them. As they progress in the hike, the players not only build their knowledge and skills, but their self-confidence **constructively** increases.

Figure 35. Picture visualising the Interaction Vision

Design goal

From the initial general objectives of empowering young girls and challenging the current mentalities, the transfer effect was defined to focus on sparking an interest and boosting the users' self-confidence, and formulated as:

> "Design a serious board game which sparks the interest and boosts the self-confidence of young girls of Lamu when engaging in STEM education."

4.3. Design requirements

After the first ideation phase (described in Chapter 7), design requirements were defined to, first, select the most suitable concepts out of the created ones. These requirements were later used as guidance to further develop the selected concept (explained in Chapter 7) and evaluate its performance (explained in Chapter 6). Eight design requirements were formulated from the client's initial project brief, the findings of the literature review and the insights obtained during field research in Lamu (previous chapters' takeaways). As prescribed by the canvas, they are categorised under the feasibility, desirability and viability evaluation criteria. For each requirement, the concerned actor is presented (legenda on the top right) and a guiding question is formulated. This is presented in Table 1.

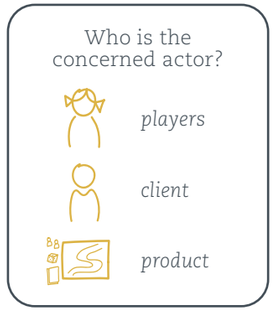


Table 1. Desing requirements for the project

Feasibility	Desirability	Viability
1. Made using locally available resources*	**3. Triggers the desired interactions**	**7. Realises transfer effects**
Is the game designed to be made with local materials and production techniques?	*Does the game spark curiosity, encouragement, collaboration and constructivity?*	*Does the game spark an interest in STEM amongst the girls? Do they feel confident when playing?*
2. Easily transportable	**4. Is fun to play**	**8. Transfers design intervention**
Is the game designed to be easily transportable and carriable by one person?	*Are the girls engaged and enthusiastic when playing the game?*	*Is the intention of the game transfered to the client? And to anyone involved in the implementation?*
	5. Fits the context	
	Is the game suitable for the given context and does it meet the needs of the target users?	
	6. Fits the client's vision	
	Does the game promote problem-solving and critical thinking?	

*This first requirement also entails economic viability of the product which is not considered as a requirement on its own for this project.

Chapter takeaways

The players of the game are the young girls of Lamu who typically avoid to engage in STEM-related activities and generally lack interest and confidence.

TA.1

This intervention aims to re-design the current interactions to be curious, encouraging, collective and constructive through a serious board game.

TA.2

The design goal is to spark the interest and boost the self-confidence of the girls when engaging in STEM education.

TA.3

The insights from field research, literature and initial client brief led to listing eight essential design requirements. These will be used to evaluate the performance of the final game design, in terms of feasibility, desirability and viability.

TA.4

With the solution space for developing the game defined, the final design is presented in the next chapter.

Chapter 5

FINAL GAME DESIGN

This chapter presents the final game prototype which was designed following the interaction vision, design goal and design requirements defined in the previous chapter. The user test to evaluate this prototype is first briefly explained and the insights relevant to the final suggested design are outlined. The chosen concept is then explained in light of the canvas tool, and the mechanics are illustrated by a typical user flow giving rise to game dynamics. The design and manufacturing of all the elements composing the game are outlined. Finally, the environment and system around the game are discussed.

5.1. Development of the game

This section describes the main insights obtained from the final user test, relevant to understand the final concept design.

Development of the game in a nutshell

To arrive to the final design, many iterations on the concept itself as well as on the design and making were done. Prototypes for three different game concepts were tested with users during field research in Lamu. One was selected to be most suitable regarding the achievements of the design requirements. This testing and selection process is described in Chapter 7. Two better prototypes for the chosen concept were developed and tested with users at the end of the field research. A final, high-fidelity prototype was tested to evaluate the performance of the final concept.

All the design iterations and the corresponding insights and conclusions can be found in Appendix F.

DESIRABILITY	VIABILITY
3. Triggers the desired interactions *Does the game spark curiosity, encouragement, collaboration and constructivity?*	**7.** Realises transfer effects *Does the game spark an interest in STEM amongst the girls? Do they feel confident when playing?*
4. Is fun to play *Are the girls engaged and enthusiastic when playing the game?*	**8.** Transfers design intervention *Is the intention of the game transfered to the client? And to anyone involved in the implementation?*
5. Fits the context *Is the game suitable for the given context and does it meet the needs of the target users?*	
6. Fits the client's vision *Does the game promote problem-solving and critical thinking?*	

Table 2. Desirability and viability requirements tested during the user test

Testing the final prototype

Objectives of the user test

The aim of the final user test was to assess whether the final prototype met the design requirements concerning desirability and viability, as presented in Table 2. Feasibility was evaluated throughout the making process.

Test set-up

The user test was conducted at Mahmoud Bin Fadhil Girls, a school that had been involved in several activities during field research. The same eight learners who had participated in the previous user test were asked to take part in this final testing. This was to collect their feedback on improvement from the last prototype. Another two girls joined the test making a group of five girls from Grade 5 and five from Grade 6. The session was facilitated by a volunteer from the KRCS whose role was to ensure the rules of the game are respected, the intention behind playing is understood by the players and the transfer effects are achieved. The game master was supported by an innovator of the IOMe who also observed the session. The user test lasted for almost two hours and the set-up is visualised in Figure 36.

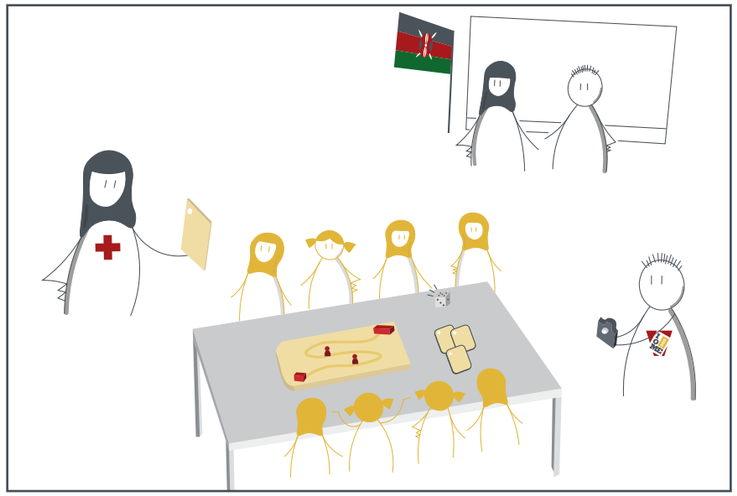


Figure 36. Visualisation of the user test set-up

Methods to collect data

Data was collected from the observer throughout the session as photos and videos. A questionnaire was prepared to give to the participants before playing, and repeat the same questionnaire after. This is to look for any effects the exposure to the game has on users, regarding the transfer effects and desired interactions. Finally, a reflection session was organised with the observer and game master which, altogether, allowed to draw the main insights which are presented on the next page.

The method for preparing and reflecting with the game master and observer, as well as the method for collecting all the different data are further explained in Appendix G.

Main insights from the user test

Even though the user test was prepared, its execution did not go precisely as planned. This gave rise to some issues (✗), positive outcomes (✓) and opportunities (↗) improve the game. The main insights are explained below. Besides, insights about how the game was used are also discussed. The complete data analysis is available in Appendix F. The discussion regarding the achievements of the design requirements on feasibility, desirability and viability are further detailed in the next chapter when evaluating the performance of the game.

✗ Timing of the test

The user test lasted for longer than initialy planned partly because they lost time when arriving at the test location. The game round could not be finished as the test had to end for the pupils to go home. That means, no team "reached school" (end of the path, as in Figure 40) and the game master, pressured by time, decided to make the participants fill in both questionnaires after playing.

"She [the game master] did it because of the pressure with all the girls being around. She broke the rules according to the environment and the dynamics." - the lab facilitator

No conclusion could be drawn from the short-term effects on users after being exposed to the game. Priorities when running such a test should be better communicated to avoid skipping essential steps.

↗ Play time

This event disrupted the test itself but shed light on the play time opportunity. One game round might be too long to play at once, and can therefore be played at several moments. This allows the players to reflect on their learning experience and construct their knowledge and confidence in-between sessions.

✓ Facilitation

The game master deviated a bit from the given game rules. She also initiated important discussions about girls in STEM when a team would pick a relevant card (from the square category, further explained on page 55).

"we had a great discussion about whether girls can study STEM" - the game master

The game master owned the facilitation. This shows the importance for the game master to understand the intention for playing the game in order to transfer it to the players and achieve the tranfer effects. It also establishes the game master as a user type of the game.

✓ The fun

The girls were engaged in the game, and focused with their team when it was their turn to answer a question. They all found the game *"very fun!"* to play.

↗ The seriousness

The game master should instruct the players to bring some paper and pens to work out the questions. However, this rule seemed contradictory to the idea of playing a game, according to the girls and the testing team.

"not everyone brought pen and paper because they knew they would play a game" - the observer

Together with the fact that the client prefers not to refer to the game as *serious game*, it confirms that the seriousness should be implicit.

↗ Difficulty

It was reported that some questions were perceived as difficult by the players. This issue mainly comes from using unsuitable language on some cards such as the word *physics* with which the girls are not familiar. Indeed, they know the broader *science* nomination because it is the name of the subject they study at school.

"I had to repeat the questions for some of the learners who did not understand right away" - the game master

However, this difficulty is experienced differently amongst the test group which is due to the individual academic level. Some technical words must be revised but the overall difficulty level of the cards should not be changed not to make the game too dull. Besides, this situation of level difference is common in class. It can actually make the strong learners encourage the weaker ones, therefore enhancing collaboration and teamwork.

✗ Keeping scores

The rule of keeping the card as a point after answering correctly was not respected. Instead, the contact teacher kept scores on a piece of paper. This rule is essential as it allows the players to have a tangible recognition of their effort and encourages them to keep on trying.

↗ Play modes

Some children suggested to play the game with the board on the box. But they played without the box, otherwise the board would be too high on the table and not so visible for some participants. Nonetheless, this showed the modularity of the game to be played both outside, on an uneven low ground or inside, on an even higher ground (like a table). This enhances the play experience.

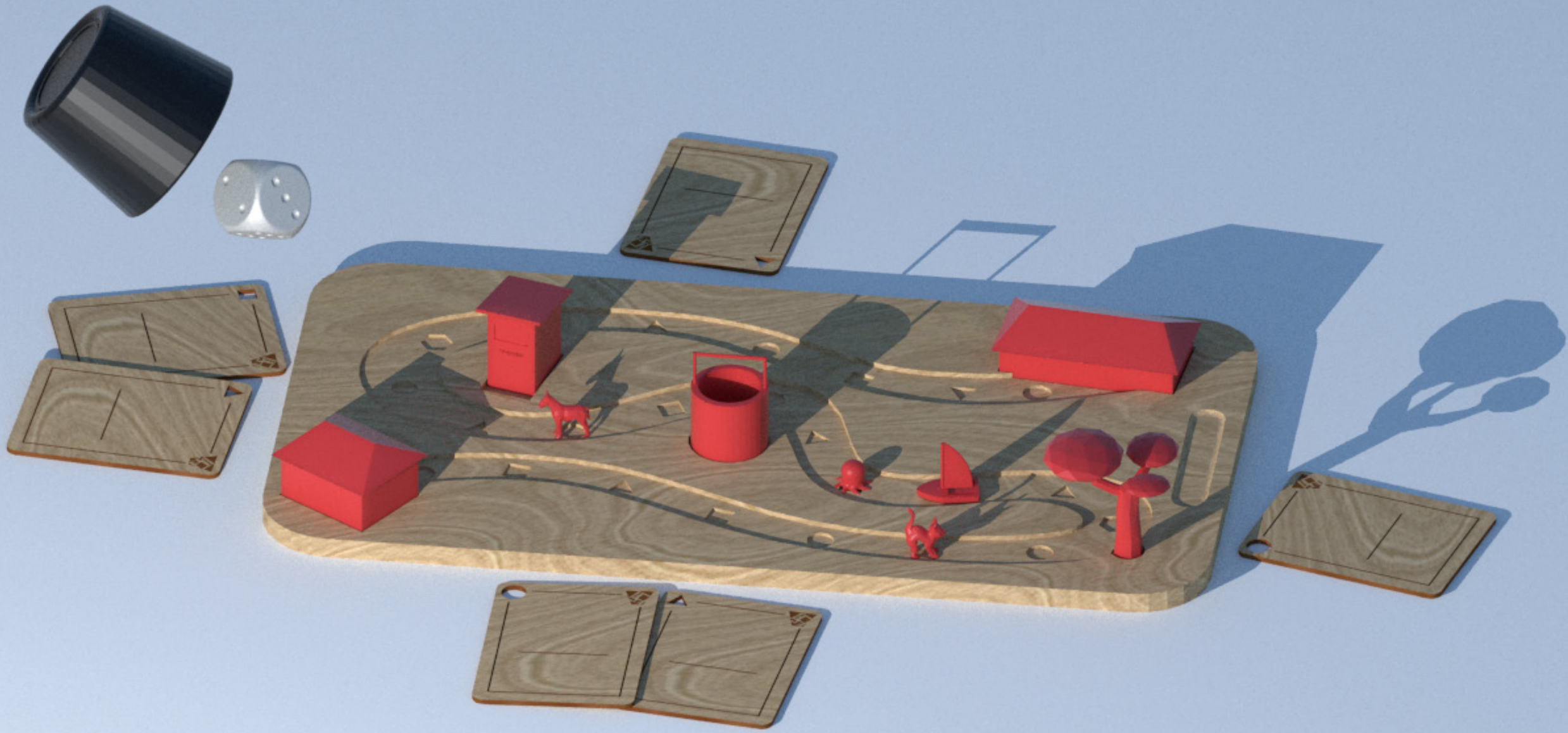


Figure 37. Render of the final design

5.2. Selected concept

The insights from the final user test led to consolidating the concept of the serious game which is illustrated by putting in practice the generator tool. The typical user flow is then demonstrated, after which, the mechanics and dynamics occuring in the game are detailed.

The concept in a nutshell

The selected game concept for this project is now explained in light of the generator tool from the toolkit and serves as example to illustrate the use of the canvas. Two transfer effect cards were picked and placed in the corresponding block. *The game aims to* spark an interest (in STEM) and boost the self-confidence (of the users). *Moving upwards, the game talks about* STEM in Lamu, IOMe maker space and role models *in a* narrative, challenging *and fun way. The game immerses the players in a story about* Lamu. *Following the large arrow, the game is built as* a roll-and-move type of game *where players play* in teams, in competition with one another, with each other but also with some interactions with the game master. *The game consists of* cards, a board, a die with a throwing pot and pawns.

The detailed design for each of the components is explained from page 53.

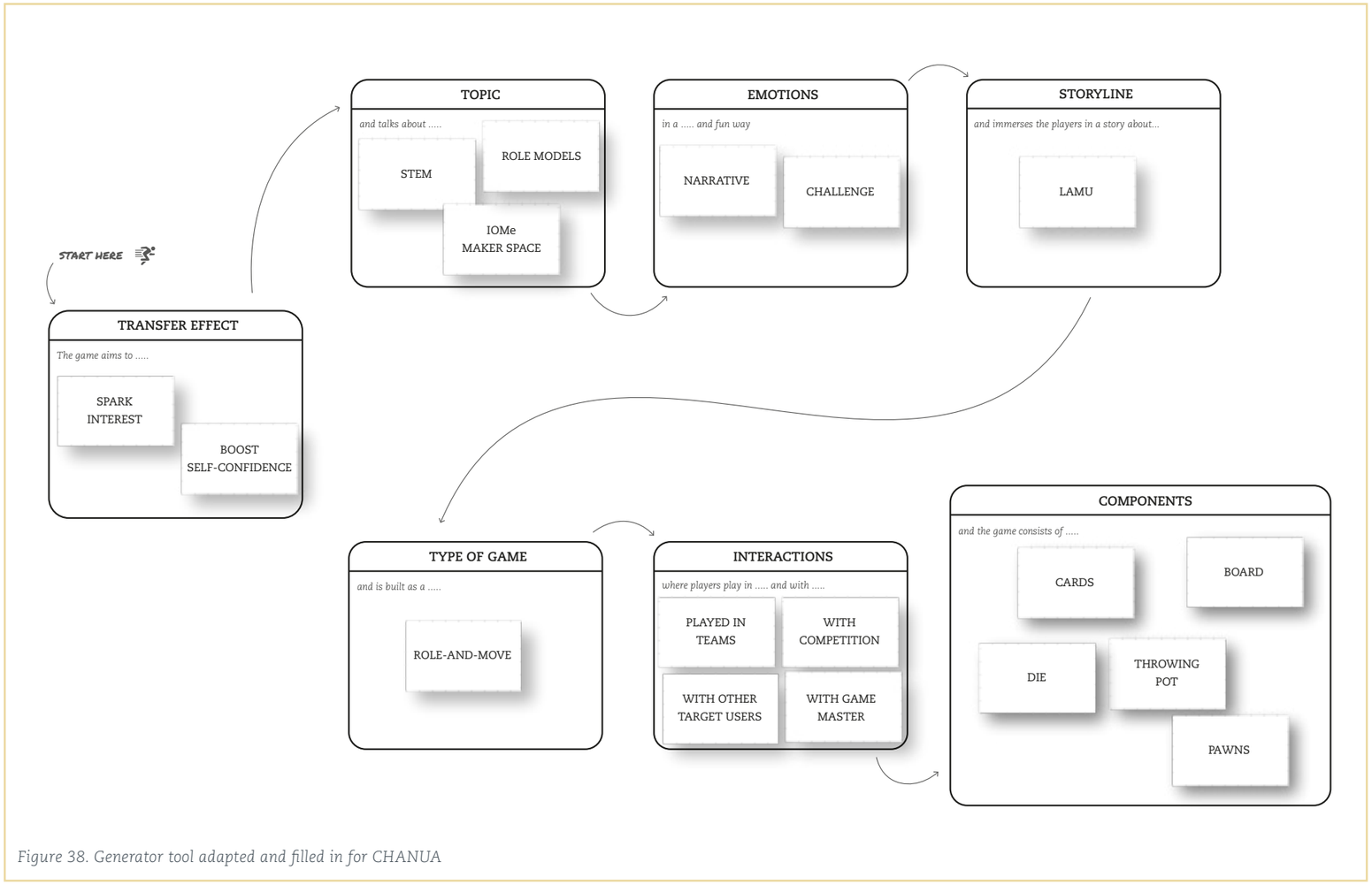


Figure 38. Generator tool adapted and filled in for CHANUA

The user flow

The user flow is illustrated in Figure 39. It corresponds to a team playing one turn and typically goes like:

1. A team throws the die and moves their pawn accordingly on the path designed on the board.
2. The team picks a card with the shape corresponding to the one their pawn landed on.
3. The team reads the question out loud.
4. When all players from the team understand the question, the game master starts a timer for two minutes.
5. The team discuss the question together and can give their answer within these two minutes.
6. The team gets to keep the card which counts for one point if the game master considers the answer to be correct. If not, the other team(s) can attempt to answer the question. They get the card if correct.

For more information on the rules, the instructions as given to the game master are in Appendix H.

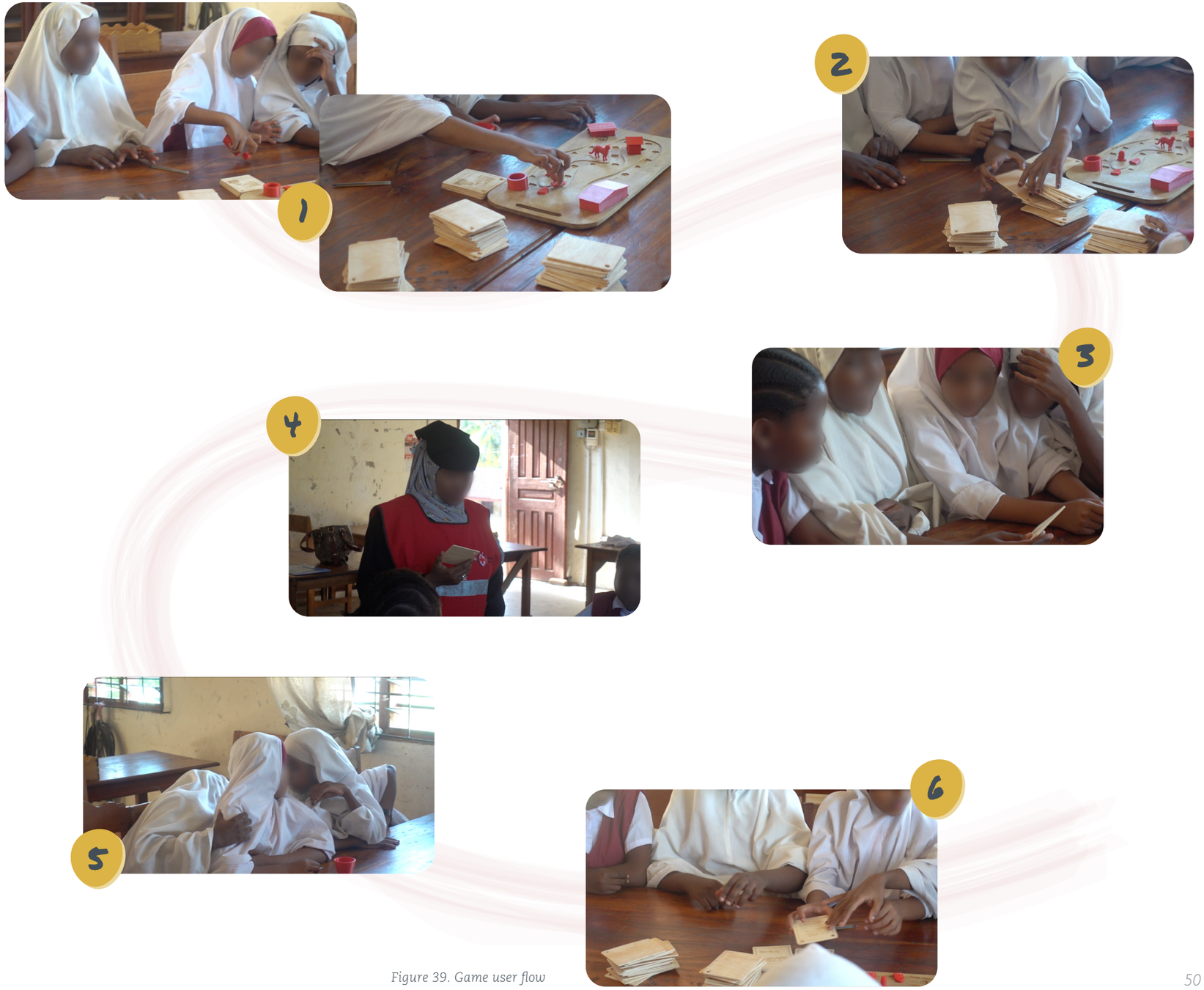


Figure 39. Game user flow

The mechanics and dynamics

Game mechanics

The following pages first describe the rules and general setting designed for this game, i.e. the mechanics, and then analyse the dynamics produced in response (Hunicke et al., 2004).

Teams setting

The players play in teams of four to six, making four teams in total. This team setting is to trigger the desired interactions of encouragement and collaboration, values which are also promoted by the CBC educational system.

Starting rule

The starting rule is taken from the widely played Ludo game whereby each team must throw a 6 in order to start on the board. The starting point is the house placed on the board, as shown in Figure 40. If one team has already started, the other teams get 3 turns to throw a 6 by which they are allowed to start on the board (this is to avoid creating too much gap from the start).

Timing

Once the card is read by a team, the team gets two minutes to complete the challenge and give their answer. The time is managed by the game master, with her phone. This first allows to increase excitement and focus amongst the players for whom the time progress is not visisble. Secondly in Kenya, pupils are used to almost one-way interactions with their teachers. The game revisits this dynamic to fit it in the facilitation. Thus, having the game master keeping track of the time strengthens the interactions with the players and game master, and avoids interactions purely between the game and the players.

Scoring points

When a team answers the question correctly, they keep the card which counts as a point. This way of scoring is more concrete than giving a point kept on a paper, and act as a tangible recognition of the players' effort. This, in turn, will encourage them to keep on trying, especially a team who has not scored much yet.

Incorrect answers

If a team gives an answer deemed incorrect by the game master or if the team could not give any answer after the time is up, the other team gets the chance to answer. If they get it correct, they keep the card.

Winning rule

At the end of the path, there is a school (Figure 40). As soon as a team arrives at school, the game is (almost) over. This team gets to pick a card from any deck and attempt to win one last point. However, the winning team is not the team who arrives at school first but rather the team who collected the most cards. This rule allows to keep the serious purpose of the game with regards to the fun.

Hexagon on the path

The winning rule might affect the fun which is triggered by throwing the die. A set of scenarios were designed to ensure the players are still engaged. These scenarios are embedded in the hexagon shapes carved in front of the baobab, well and shop (iconic features of the way to school as identified during a co-creation session with children, more in Appendix I). They are designed to trigger excitement and reinforce interactions amongst the players and with the game master. This rule is detailed in the manual of instructions in Appendix H.

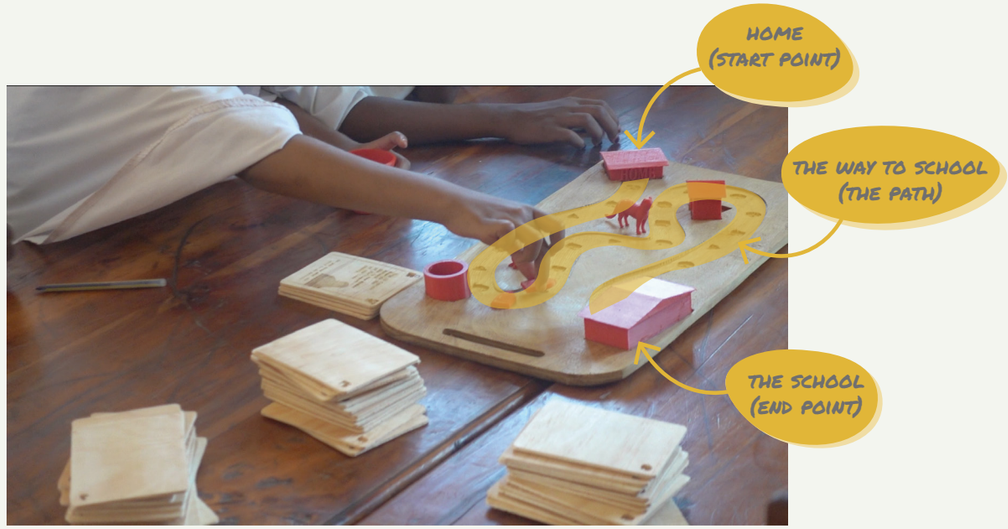


Figure 40. The path with its starting and ending points

Game dynamics

Competition spirit

The mechanics of time and teams create competition, reinforced by the rule whereby other team can win the card if the playing team gives an incorrect answer. Mild competition can be an asset for children to complete tasks as it can increase their motivation.

Teamwork spirit

The team and time mechanics, and consequential competition atmosphere reinforces the teamwork spirit. The players immediately start working together as a team when the two minutes start counting. They also take time to listen to one another to make sure they have the best answer to give to the game master.

Challenge

The serious purpose takes form through the questions. These give rise to some challenge as they require the players to actively think and reason. Examples of questions are shown on the right, in Figure 41. This challenge eventually makes the players grow in knowledge and confidence.

Fun

The several rules, in combination with throwing the die with the pot and having iconic features and pawn on the board make up the fun of the game. This is essential to make the learning experience meaningful.

Other

A common game dynamic observed amongst players is cheating or bluffing. This dynamic is hardly operational with the present game as the game master has the final word on actions taken by players.

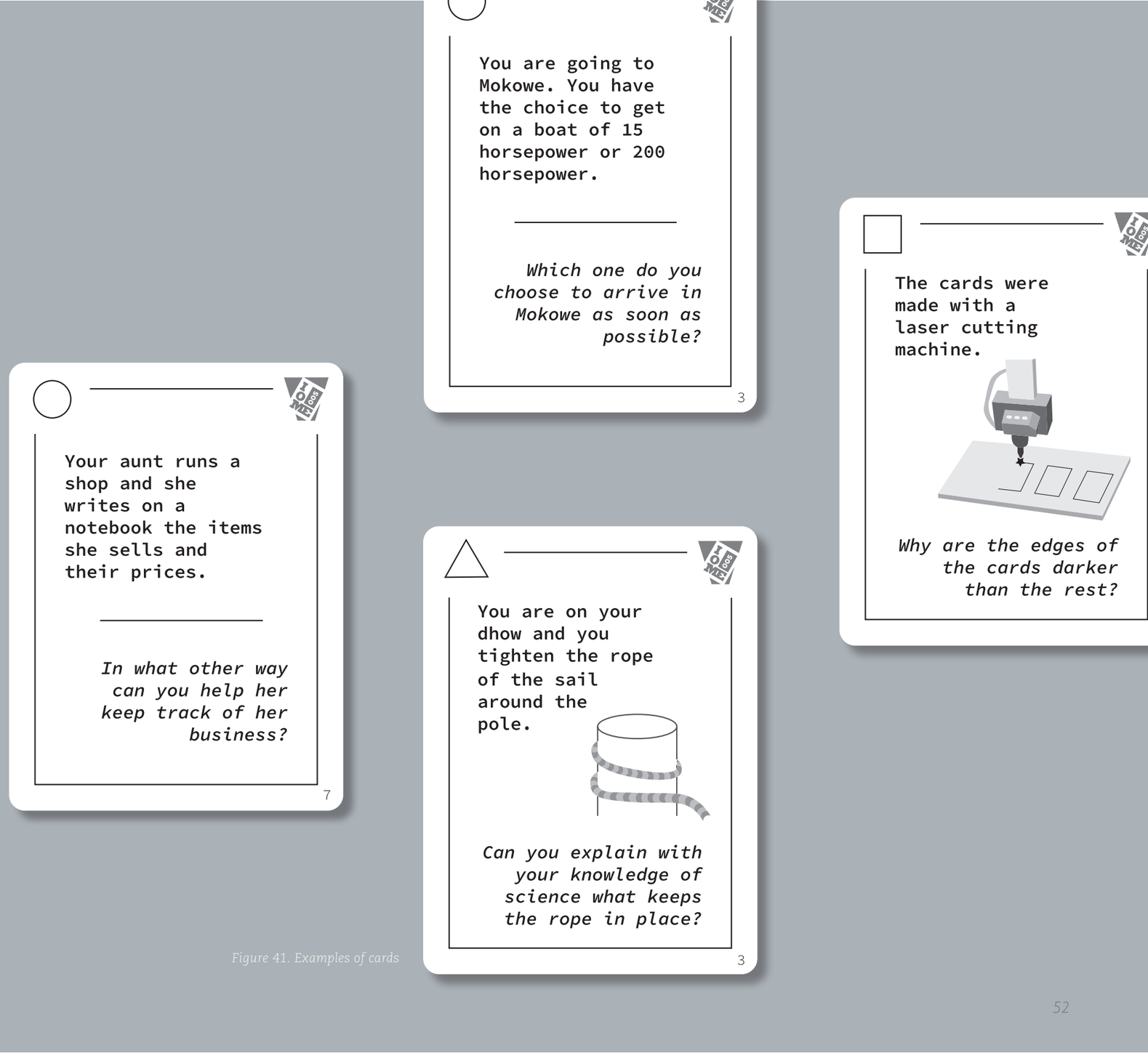


Figure 41. Examples of cards

5.3. Detailed design

With the selected concept presented, the design and making of each component are now communicated to understand their respective function in addressing the transfer effects and other design requirements. This is shown with pictures of the final prototype made in Delft.

Overview

The design iterations which led to designing the game as such are illustrated in Appendix I.

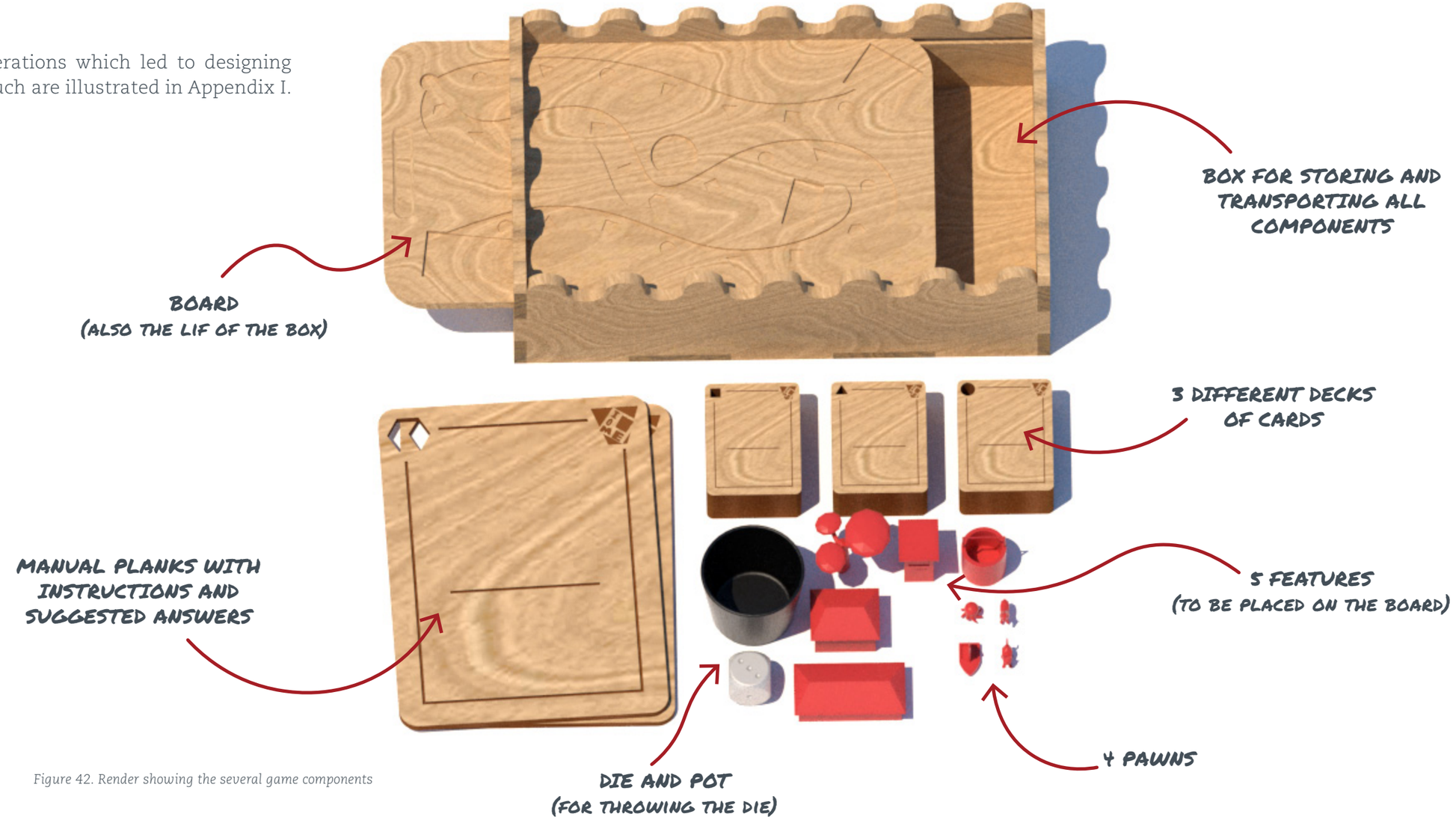


Figure 42. Render showing the several game components

The board and features

Board design

The board was designed with a path that represents the way to school from home. It is the foundation of the game world in which the players are immersed.

> *Like hiking with friends in the mountains*, the girls walk from their house to school and encounter challenges on their way. They must complete them to arrive to class.

Board manufacturing

The board is manufactured using the CNC machine of the IOMe to carve the wood and create different depths.

Features design

The board features were designed to support the immersion in the game world and enhance playfulness. They are iconic things that girls see on their way to school in Lamu, as found by conducting a co-design session with children (Appendix FIXME). They are placed in their respective slots when setting up the game which enhances playfulness.

Features manufacturing

The board features are 3D printed with the printers of the IOMe to allow for details and achieve the objective to use different production techniques of the IOMe.

Figure 43. Final design of the board and features

The cards

Card design

The cards are categorised in three groups according to the question carved on them:

- Answer a question: close-ended questions with one possible answer. The aim of this category is to make the girls relate to topics they learn in class (questions inspired from the syllabus) with a critical eye and a new perspective.
- Solve a problem: often an open-ended challenge, can be a creative problem. The aim of this category is to make the girls adopt a problem-solving approach.
- Think wide: open-ended questions which should spark discussions where answers are not just one word. The aim of this category is to widen the exposure of the girls to STEM, make them think critically of the status quo and inspire them by presenting role models.

Examples of these three categories can be read on Figure FIXME.

All questions are formulated with a storyline because “storytelling is important in Africa” according to a Lamu Women Alliance member. This reflects something typical of Lamu, but not necessarily of girls and women. Examples are dhows, the surrounding nature, what they eat (fried potatoes) and drink (juice).

Having different categories can make players, after they are familiar with the game, wish to land on a certain shape to get a certain type of question.

Card manufacturing

The cards were designed to be almost identical in shape to make the production easy. They have a circle, triangle or square hole at the top left corner to categorise them. They are manufactured from plywood with the laser cutting machine of the IOMe. This technology was chosen to be able to engrave images to support the understanding of the questions.

Figure 44. Final set of cards

The die and throwing pot

Die design

The die was designed to a user-friendly size. This component is the fun element of the game, it triggers excitement and enthusiasm.
On a deeper level, it offers a dimension of randomness which represents the struggles and challenges of life reflected through the game narrative (questions), mechanics and dynamics (die and competition).

Die manufacturing

It was decided to design and manufacture the die at the lab instead of ordering it to avoid high costs and unreliability of shipping. The die is 3D printed with the printers of the IOMe.
The filament colour is red as it is the main colour available at the lab, and it also remind the Red Cross.

Pot design

A throwing pot was designed after observing children using a container to throw the die when testing a prototype. It was designed to a user-friendly size and large enough to hold the die.

Pot manufacturing

The throwing pot is also 3D printed.

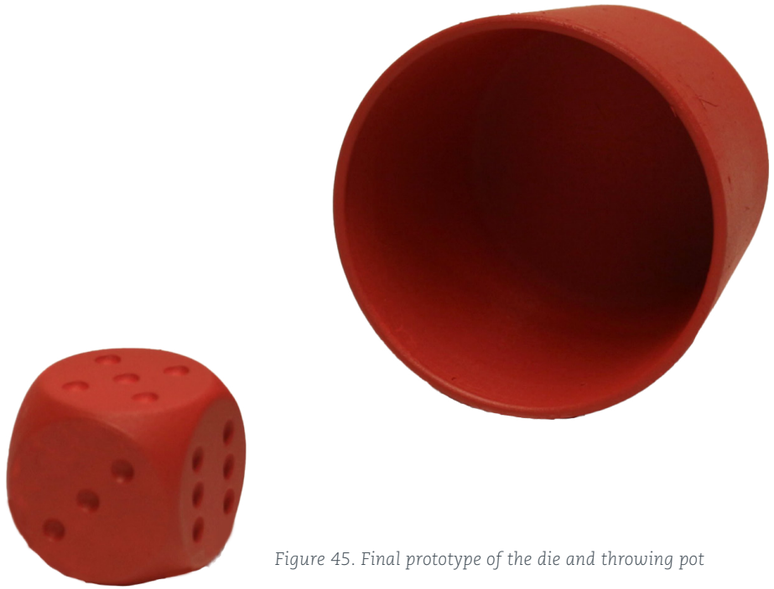


Figure 45. Final prototype of the die and throwing pot

The pawns

Pawn design

The pawns were designed as iconic elements of Lamu, easily recognisable by the players and fitting to their real world. This is for the players to relate to their chosen pawn and reflect their progress in the movement of the pawn.

Different designs were selected instead of different colours because there are not always several colours of filament available at the IOMe. An octopus (common seafood), a cat (many of them in Lamu), a donkey (widely used for carrying things) and a sailing boat (like the traditional dhow) were chosen as designs for the pawns. They were downloaded from UltiMaker Thingiverse.

Pawn manufacturing

The pawns are 3D printed with the printers of the IOMe, all in the same colour.

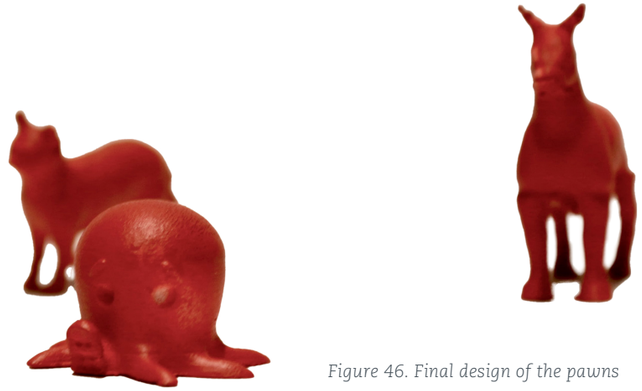


Figure 46. Final design of the pawns

The box

Box design

The box was designed to store all the loose components of the game and transport the game set. In order to minimise the use of material, the board was designed to also serve as the lid for the box. This also allows to use the box as a support when playing on uneven ground (outside class for example), with the board still on the box.

The top edges of the box were designed to enhance user-friendliness and reflect Lamu's cultural heritage of carpentry.

Figure 47. Final design of the box

Figure 48. Box storing game components

Box manufacturing

The box is manufactured using the CNC machine which allows to carve in the wood to make the slots for sliding the lid in and out.

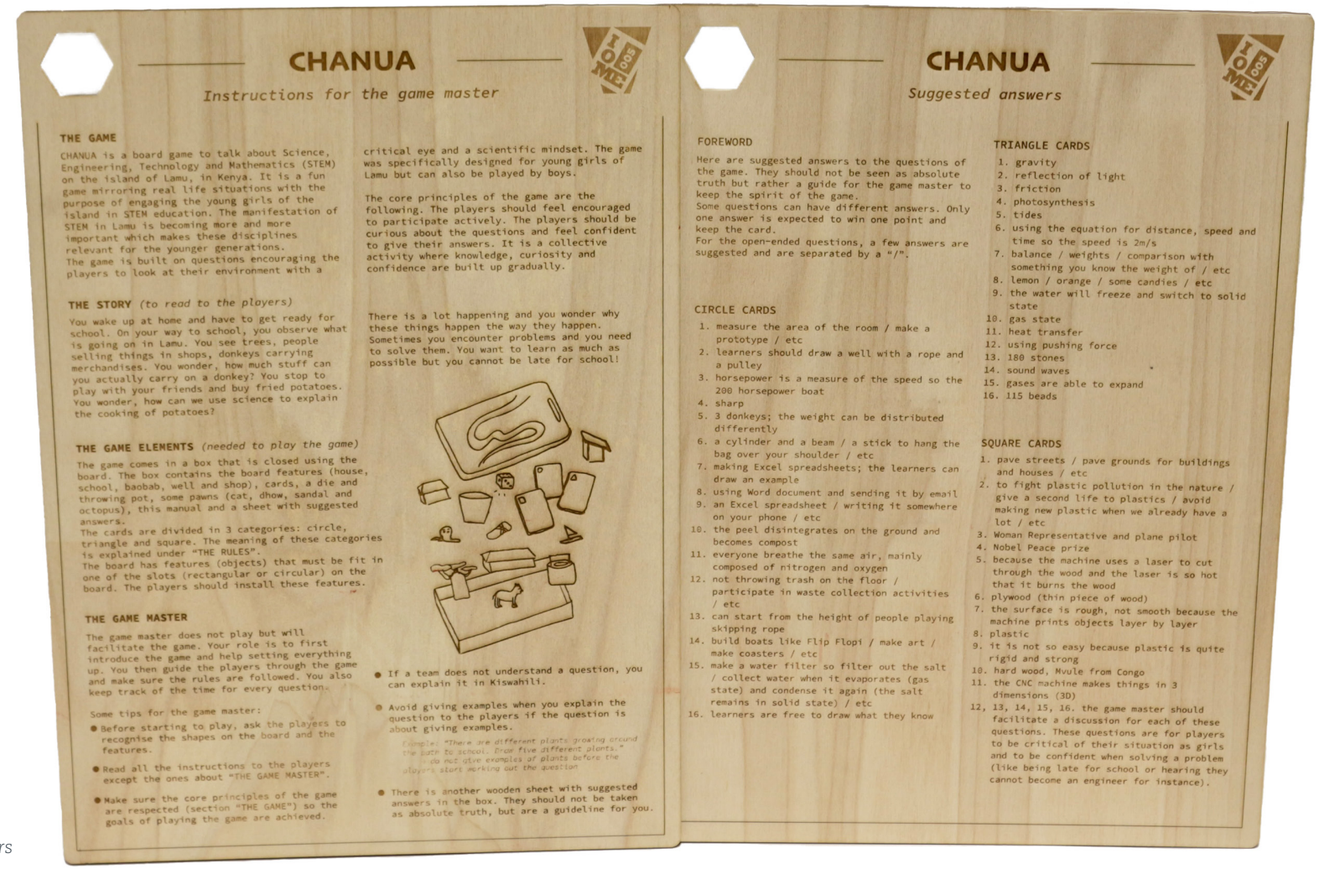
The manual

Manual design

The manual was designed to contain the game rules and suggested answers to the questions. This manual is for the game master to use, to first get sensitised to the goals of playing the game, to then give the instructions to the players and later be supported when confirming given answers.
The manual stresses the importance to consider these answers as suggestions arther than absolute truth. This is to leave some freedom to the game master in his/her facilitation.

Manual manufacturing

The instructions are laser cut with the machine at the IOMe on both side of a plywood sheet of the same shape of the cards, only larger. The suggested answers are also laser cut on a separate similar piece of plywood.



CHANUA

Instructions for the game master

THE GAME

CHANUA is a board game to talk about Science, Engineering, Technology and Mathematics (STEM) on the island of Lamu, in Kenya. It is a fun game mirroring real life situations with the purpose of engaging the young girls of the island in STEM education. The manifestation of STEM in Lamu is becoming more and more important which makes these disciplines relevant for the younger generations.
The game is built on questions encouraging the players to look at their environment with a critical eye and a scientific mindset. The game was specifically designed for young girls of Lamu but can also be played by boys.

The core principles of the game are the following. The players should feel encouraged to participate actively. The players should be curious about the questions and feel confident to give their answers. It is a collective activity where knowledge, curiosity and confidence are built up gradually.

THE STORY *(to read to the players)*

You wake up at home and have to get ready for school. On your way to school, you observe what is going on in Lamu. You see trees, people selling things in shops, donkeys carrying merchandises. You wonder, how much stuff can you actually carry on a donkey? You stop to play with your friends and buy fried potatoes. You wonder, how can we use science to explain the cooking of potatoes?

There is a lot happening and you wonder why these things happen the way they happen. Sometimes you encounter problems and you need to solve them. You want to learn as much as possible but you cannot be late for school!

THE GAME ELEMENTS *(needed to play the game)*

The game comes in a box that is closed using the board. The box contains the board features (house, school, baobab, well and shop), cards, a die and throwing pot, some pawns (cat, dhow, sandal and octopus), this manual and a sheet with suggested answers.
The cards are divided in 3 categories: circle, triangle and square. The meaning of these categories is explained under "THE RULES".
The board has features (objects) that must be fit in one of the slots (rectangular or circular) on the board. The players should install these features.

THE GAME MASTER

The game master does not play but will facilitate the game. Your role is to first introduce the game and help setting everything up. You then guide the players through the game and make sure the rules are followed. You also keep track of the time for every question.

Some tips for the game master:

- Before starting to play, ask the players to recognise the shapes on the board and the features.
- Read all the instructions to the players except the ones about "THE GAME MASTER".
- Make sure the core principles of the game are respected (section "THE GAME") so the goals of playing the game are achieved.
- If a team does not understand a question, you can explain it in Kiswahili.
- Avoid giving examples when you explain the question to the players if the question is about giving examples.

  Example: "There are different plants growing around the path to school. Draw five different plants." - do not give examples of plants before the players start working out the question
- There is another wooden sheet with suggested answers in the box. They should not be taken as absolute truth, but are a guideline for you.

CHANUA

Suggested answers

FOREWORD

Here are suggested answers to the questions of the game. They should not be seen as absolute truth but rather a guide for the game master to keep the spirit of the game.
Some questions can have different answers. Only one answer is expected to win one point and keep the card.
For the open-ended questions, a few answers are suggested and are separated by a "/".

CIRCLE CARDS

1. measure the area of the room / make a prototype / etc
2. learners should draw a well with a rope and a pulley
3. horsepower is a measure of the speed so the 200 horsepower boat
4. sharp
5. 3 donkeys; the weight can be distributed differently
6. a cylinder and a beam / a stick to hang the bag over your shoulder / etc
7. making Excel spreadsheets; the learners can draw an example
8. using Word document and sending it by email
9. an Excel spreadsheet / writing it somewhere on your phone / etc
10. the peel disintegrates on the ground and becomes compost
11. everyone breathe the same air, mainly composed of nitrogen and oxygen
12. not throwing trash on the floor / participate in waste collection activities / etc
13. can start from the height of people playing skipping rope
14. build boats like Flip Flop1 / make art / make coasters / etc
15. make a water filter so filter out the salt / collect water when it evaporates (gas state) and condense it again (the salt remains in solid state) / etc
16. learners are free to draw what they know

TRIANGLE CARDS

1. gravity
2. reflection of light
3. friction
4. photosynthesis
5. tides
6. using the equation for distance, speed and time so the speed is 2m/s
7. balance / weights / comparison with something you know the weight of / etc
8. lemon / orange / some candies / etc
9. the water will freeze and switch to solid state
10. gas state
11. heat transfer
12. using pushing force
13. 180 stones
14. sound waves
15. gases are able to expand
16. 115 beads

SQUARE CARDS

1. pave streets / pave grounds for buildings and houses / etc
2. to fight plastic pollution in the nature / give a second life to plastics / avoid making new plastic when we already have a lot / etc
3. Woman Representative and plane pilot
4. Nobel Peace prize
5. because the machine uses a laser to cut through the wood and the laser is so hot that it burns the wood
6. plywood (thin piece of wood)
7. the surface is rough, not smooth because the machine prints objects layer by layer
8. plastic
9. it is not so easy because plastic is quite rigid and strong
10. hard wood, Mvule from Congo
11. the CNC machine makes things in 3 dimensions (3D)
12. 13, 14, 15, 16. the game master should facilitate a discussion for each of these questions. These questions are for players to be critical of their situation as girls and to be confident when solving a problem (like being late for school or hearing they cannot become an engineer for instance).

Figure 49. Final design of manual of instructions and suggested answers

Figure 50. Final prototype made in Delft

5.4. The bigger picture

To conclude with this chapter, the following pages situate the game in the environment where it is used, regarding the location where it is played and its implementation in practice.

Different ways to play the game

The design of the box, with the board serving as the lid, offers two different ways of playing the game, as explaiend below.

On even, higher grounds

If the game is played on an even, high ground such as a table, the board should be removed from the box and placed flat on the table. That way, the board can be seen by all players. This is typically the case if the game is played in class, as part of the lesson.

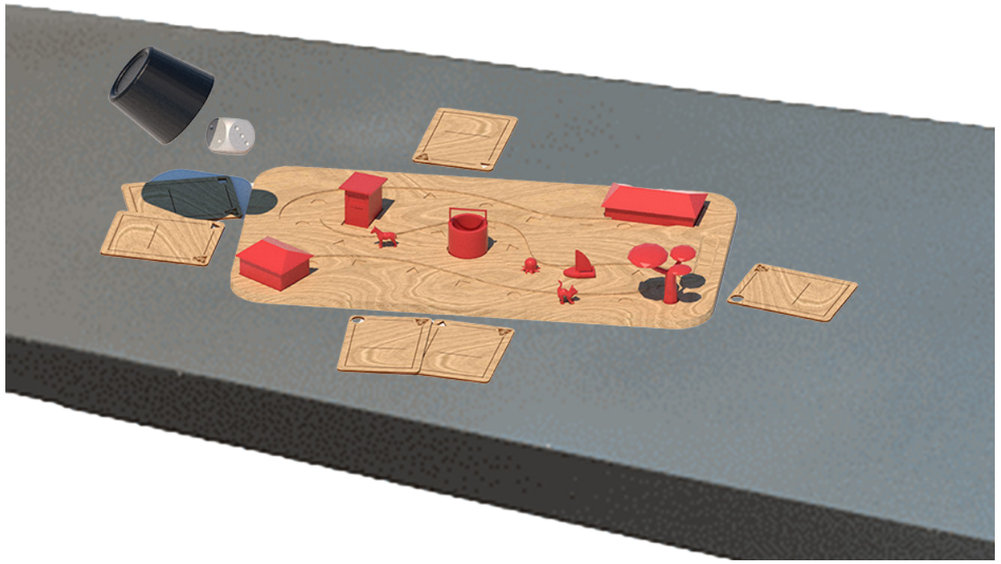


Figure 51. Game on a table, played without the box

On uneven, lower grounds

If the game is played on an uneven, low ground such as the muddy or sandy ground of the school, the board can be kept on the box. The box therefore serves as a support to elevate the board and allows more comfort when playing. It also prevents too much dirt coming on the board. This is typically the case if the game is played outside class, during the break or after hours as part of Amani club activities (see next page).

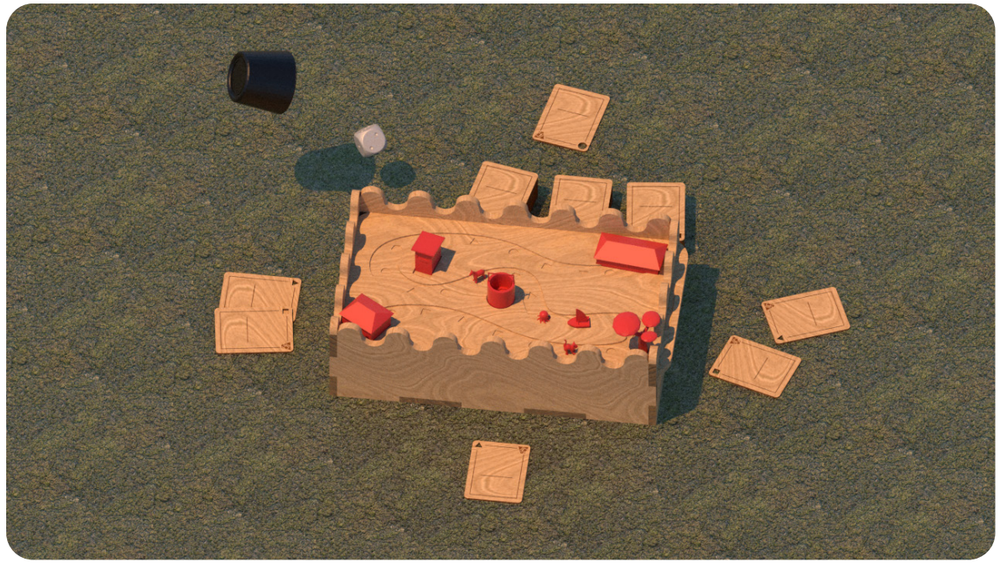


Figure 52. Game on grass, played using the box as support

Practical implementation of the game

The design and making of the game

The game was co-designed by the IOMe facilitators and the researcher of this project. As explained in the previous section of this chapter, it was designed to be producible at the IOMe, using the available resources. Eventually, a game set is made by the facilitators and/or students of the IOMe.

The implementation of the game

Implementing the game, i.e. bringing it to the children involves the participation of other stakeholders. The IOMe, as being a Kenya Red Cross Society initiative, will involve the KRCS volunteers to bring the game to Lamu. Currently, these volunteers intervene in schools to run sensitisation campaigns on severeal topics. The IOMe wants to go beyond these campaigns and involve these volunteers in the introduction of advanced STEM education. Besides, the teachers and head teachers are also an important stakeholder as they are the contact person for bringing the game to schools. They are eager to use the game as teaching support in their *Science and technology* class. Therefore, the game can be played by the girls as part of a class, or after class if the school program does not allow it (or not possible with the teacher). After class, Amani clubs, which were set up by the KRCS to conduct extra-curricular activities for the children, are ran. The girls can also play then.

The future of this design intervention

The long-term viability of this intervention was thought with some teachers of the involved schools during a co-design and feedback session. The children for whom the game sparked interest and enthusiasm could attend a trip to the IOMe and see the machines and production for themselves. They could even get a project to do during the time they are at the lab, such as make new cards by first designing the question and then producing the card.

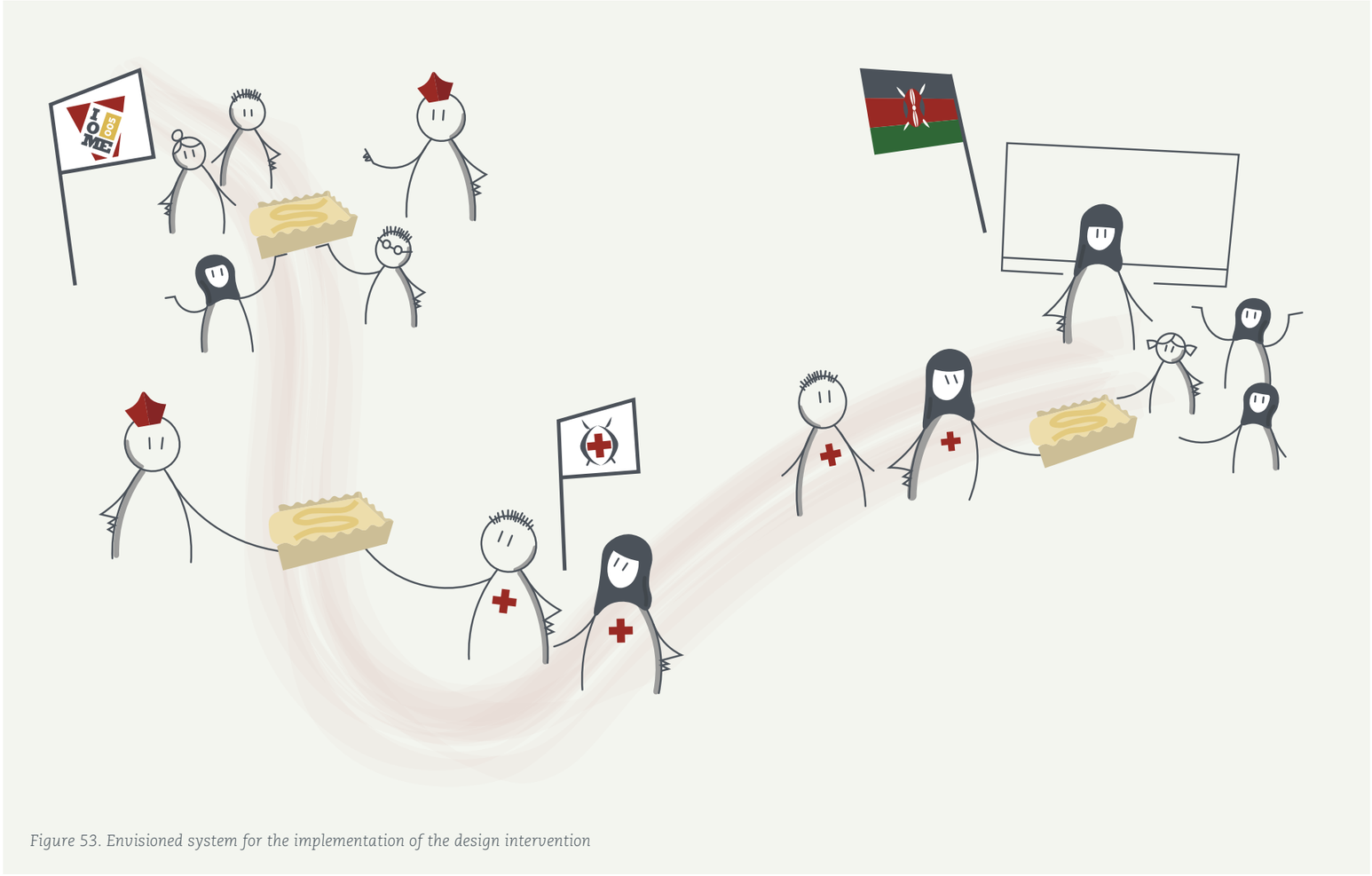


Figure 53. Envisioned system for the implementation of the design intervention

Chapter takeaways

A final user test was conducted with a group of girls which indicated areas for improvements and opportunities to develop the final design.

TA.1

This final design was imagined such as to trigger the desired interactions and dynamics, by designing the mechanics accordingly.

TA.2

It consists of a board carved with a path on which players move their pawn after rolling a die. It also comes with questions written on cards, which players must answer to eventually win the game.

TA.3

These components are designed to be made with the different production techniques available at the IOMe to bring their expertise forward and show tangible end-products to the target users.

TA.4

The client is enthusiastic by this aspect of the design as it is the first example of such a product.

++

The importance of the game master to support the achievement of the transfer effects was found to be crucial.

TA.5

The game master should be considered as a separate type of user of the game to ensure the facilitation of the game is designed according to their needs.

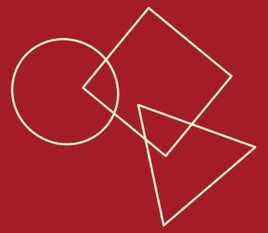
R.1

The iterations leading to this final design are explained in Chapter 7. The next chapter will present the preliminary evaluation of the performance of this final prototype against the design requirements as defined in Chapter 4.

Chapter 6

GAME EVALUATION

The final game prototype as detailed in the previous chapter was tested and evaluated with regards to the achievements of the design requirements. This chapter presents the preliminary assessment of the performance of this suggested design. First, the evaluation of each requirement is reviewed and supported by quotes and photos. Secondly, the quality of the final design is concluded, and recommendations and bottlenecks are highlighted.



6.1. Evaluation of each requirement

First, the achievement (or not) of each design requirement as defined in Chapter 4 is reviewed and supported by photos and quotes.

As explained in Chapter 4, the game is evaluated through the feasibility, desirability and viability criteria which were translated into eight tangible design requirements, as recalled by Table 3.
The two feasibility requirements (1 & 2) and last two desirability (5 & 6) were assessed throughout the making process whereby the design was iteratively re-adjusted to meet the requirements. They were confirmed with stakeholder feedback. The first two desirability (3 & 4) requirements, as well as the two viability requirements (7 & 8)were evaluated from the final user test insights. The quotes mainly come from the game master (KRCS volunteer) and observer (IOMe student).

FEASIBILITY

1. Made using locally available resources — *Is the game designed to be made with local materials and production techniques?*
2. Easily transportable — *Is the game designed to be easily transportable and carriable by one person?*

DESIRABILITY

3. Triggers the desired interactions — *Does the game spark curiosity, encouragement, collaboration and constructivity?*
5. Fits the context — *Is the game suitable for the given context and does it meet the needs of the target users?*
4. Is fun to play — *Are the girls engaged and enthusiastic when playing the game?*
6. Fits the client's vision — *Does the game promote problem-solving and critical thinking?*

VIABILITY

7. Realises transfer effects — *Does the game spark an interest in STEM amongst the girls? Do they feel confident when playing?*
8. Transfers design intervention — *Is the intention of the game transfered to the client? And to anyone involved in the implementation?*

Table 3. Design requirements as defined in Chapter 4

Feasibility

1. Can the game be made with local materials and production techniques?

YES.

The game components were designed to be produced using different machines available at the IOMe: CNC machine, laser cutting machine and 3D printer, as shown in Figure 54 which presents the tested prototype. The client found the game ideal as the first example of end-product showcasing the expertise of the maker space.
All components are either made with plastic filament which the maker space always has at hand or plywood and hard wood which can be bought in nearby stores.

> *"The game came in handy. We have not integrated all the techno of the lab in one product. I really liked the idea because you integrated."* - IOMe facilitator

2. Is the game easily transportable over land and sea, and carriable by one person?

YES.

The game has multiple loose parts (pawns, board features, die, throwing pot, cards) so a box was designed to store and transport everything without loosing pieces, as shown in Figure 55. Moreover, the board was designed to serve as lid to close the box off. This minimises the amount of material needed to make the game and allows to have a compact design. That makes a product that can be carried by one person and transported on any land vehicle (car or boda boda) and on boat to reach the island.

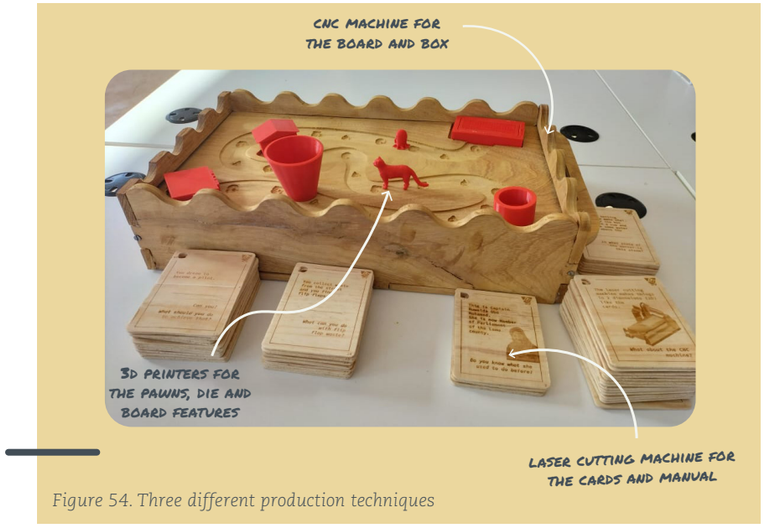


Figure 54. Three different production techniques

Figure 55. Compact box design to store and transport the game set

Desirability

3. Does the game spark curiosity, collaboration, encouragement and constructivity amongst players?

Yes, the game sparks curiosity

The physical appearance of the game already sparks the curiosity of any children around.

"Before starting to play the game, almost the whole school went crowding us. All the girls were curious." - the game master

Besides, the questions discussing things the girls are not usually exposed to get them intrigued.

"When discovering the questions about the lab machines, the girls were really excited, maybe asking "what is this machine?". *The girls were curious to know more about the machines."* - the observer

Yes, the game induces teamwork

Besides, the mechanics of dividing players in teams, timing answers and counting points create competition which reinforces teamwork.

"no one was giving the answer before discussing with their teammates" - the game master

"very good teamwork spirit"- the observer

Yes, the game triggers encouragement

These mechanics and dynamics make the girls consert each other and encourage one another to share their thoughts during the working out time. Besides, the mechanics of keeping the card as a point allows the players to have a tangible recognition of their effort and success. It encourages them to keep on trying.

"they gave the opportunity to everyone to give their answer" - the observer

Figure 56. Pictures showing how the desired interactions took place during the final user test

Yes, the interactions with the game happen in a constructive way

This game is designed to be a roll-and-move game where players repeat a basic user flow (as described on page 50). This gives the chance to users to try again if they fail the first time. It allows them to gradually construct their knowledge, which they can immediately apply during the game, and build their confidence. Besides, as the game is long enough for a round to be played in several times, the players might reflect on their learning experience before playing again.

Figure 57. Interaction Vision picture

4. Are the girls engaged and enthusiast when playing the game?

YES.

The game is designed to balance the fun and serious factors, with the seriousness being hidden in the fun. The players enjoy throwing the die which triggers the enthusiasm to keep on playing. Furthermore, when players start to get familiar with the game, they might start to build a preference for a certain card category to pick which makes them wish to throw a certain number, which, in turn, enhances the excitement and fun.

> *"Even the two new girls were active from the beginning of the session. They participated actively in the discussions."* - the game master

According to the participants of the final user test, the game is *"very fun!"* and it makes them feel *"happy"* or *"excited"*.

5. Does the game promote problem-solving and critical thinking? (client's vision)

YES.

The client vision was used as a guideline to develop the concept of the game whereby players must answer questions around STEM to keep on moving and potentiall win the game. These questions are designed to trigger problem-solving approaches, as well as critical thinking mindset.

> *"The game rhymes with everything we are doing at the lab. It entails some learning, some fun."* - IOMe facilitator

"it has created critical thinking" - Grade 6 teacher

Figure 58. Top: pictures showing girls engaged and having fun
Bottom: examples of questions and components relevant for the users

6. Is the game suitable for the given context and does it meet the needs of the target users?

YES, THE DESIGN MIRRORS THE LOCAL CONTEXT

The game was designed to be narrated through the storyline of Lamu and what children see and find on their way to school. These were found through research there. The game world is therefore presented to mirror the users' real world which is illustrated by the board and its features, the pawns and the questions formulated through a story.

YES, THE CONTENT IS APPROPRIATE TO THE CONTEXT

Besides, the questions from the square category aim to trigger a discussion amongst the players such that they question the status quo themselves. These questions are about the stereotypes, biases and other factors tending to push girls away (as explained in the litearture review). Despite the critical aspect of discussing such topics in the context of study, the several stakeholders accept and appreciate it.

> *"there should be more cards like these* [square cards]" - Grade 6 teacher

THE LEVEL OF CHALLENGE IS IN GENERAL SUITED FOR THE USERS BUT SHOULD BE REVIEWED

Finally perception of difficulty is varied amongst players, showing differences in academic levels. As it is essential to keep some challenge, the overall difficulty level is deemed appropriate however a teacher should review all the cards to remove any unnecessary extra difficulty.

> *"some questions were hard but most of them were good"* - Grade 6 teacher

Viability

7. Does the game spark an interest in STEM amongst the girls? Do they feel confident when playing?

Yes, the game sparks an interest overall

In general, the game content sparks an interest in STEM amongst users as it presents the related topics in a new form compared to what they are used to at school.

> *"They acquired information about something. They will remember when encountering the same situations."* - the observer

But the long-term knowledge transfer cannot be confirmed

First of all, the acquirement of knowledge highly depends on the academic level of the individual learner. This was observed during the final user test. When asking the girls what they learnt, answers were varied.

- Some understood the goal of the game: *"I learnt that girls can also be great scientists or great engineers because they learn the same subject"* and *"also girls can be engineers"*.
- Some could point out specific things they learnt: *"tides can also make the water high and low"* and *"materials of making dice and the cards"*.
- Others kept their answer broad: *"very many interesting things"* or could only comment on the fun aspect of the game: *"how to play the game"* and *"the game is funny"*.

This data shows that there can be knowledge transfer on the short-term.

Secondly and most importantly, the long-term effects of this design intervention on knowledge transfer are hardly assessable within the timeframe of the project. To evaluate that, questionnaires assessing knoweldge acquisition by the game could be given to the same participants after a certain time.

Yes, in general girls can play with confidence

Firstly, the questions mirror the users' real world but belong to the game world. There is therefore no consequence for giving a wrong answer in the real world. This contributes in boosting the girls' self-confidence when directly engaging with the game (game world), and indirectly with STEM (real world).

> *"Some of them were shy to give the answer but the majority of them were confident."* - the observer

Besides, the repeated exposure to the game might contribute to building their confidence in the long-run.
Finally, the square questions aim to trigger serious discussions on the current stigmas about girls in STEM. Supported by the game master, this is to provide a safe space of the girls to question the status quo and adopt a more positive view on it. This should also contribute to the confidence construction.
The discussion below happened between the user test participants and the game master. The participants all answered that "of course I can" study STEM on the questionnaire given after playing the game.

> *"I asked them:* "what do boys learn at school? and what do you? Why are boys becoming engineers and not you?".
> *They asked:* "Is it possible for us to become great engineer?"
> [the game master showed them *"great women"*]
> *and they agreed that they can also become engineers"*
> - the game master

8. Is the intention of the game transfered to the client? And to anyone involved in the implementation?

Yes and no.

The game was designed to be facilitated by an adult (typically a volunteer of the KRCS) whose role is to ensure the rules are respected, the intention for playing the game is understood and the design goal is achieved. However, to do so, the game master must understand all of the above well to be able to transfer it to the players. During field research, it happened once that the volunteer who was in charge of the facilitation did not understand the game values. This resulted in the game not being played as it should with the transfer effects not being achieved because the game master would not support it.

> *"girls learn home science, they learn how to cook"* - KRCS volunteer

Finally, the long-term viability of this design intervention also depends on its acceptance by the teachers of the schools the game is brought to. The teachers who were involved in the iterative process of this project all expressed the wish to get a sample of the game and use it as teaching support.

> *"it could be very good if I can use in some of my lessons"* - Grade 6 teacher

6.2. Conclusion and discussion

The evaluation of each design requirement in the tested prototype have highlighted qualities of the suggested design, as well as recommendations to improve it and bottlenecks.

Qualities

Nearly all design requirements are satisfied by the final game design. It can be concluded that the game reduces the gap between the girls and STEM. First of all, a single game set can be made in the local context, with the client's range of facilities and resources. The product is a game which is not commonly encountered amongst educational resources in Kenyan schools. This results in triggering a natural curiosity from the girls, and a desire to engage with it. Hence, the first interest layer is activated. The game encourages active cooperation between players because of the group setting. This, together with the facilitation by an adult and the recognition of players' effort by winning cards as points encourage the girls to keep on playing. This encouragement comes from the mechanics of the game, as well as from the game master and fellow players. Besides, the game was designed with a basic user flow to be repeated until the game is over which supports the construction of knowledge and confidence. With features and pawns to place and move, the game is designed in a whimsical manner. One round (basic user flow) is quick to complete which altogether makes the game fun to play. When creating the final concept, the cultural and religious context was given careful consideration. With its recognizable components, typical events and scenarios, the game world is a replica of Lamu. Even though some of the questions are still regarded as challenging by the players and teachers, a local teacher who assessed the language and content for appropriateness approved them. Finally, the game fulfills the client's goal of fostering innovative teaching and learning methods.

Recommendations

The assessment of the desired interactions was done by analysing qualitative data which is subject to the researcher's own interpretation. These could be better assessed with metrics or official approaches.

The issue regarding difficult questions was raised by the participants to ther user test as well as the testing team and teachers. It is advised to go over the cards once more with a local teacher to see whether the language and sentence structure needs to be adjusted. However, as mentioned earlier, the game should not become too easy and dull to avoid erasing the *serious* from the serious game.

Transfer effects have a long-term dimension. The project goal of sparking the interest of the users in STEM is meant to be achieved on the long run. The same applies to the other design goal of boosting the girls' self-confidence. The timeframe of this project therefore limits the evaluation of the achievements of the transfer effects. In order to assess them, it is recommended to expose the same group of users to the game over an extended period of time and regularly monitor the progress of some parameters. This can be done by providing the same Likert-type scale questionnaire with statements regarding the transfer effects (similarly to the questionnaire for the user test, available in Appendix G).

Bottlenecks

The successful long-term transfer of the goals and intention behind this design intervention to any person involved in the future is still not ensured. Indeed, as it was observed during prototype testing, not all volunteers grasp the objectives of the game. Only the facilitators, innovators and volunteers involved in the design process of this project could very well transfer them.
A manual of instructions outlining the product's values was created as part of the training for new game masters to help mediate that. Additionally, the facilitators who co-designed the game will also train them. Even with these precautions, it is likely that after a few generations of volunteers, the design intervention's fundamental principles will be been forgotten.

Finally, it is crucial to take into consideration the implications that such a design intervention may have on the wider sociocultural circles and the community at large. The project's scope was narrowed to solely include girls as the game's intended users, leaving out other potentially important parties like the girls' parents. However, the acceptance of higher authority figures who are in charge of these users also plays a role in whether the transfer effects are successfully realised.

Chapter takeaways

The final user test insights, stakeholder's and client's feedback, as well as the outcome and experience of the co-design process allowed to make a preliminary evaluation of the performance of the final design presented in Chapter 5.

TA.1

The feasibility of producing one game set in the local context is confirmed.

TA.2

There is a desire from the end users to interact with the game as it fits their context and matches their needs. It also introduced a play environment that the girls enjoy and feel comfortable in.

TA.3

This fun element is well balanced with the serious purpose of learning and discussing serious issues related to the users. This is done by encouraging them to adopt progressive approaches fitting the client's vision.

TA.4

Despite the recommendations and bottlenceks, this preliminary assessment allowed to conclude that this design intervention reduces the gap between the young girls of Lamu and STEM education.

TA.5

The participants of the final user test asked if they could have a sample of the game to play during their break.

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To confirm the realisation of the transfer effects, a regular exposure of the users to the game together with a systematic feedback collection is recommended.

R.1

Besides, the issue of question difficulty should be reviewed with a local teacher.

R.2

The first bottleneck is found in the transfer of this design intervention on the long-term. Indeed, the core values and intention behind the game might be lost which would make the objectives of playing the game dull.

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Secondly, the largest obstacle to achieving the design goal is the refusal to self-empowerement from the high-authority figures above the end users which is out of scope for this project.

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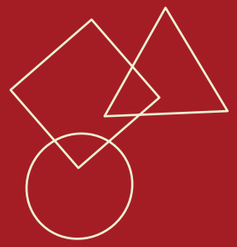
Now that the performance of the final design has been assessed, the next chapter will go back in the chronology of the project to illustrate the decisions that led to selecting this concept as final concept.

Chapter 7

CONCEPT SELECTION



The final product is the result of many design iteration phases. This chapter focuses on the initial phase which entailed conceptualising, prototyping and testing three different ideas for the game, during field research in Lamu. Their strengths, weaknesses and opportunities for further development translated from the user test insights are then analysed. Finally, a comparison on the achievement of the design requirements is done to reveal the decision for choosing the concept which led to develop CHANUA.

7.1. 3 prototypes for 3 concepts

First, the three initial concepts developed into prototypes and tested during field research are presented to later compare them and select one.

Concept 1 - *Role model memory game*

The concept

This concept is a revisited version of the card memory game. Instead of similar cards to pair, players must pair one female role model from Kenya or African origin with the school subjects she is good at because of her profession. For instance, the game features Captain Ruweida, a woman from the Lamu county who became pilot when this profession was reserved for men. She is to be matched with mathematics, a subject pilots need to be good at.
The concept as generated with the canvas tool is presented in Appendix F.

The prototype

The prototype, as shown in Figure 59, to test this concept was made as part of the first ideation phase in Delft. It served as generative material for the field research. It consists of four pairs of matching cards made form recycled cardboard. Half have a printed photo of a role model and the other half have a picture representing their professional occupation.

The user test

The test was conducted at Wiyoni Primary, a mixed school. Three girls and four boys from Grade 5 and 6 participated as it can be seen in Figure 60. The testing was facilitated by a KRCS volunteer and the researcher of the project observed. At the end, the facilitator reflected with the children on the things they liked, they disliked and they learnt. The test lasted for 30 minutes.
All the insights from the user test are in Appendix F.

Figure 59. Prototype of the 'Role model' memory game concept

Figure 60. Children of Wiyoni Primary testing the memory game

Concept 2 - *Fixing your dhow*

The concept

The game is a board game with the storyline of fixing your own dhow, the traditional boat from Lamu. The game is a roll-and-move where the path is “through the ocean”. Players play in teams, roll the die, move their pawn and pick the card corresponding to the shape they land on. The cards are categorised in three groups: technology boost (triangle), technology obstacle (circle), technology inspiration (square). Players read the card they pick out loud and move their pawn as indicated by the card. By playing the game, the players get to understand the potential of STEM knowledge and skills for their everyday life. The cards also tackle the factors pushing girls away from STEM (see page 22).

The prototype

The prototype to test this concept was made as part of the first ideation phase in Delft and is displayed in Figure 61. It served as generative material for the field research. It consists of a board made out of recycled cardboard with a printed illustration of the game world. It comes with a die, pawns and cards with different shapes according to their respective category.

The user test

The test was conducted at Wiyoni Primary, a mixed school. The same three girls and four boys from Grade 5 and 6 as for the test of the momory game participated. The testing was facilitated by a KRCS volunteer and the researcher of the project observed. At the end, the facilitator reflected with the children on the things they liked, they disliked and they learnt. The test lasted for 30 minutes.

Figure 61. Prototype of the ‘Fixing your dhow’ board game concept

Figure 62. Children of Wiyoni Primary testing the board game

Concept 3 - *On your way to school*

The concept

This concept is a board game with a game world mirroring the users' real world; the context of Lamu. The game is a roll-and-move where the path is "the way to school" through which players encounter challenges. These challenges are formulated as questions, written on cards and divided in three different categories recognisable by a shape (circle, triangle and square). They are formulated with a short storyline reflecting something from Lamu with the aim to make the players look at their environment with a critical and scientific mindset. The players play in teams, throw the die, move their pawn and pick a card from the deck with the corresponding shape. They must answer the question within a time limit and get a point if they answer correctly. The game ends when a team finishes on the path.

The prototype

The prototype to test this concept was made in Lamu and is shown in Figure 63. Initially, it was planned to use the lab facilities to make part of this prototype but a two day-long powercut made it impossible to use the machines or even printers. Only the pawns could be 3D printed. The rest was drawn and written by hand. The same die was used.

The user test

The test was conducted at Wiyoni Primary with six girls from Grade 5 and 6. The testing was facilitated by a KRCS volunteer and the researcher of the project observed. At the end, the facilitator reflected with the children on the things they liked, they disliked and they learnt. The test lasted for a bit more than 30 minutes.

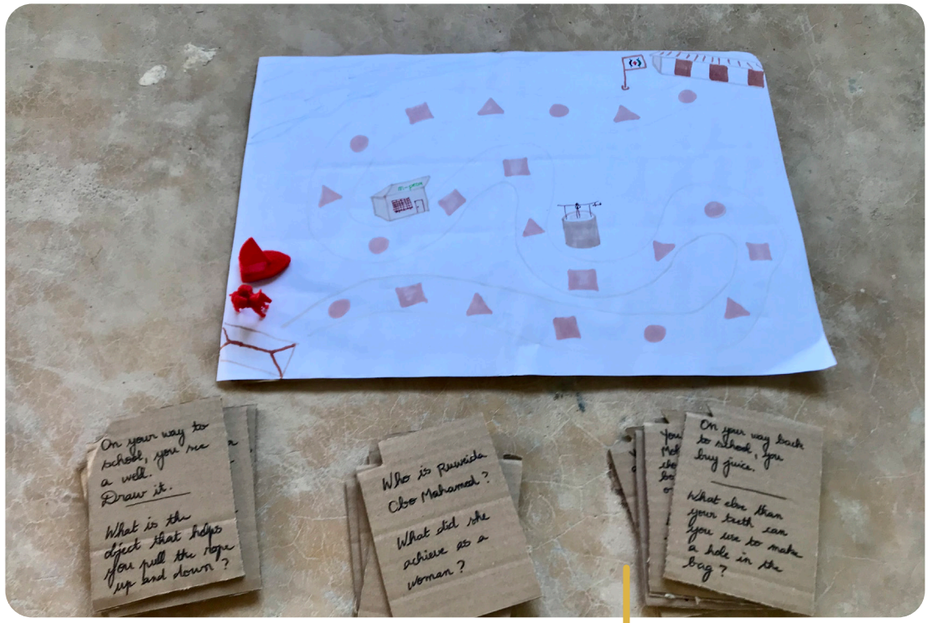


Figure 63. Prototype of the 'On my way to school' board game concept

Figure 64. Girls of Wiyoni Primary testing the board game

7.2. Selection of 1 concept

Now that the three prototypes are explained, their strengths, weaknesses and opportunities are analysed. Secondly, the achievements of the design requirements for each concept are analysed through Harris profiles which helps conclude on the selection of Concept 3.

Strengths, Weaknesses and Opportunities analysis

The complete analysis is available for each of the tree concepts in Appendix F.

The game setting

All the concepts involve teamwork which is appreciated by all children. For all sessions, a local volunteer was facilitating the game which made it easy for translation if needed.

The game concept

The players had most difficulty playing with the first prototype. The general memory card game is not familiar to people from Lamu and designing such a game increases the threshold to reach the learning content. The other two games have the same starting game mechanic to the widely played game Ludo which made it easy for the children to understand the rules, and therefore reach the objectives of the game. Besides, the die is a good metaphor for the struggle in life and brings the fun element. Reading the cards suits the target users. In general, it was observed that the mechanics of Concept 3 better allow the realisation of the the transfer effects.

The game world

Concept 1 was not designed with a game world. The only narrative aspect is about the role models' stories which are real stories. Concepts 2 and 3 were designed for the players to immerse in a game world which mirrors some aspects of Lamu. The storyline about dhows (Concept 2) is not relatable enough by the children in comparison to the way to school (Concept 3§) which is more familiar.

The fun aspect

Overall, the participants to the several user tests had much fun with the games and found them moderately easy. The difference in fun could be made by observing the engagement of the kids with each of the prototypes. Concept 2 and Concept 3 triggered more enthusiasm and engagement. Moreover, the players were more focused with the content of the game with Concept 3. Indeed, the questions bring the balance between serious and fun which is lacking in Concept 2 where the children are more focused on throwing the die than reading the cards.

The serious apsect

All concepts aim to make the players acquire some knowledge, together with other transfer effects. This is best done with Concept 1 and Concept 3. Concept 1 allows the children to acquire knowledge they do not discuss in a normal school setting while Concept 3 stimulates the players to think critically and solve problems. Concept 2 has a shallow STEM content and does not stimulate the players on the cognitive level.

The game vision

The game vision is best perceived with Concept 3 but is still not fully acquired.

Opportunities for development

The development of Concept 1 is limited to creating more cards and possibly finding ways to make these modular so that the game can be played in different ways. The storyline is not strong and the topic is limited to role models, limiting the realisation of multiple transfer effects.

The first main limitation for developing Concept 2 comes from the game world which does not fit the target users. Imagining a new storyline would be needed to make it more relevant. Secondly, the learning experience is shallow due to the fact that the children read statements on cards and are not encouraged to actively think about these. This learning aspect also needs to be revised. Both recommendations would fundamentally change the game concept.

Finally, Concept 3 offers a good balance between fun and serious. The game world is broad enough to offer the possibility to make a lot of questions. These should be carefully reviewed to better fit the language the girls are used to. There are a few practical ideas to make the game more complete such as designing a scoring system.

Harris profiles

The strengths, weaknesses and opportunities of each three concepts have been listed and discussed. In parralel, the Harris profiles were made to evaluate the performance of each of the concept against the design requirements (as defined in Chapter 4).

These requirements are listed in order of importance (the higher in the table, the more important). However, this does not mean that they vary much in importance. This importance label should also be understood by considering the easiness for meeting the requirement. For instance, using locally available resources and making it easily transportable are rather easy requirements to meet compared to realising the transfer effects. The transfer of the design intervention is rather difficult to meet as it involves communication with several parties, on a timeframe outside of the project. Fitting the client's vision is deemed easier. Besides, being a fun game to play and triggering the desired interactions are closely as important as each other, and are in turn ranked shortly after the requirement on fitting the context.

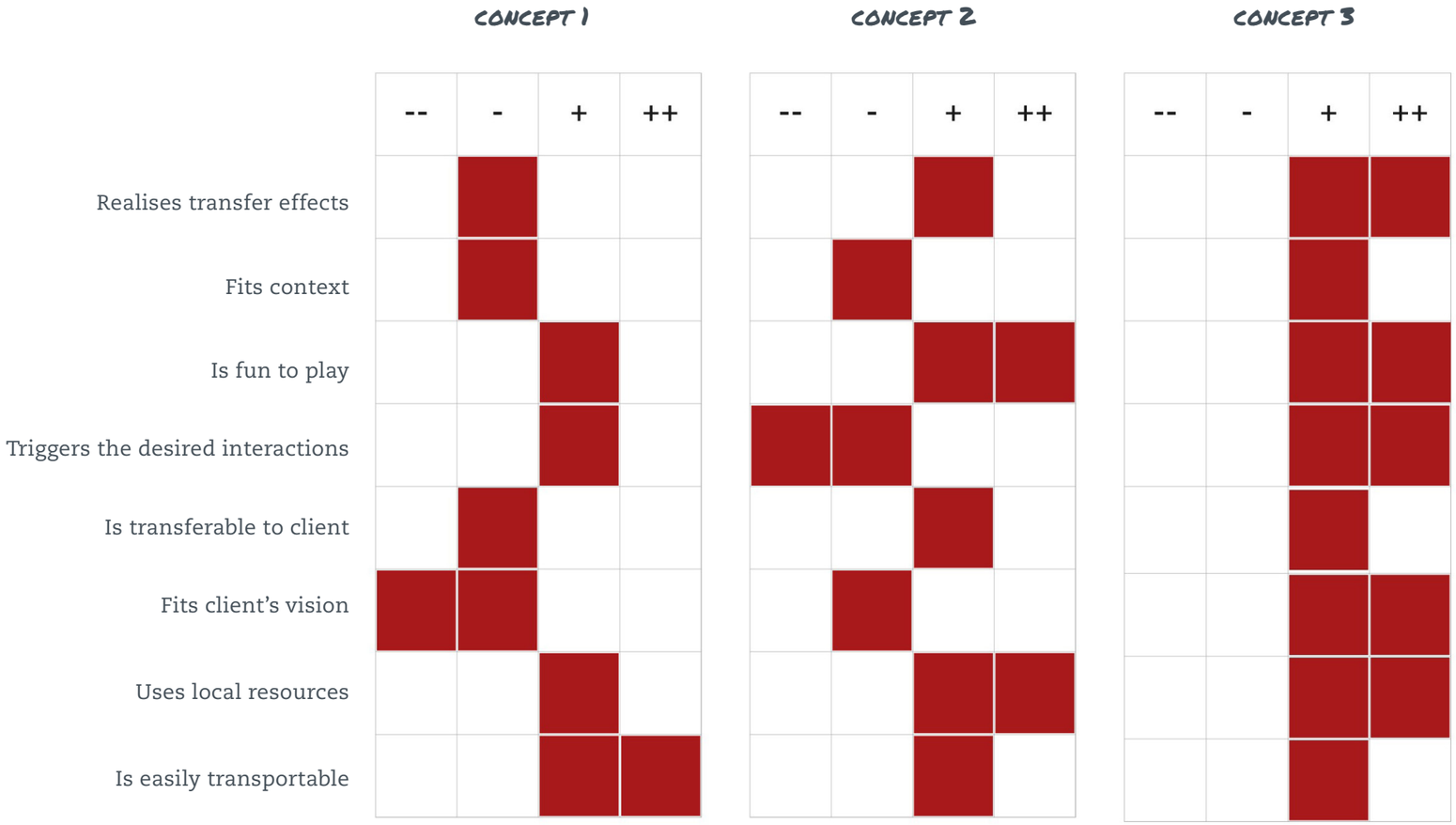


Figure 65. Harris profiles comparing the three concepts against the design requirements

Harris profile analysis

Made using locally available resources

All concepts allow to make the corresponding games using locally available resources. However, the more elaborated physical complexity of Concepts 2 and 3 allow to use the different production techniques available at the IOMe. This gives the advantage to show tangible end-products made at the lab and expand their exposure.

Easily transportable

The easiest to transport is the memory game because it does not involve many pieces and the cards are rather small. Concepts 2 and 3 would require a box to store and transport all the loose pieces. However, the current designs allow one person to carry everything herself.

Triggers the desired interactions

Concept 2 hardly triggers curiosity as the fun element shadows the learning goals. Encouragement and collaboration do not find a place either because players do not have to actively think and act. In contrast, Concept 1 triggers some curiosity and collaboration (players must memorise the cards as a team) but does not offer space for constructiveness. Concept 3 stimulates the curiosity of players as they must actively participate, which in turn makes the players work in teams, encourage each other to build up their knowledge ane confidence. Ultimately, receiving a point for a correct answer aims to encourage players to keep on playing.

Is fun to play

Children had fun in playing all the games but Concepts 2 and 3 do trigger more engagement and enthusiasm amongst players.

Fits context

The game structure of Concept 1 does not fit the playing habits of the target users. Moreover, only focussing on female role models might be too controversial and not accepted by the local social sphere. The storyline of Concept 2 is not so relevant to the users' real world which might impede the immersion of the players in the game. In comparison, the game world of Concept 3, as well as the learning content matches well with the users' reality and needs.

Fits client's vision

The IOMe's vision of promoting problem-solving and critical thinking approaches in STEM education is not met with Concept 1 nor Concept 2. Only Concept 3 stimulates players to reason about STEM problems and adopt the desired mindset.

Realises transfer effects

The effect of changing mentalities can be realised through Concept 1 which aims at inspiring the users. It can better be realised through both Concepts 2 and 3 which directly tackle stereotypes and other factors explaining the current stigmas. Boosting self-confidence is best achieved by Concept 3 which stimulates the girls to actively participate in order to build that confidence. Finally, all concepts are designed for the players to acquire knowledge. However, by practicing that knowledge, Concept 3 scores best in that.

Transferable to client

The client expressed their preference for Concepts 2 and 3 which makes both these concepts better transferable and ownable by the client.

Selection of Concept 3

The first analysis shows that Concept 3 presents more strengths and offers more relevant opportunities for development than the other two concepts. Besides, this concept also scores best in terms of meeting the design requirements, according to the Harris profiles. Therefore, *On my way to school* was selected to be the concept to further develop into a final design.

NB: *On my way to school* became *CHANUA*.

Follow-up iterations

After selecting Concept 3, the co-design process with the IOMe started. New and better prototypes were made using the IOMe facilities. A last user test was conducted before the end of the field trip and the teachers and volunteers were also consulted by means of a co-creation and feedback session, respectively. The iterations on the concept then continued at a distance when back to Delft in order to arrive to the final prototype as presented in Chapter 5.

Appendix I illustrates the prototypes developed during this in-between phase. The decisions for designing the components of the game are explained with the outcomes of the user tests, interviews and sessions with relevant stakeholders.

Chapter takeaways

The game concept as presented in Chapter 5 was selected amongst two other concepts after prototyping and testing the three on the field. It was chosen because it had the best fun to serious balance, offered most opportunities for further development and best met the design requirements.

TA.1

The final prototype from Chapter 5 was shaped from the feedback and observations collected in numerous research and design activities with end users and secondary stakeholders.

TA.2

Besides, this final prototype is the result of an iterative co-design process with the IOMe facilitators which started in Lamu at the maker space and ended at a distance between Lamu and Delft.

TA.3

The distance made it difficult to collaborate at some points and the IOMe facilitator suggested the researcher would come for a longer period of time so ideas can be strongly built before leaving.

R.1

This chapter marks the end of the explanation of this project. The impact of the proposed design will now be discussed while highlighting certain limitations of the project and suggesting recommendations for future work.

Chapter 8

PROJECT WRAP-UP

The game performance evaluation led to suggesting a final design for CHANUA. Besides, a toolkit was made as final product for the canvas. This chapter will now discuss the impact of these two final designs on the end users, secondary stakeholders and client. Conclusions on the feasibility, desirability and viability of the game are also drawn which results in addressing the limitations of this project. Besides, recommendations for future work are presented which should consolidate the suggested designs. Finally, a personal reflection from the author is shared.

8.1. Discussion and conclusion

To conclude this report, the achievement of the design goal and the impact on the end users and other stakeholders are first discussed. Besides, the feasibility, desirability and viability of CHANUA are reviewed and the limitations of the project are considered.

Impact of the proposed designs

The project started with the intention of the IOMe to develop toolkits to bring innovation and STEM education to the rural areas of Lamu. However, it was found that such an intervention could have the negative impact of marginalising half of the children as boys and girls have different needs towards STEM and education. The assignment for this project was therefore scoped to design a game which sparks the interest and boosts the self-confidence of the young girls of Lamu when engaging with STEM education. Additionally, the method for developing such games was elaborated to be used by the IOMe innovators and documented for the client.
The outcomes of the several user tests have shown that CHANUA is well designed to not only meet the end user's needs but also contribute to amplifying the client's exposure to the community and empower secondary stakeholders. The game fits well in the context and it brings innovation with a new energy to the rural schools of Lamu. The final design of both the game and the canvas create the following value propositions for the users of the game, of the canvas, and for other stakeholders.

For the young girls of Lamu (and their teachers)

This game provides a fun and meaningful experience while bridging the gap between the young girls of Lamu and STEM education. The playful nature of this design intervention creates positive interactions which, in turn, produces a good experience on which the girls can fall back when they face stigmas, stereotypes or biases. CHANUA can break the monotony of traditional classes which lack modern resources and tend to be very theoretical. This is very well received by the teachers who see the potential of CHANUA to enhance the children's learning experience.

For the community

The impacts on the young girls from being exposed to CHANUA will show on the long-run. This will contribute to the local women's empowerment which will strengthen not only the female community resilience but the whole community resilience in general.

For the KRCS volunteers

This design intervention is an opportunity for the volunteers of the KRCS to be involved in different activities that they are used to (usually sensitisation campaigns and food distributions). It allows them to expand their horizons and enlarge the impact they can have on their community, which they find very important. Besides, the game master was found to be a user of the game on her own as this role is essential to ensure the game is played in the right intention. Giving this role to a volunteer is an opportunity for personal development and self-empowerment.

For the IOMe innovators

The innovators of the IOMe who were involved in the co-creation process got to collaborate with international people, learn new ways of thinking and doing. Besides, this design intervention gives the opportunity to participate in a multi-disciplinary project where the different expertise of the lab must be combined. Furthermore, these innovators often seek to start their own project. By leaving the canvas to the IOMe, a method to develop games is available to guide and encourage new ideas for games. This was particularly appreciated by the IOMe facilitators who saw a lot of potential for their students.

For the IOMe facilitators

This project was a meaningful experience to learn and improve collaboration with international parties for both the researcher of this project and the IOMe facilitators. CHANUA is the first example of serious game made at the IOMe, using the different production machines. This has shown that it is possible to manufacture a product combining different materials and techniques which, in turn, increasing the exposure of the IOMe in the process. Together with the support of the canvas toolkit, it will allow the IOMe to further develop other games to serve other purposes, "especially on humanitarian issues" (-IOMe facilitator), i.e. for the good of the surrounding communities.
Finally, the IOMe has been focused on bringing innovation to any children and using toolkits only, until now. CHANUA has provided the opportunity for the client to take on an even more social justice role.

Discussion on the feasibility, desirability and viability of the game

Feasibility

The feasibility requirements were proved to be met with the proposed design. One game set is produced using materials which can be purchased in the area and machines which are available at the maker space. Furthermore, the box design allows to store and transport all the game components together. One game set is carriable by one adult. However, the board and box are quite large which makes it difficult for a girl (end user) to carry it herself. The design could be made smaller but it should be noted that there will be a lot of girls around one board as the classes in Kenya have 50 pupils on average. Therefore, the board should not be too small, otherwise it will be hardly visible for some players.

Besides, the implementation of the game still needs to be allowed by the Ministry of Education who must approve any material used in schools before they get to the class rooms. This responsibility is left to the KRCS.

Desirability

The desirability to play the game by the girls was evaluated by looking at whether the desired interactions take place when playing. These could be observed during the final user test; the girls were curious and were actively and collectively participating in working out the questions. Moreover, they were encouraging each other by giving space for everyone to participate with their teams. Besides, the roll-and-move type of game is constructive in that it repeats a basic user flow which allows players to improve at every new round. Nonetheless, it was also noticed that sometimes the girls did not dare to give their answer right away. The game setting might still be impressive and the reassurance that there is no risk for giving a wrong answer in the real world should be emphasised.

The fun nature of the product also makes the players engaged and enthusiastic to participate which supports the realisation of the transfer effects. The users relate to the game world portrayed through the several components. It mirrors the users' real world that is Lamu with its iconic items, scenes, social dynamics, etc. The game was also deemed appropriate to the social norms and beliefs of the context while allowing to tackle the current stigmas against girls in STEM. However, this intention of challenging the status quo is not always understood by adults, whether it is by the volunteers as potential game masters or by the teachers of the girls. This is further discussed under Viability.

Finally, CHANUA is designed to promote progressive ways of working out problems which fit the client's vision. Besides, the facilitator who co-created the game took his own initiatives in the process which showed that the client felt the ownership.

Viability

Chapter 6 concluded on the difficulty to confirm the realisation of the transfer effects as these have an impact on the long-term. The cards are designed to reinforce or build the knowledge of the players, however it cannot be concluded whether this knowledge is kept on the long-run. Regarding confidence boost, it was observed during the final user test that the girls did get confident that they could pursue their studies in STEM after a discussion they had with the game master, after picking one of the square cards. Even though nothing can be confirmed within the time span of this project, a repeated exposure to CHANUA will definitely positively shape the mentalities for these girls.

Finally, the transfer of the design intervention still remains a bottleneck. This comes from both the game master who should understand the objectives of the game and the secondary stakeholders like the teachers who receive the design intervention. The wrong perception of the game intention was observed during field research with both volunteers and teachers who found the cards not to be "specific to girls" enough. However, this is the whole point of the game; i.e. to encourage the girls to look away from the current patterns. The risk here is to fall back to the current situation whereby girls are sensitised to "what they should be sensitised", i.e. female-oriented activities and tasks. Besides, the game master should feel the ownership over the facilitation of the game. But too much ownership might lead the game master to change the rules of the game (as it happened during the final user test). This can be good when these changes make the players more engaged like matching the rules with cultural habits and behaviours. However, it can also be detrimental to the realisation of transfer effects.

Limitations of the project

A reflection session with the lead of the IOMe team and the two facilitators was organised to reflect on the co-creation process and collaboration between Lamu and Delft. This session allowed to confirm some hypotheses on the culture differences and point out some limitations of the project.

Duration of the field research

Due to financial constraint, only one trip to Lamu was possible which occured at the beginning of the project, so focused on the research and initial prototyping phases. Ideally, another trip would have been organised to test and evaluate the final design by the researcher. Moreover, this final design was tested once only due to this physical distance. To confirm these findings, at least one other user test should be carried out. Besides, the 5-week long stay in Lamu was found too short by the facilitators. The following iteration phases were then conducted at a distance which was not optimal.

Conducting research with Kenyans

Although the research was fruitful, it was also constrained by the culture differences, particularly by the Kenyan tendency to strive for perfection. When they are unsure if what they are saying is accurate or pertinent, Kenyans frequently hesitate to speak up. There is no space for failure, at school, as well as outside, in the daily life. During the volunteers feedback session, one volunteer explained how he would end an activity to make kids explore STEM topics: “I would pick the perfect answer and explain why it is so [to other kids]”. The intention of an activity to let kids explore with no judgement and no wrong answers clashes with the Kenyan culture, which was also somewhat when testing the canvas.

In general, Kenyans do not share their opinion or feedback if they believe it is negative. This behavioural tendency is supported by the cultural dimensions which suggest that Kenyans prefer indirect rather than direct negative feedback (Meyer, 2016). These cultural traits have affected the veracity of answers and comments obtained from the research and design activities, especially when asking for personal opinions. And this behaviour was enhanced because of and can be explained by the fact that the participants in question were communicating with a “mzungu”, a White person.

Conducting research with the Lamu community

Lamu is a rather close community where the vast majority of people who live on the island are originally from the island. People are therefore used to engage with each other and tend to be cautious when interacting with mzungus. The locals difficutly open to a foreigner, even more when the physical appearance is very different and the contact period is very short. This behaviour can also be explained with the cultural dimensions that illustrate the Kenyan trust culture as relationship-based. This means the Kenyans tend to share things on a deep level to be able to trust one another. To remedy the trust issue, a local was always accompagnying the activities at schools and the facilitation of sessions was done by this local person to put the participants more at ease. However, this trust gap was still experienced.

Impact of the design intervention

Finally, the exposure to the game is too short to ensure the realisation of the transfer effects. And it is definitely too short to change mentalities. Hence, the game should be seen as an ice breaker, a sensitisation tool. Furthermore, the project focused on girls as users of the game but in reality, there are other important stakeholders to consider in the equation. This is discussed in the next page.

8.2. Recommendations

In response to the previously listed discussion points and limitations of the project, recommendations to improve the end products and the process are suggested.

A reflection session with the lead of the IOMe team and the two facilitators was organised to reflect on the co-creation process and collaboration between Lamu and Delft. This session allowed to confirm some hypotheses on the culture differences and point out some limitations of the project.

Include parents in the stakeholders map

Girls are a part of a wider social structure and, because they are minors, are responsible to a higher authority figure (their parents or legal guardians). The design intervention may be successful with the intended audience, but what if this higher authority rejects it? The scope did not include these authorities as a stakeholder or target group due to time constraints but in order to ensure impact is being made, future work on this project will need to take the parents into consideration.

Keep on including the teachers as stakeholders

The teachers took part in the research and design activities of this project and their opinions were taken into account. This recommendation is addressed to the IOMe to keep on including the teachers in the development of such tools so they get their acceptance which is crucial for the long-term viability of the initiative. According to a teacher from Mahmoud Bin Fadhil Boys, “if it’s only about the volunteers, the project will be a failure”.

Consider the game master as a user of the game

As discussed throughout the report, the understanding of the rules and objectives by the game master is essential for these to be transferred to the players, and ultimately realise the transfer effects. It is therefore recommended to regard the game master as a type of user of the game and carry out follow-up research to better understand the needs and values of this target group. This will improve the way the game is transferred to these users (right now, only by the manual of instructions and the training by the facilitators who co-designed the game). Besides, the research should also define ways to ensure the game master feels the ownership over the facilitation to enhance the playing and learning experience of the children.

Use videos to transfer the intended use of the products

Videos are an effective way to communicate a vision via the use of visuals. Furthermore, it was observed that the majority of people in Lamu have a phone, especially the youth. They like to watch videos and be on social media. Videos therefore fit well in the culture. It is recommended to make a video to explain the intention behind playing the game and another one to illustrate the use of the canvas.

Evaluate the performance of the canvas

As was done for the game, the performance of the canvas with regards to feasibility, desirability and viability should be assessed. This was not possible due to limited time.

Make some changes to the game

Certain practical aspects of the game can still be improved. First, the box can be made with plywood to make it lighter, thus easier to carry. Secondly, compartments should be designed to constraint the components that are stored in the box. This would also allow to ensure all the components are stored after playing to avoid loosing any piece. Thirdly, the questions should be reviewed by a teacher one more time to verify the right level of difficulty of the language and content. Moreover, it is highly suggested to design more square cards as these convey the messages of the game and were well accepted by all parties. Finally, the importance of the reflection moment after playing the game should be stressed to make sure the game master facilitates this moment.

Consolidate the implementation of the game

As mentioned in Chapter 5, the implementation of the game involves different stakeholders which creates a system around this design intervention. This recommendation is specifically for the IOMe to confirm the acceptance of the teachers and use the enthusiastic momentum to introduce the tool, and even, welcome learners to the IOMe.

Suggestion to the IOMe for the next game

Boys are marginalised from this design initiative although they suffer from a lot of pressure from the society to provide for their family and community. As we start empowering girls and women, we leave out the other half for which these initiatives might have indirect negative impact. Similar comments were collected from a few men about the fact that a lot is being done for girls nowadays and not for boys. They find it unfair as they feel the pressure to bring food on the table and do not have the space for them to get empowered as well. Therefore, the IOMe could develop a game like CHANUA which focuses on empowering the young boys of Lamu.

8.3. Personal reflection

To wrap up this report, a personal reflection from the author is shared, in the form of a letter to future self.

Dear future me,

I would like to address this reflection to the future Emma for her to remember and take away the highlights of this beautiful journey. I never thought graduation would be so surprising, fun, meaningful and challenging. Before commenting on these four aspects, I would like to share a few introduction words. Well, first, of course this project helped me grow so much just by the fact that I had to research and design for and with another culture. It was for sure an extra challenge, compared to projects conducted in the Netherlands solely, but a challenge I knew I absolutely wanted to take on for my final year project. It encompassed everything I wanted in a thesis: designing with and for children as well as diving into game design while immersing myself in a new and exotic context. Throughout the project, I logged weekly reflections and daily thoughts during my stay in Lamu, on my own as well as with Dorrit. I am very grateful I had her by my side to share the fun and overwhelming moments. At night, we would sit on the terrace with the breeze cooling us down after a very busy and warm day. We would reflect on our learnings, laugh from funny situations we encountered but also just get to know each other even more. When I was organising my reflections, I had a hard time choosing what I would find most important or interesting to share. In my eyes, every little moments of this project were meaningful and helped me grow, not only as a designer but as an individual human being. Amongst others, the future Emma should remember the following most surprising, funny, meaningful and challenging moments.

The most surprising moment was actually the process to find a name for the game. After suggesting a few names during field research, it was clear that we wanted to find a short name, preferably in Kiswahili, that resonates both with the client and the users. Not so easy actually! The girls suggested "Magic journey" during the user test which I was not really fond of because it sounded too childlish and undermined the seriousness. I suggested "Udadisi" which literally translates to "Curiosity". Two of the three facilitators hesitated about it but eventually found it ok. But when I consulted the facilitator who is orginally from Lamu, he told me that "Udadisi" also has a negative connotation about people stealing stuff. What a surprise! I found it very interesting that only when I asked the local person I would get the full story. Perhaps, this connotation is tight to the Lamu culture particularly. I am not sure actually... After brainstorming together, he came up with "Chanua" which we adopted for the game and whose meaning I tried my best to explain on the second page of this report. This process was surprisingly tough as I was realising more and more the importance as well of the criticality of finding a name that fits well. But it also made me realise even more how language is a building block of a culture and that if you truly want to understand someone from another background, learning the language is the best way to do so.

The funniest moments were definitely when interacting with the locals of Lamu. I specifically appreciated the Kenyan culture of "hakuna haraka" (no rush) which you should adopt if you want to adapt. As Lamu is a small town, saying hello and taking the time to chat to anyone you know passing by in the street is fundamental to building relationships. I was once busy with my thoughts and did not see one of the teachers I was working with walking past me. The next day he asked me "why didn't you say hi to me??" and I had to apologise for not paying attention. I thought it was funny because I thought that so far, I was doing pretty great in acknowledging everyone in the street but apparently I was not!

One of the most meaningful lessons is the reflection I had on my own working process. When I was processing the data from the first three research sessions in Lamu, I realised that strictly following an analysis method is not necessarily essential. The process, inspired from methods and previous experience in this kind of design exercise, comes naturally. I became confident in trusting my own intuition when it comes to following a design process that I make myself. And this is even more relevant when conducting research on the field, in an environment where time is not perceived the same as in your own culture.

Finally, the most challenging thing was the communication with the client when I got back to Delft. My messages would be left unanswered and calls would not be returned. It was difficult to organise my time and not feel stressed that I will not meet the milestones. The most challenging moment was when the deadline to have the final prototype ready for the final user test was getting closer and closer and I was not receiving any news from the IOMe. The facilitator I was collaborating with later told me that it was a lot of pressure on him and that some things were missing for him to produce the game. However, he never shared these difficulties with me. I could have helped him but instead I could only feel bad that he was experiencing this pressure. I wish we would have had more regular communication to avoid this kind of situation that was unnecessarily stressful for both parties.

Voilà, this is the end of this journey. I hope that this letter will help you, future Emma, to remember as vividly as possible these beautiful and constructive moments.

Hakuna matata,

Emma

Chapter takeaways

The impact of the design interventiom through CHANUA is such that the young girls of Lamu get a positive experience which might help them face stigmas in the future.

TA.1

However, the larger social system around these users should be considered by including their parents to make the impacts of this intervention even more meaningful.

R.1

The game and the canvas also allow to empower other stakeholders like the KRCS volunteers and the IOMe innovators.

TA.2

While the volunteers should be considered as a target group on their own, subsequent research should be conducted to better adapt the tools left for them to use or facilitate to their needs.

R.2

The game was well received by the client as being the first game they ever designed as well as the first end-product made with different materials using the different machines of the lab. Besides, the canvas is also the first brainstorming tool developed specifically for the IOMe which supports the need of the students to create meaningful solutions for their community.

TA.3

Future work should focus on finding an effective and viable way to transfer the intentions behind playing the game and using the canvas.

R.3

Finally, this project faced a few limitations which brings to consider the game as a sensitisation tool, a trigger to start challenging the gender-related mentalities in Lamu.

TA.4

Other recommendations are suggested in this chapter for follow-up research.

R.4

This is the end of the core of this report. The list of references is provided in the next pages and appendices are attached with in-depth learnings from this project and tips and tricks for collaboration with the IOMe.

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