PROJECT HANDOVER
A GAME SCRIPT

ZWOLLE, 17 DECEMBER 2020
WINDESHEIM HONOURS COLLEGE
GLOBAL PROJECT & CHANGE MANAGEMENT
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S.O.I.L.

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1 INTRODUCTION

1.1 THE PROJECT

This project has been carried out between September and December 2020, and was provided by Laurie van Reemst and Pieter Temminck. They were the clients to a project group consisting of four Windesheim Honours College students, and have been supervising and working with the project team. As 'Global Project and Change Management' students, managing a project focussed on change, is part of the curriculum of their 2nd year of the study. Wageningen University Research (represented by Laurie van Reemst) and Zone.college (represented by Pieter Temminck) are working together on this project of the NUFFIC (a Dutch organisation for internationalisation in education) in Uganda. The goal of the project is to develop an agricultural curriculum for vocational training in Uganda. Soil and sustainability are two important topics in this curriculum and a soil game is an example/opportunity to share knowledge in a more practical way. This project is the start of the development of a soil game that contributes to reaching that goal. The clients will therefore continuously lead this project.

1.2 THE PROBLEM STATEMENT

The problem this project tries to tackle is that there is often a lack of knowledge about soil fertility amongst people, also amongst farmers in Uganda (Pincus et al., 2017, p. 433). This gap in knowledge results in unawareness of how to preserve or build soil quality, which results in the degradation of soils. This can lead to farmers not reaching the full potential of their land and the yields of their crops, leading to less food and less income. Therefore, lack of knowledge about healthy soil, is relating to the issue of hunger, water pollution and unemployment. The key challenge and therefore the base of this project, is hence increasing the crucial knowledge about healthy soil and the management of soil, in order to help farmers in Uganda to reach their full potential (Stewart et al., 2019, p. 634).

1.3 THE PROJECT GROUP

The project group and the authors of this document – the game script – consists of the following four members who are all 2nd year students at Windesheim Honours College of the study Global Project & Change Management: Daan Bakker, Myrthe de Rooy, Eva Härter and Marit Oomens.

1.4 CLIENTS AND STAKEHOLDERS

CLIENTS

Laurie van Reemst (MSc) works for Wageningen Environmental Research and is a PhD candidate at Wageningen University. She lives in Kampala, Uganda since almost 5 years. Her expertise lays in plant production systems and soil fertility.

Pieter Temmink is a lecturer at Zone.college Twello in the Netherlands. Zone.college has a focus on healthy living, safe food, sustainability, nature and a green living environment. Pieter has very close connections to Windesheim Honours College and worked with students a lot in the past.

STAKEHOLDERS

Clovis Kabaseke (MSc) is a lecturer and researcher in the School of Agriculture and Environmental Sciences at Mountains of the Moon University in Fort Portal, Uganda. He is a PhD candidate of Agroecology and Food Systems. He is the main contact person in Uganda for this project.

Cibap is a vocational college for the creative arts in Zwolle. They focus on creativity, entrepreneurship and technical fields. The contact persons for this project are Jos Tomassen and Jeanette Bazuin.

038Games is an organization that provides internships to students on the topic of game development. Windesheim and Cibap worked together to set up 038Games. The contact person for this project is Teun Lucassen.

UGANDAN EDUCATIONAL STAKEHOLDERS

Mountains of the Moon University, Fort Portal

IABC (Innovative Institute for Agriculture, Business and Capacity Building)

Muni University, Arua

DUTCH EDUCATIONAL STAKEHOLDERS

Wageningen University & Research

Zone College is a vocational institute and the team GWO (Green World Orientation) is specialized in vocational training and soil management. Their experience and knowledge can be supportive for the development of the soil game.

2 IMPORTANT DETAILS OF THE GAME

2.1 PURPOSE OF THE GAME

The purpose of the game is to share knowledge and raise awareness about the importance of soils for sustainable food production and food security.

2.2 USER PROFILE OF TYPICAL PLAYER

The user profile gives an idea of a possible player of the soil game. Eventually, this game has the goal to be assessable to many more people, also outside of the project. The current scope of the project focusses on the curriculum for vocational training in Uganda. Therefore, the user profile will describe an example of a typical vocational student in Uganda as detailed as possible. The data used to back these assumptions up are displayed in the appendix 2.

Sabo is 19 years old. He finished his primary school and is now enrolled in secondary education program. He goes to a government aided vocational institution. When he is not studying, he works in a motorcycle garage. When he is at home with his family, he helps his dad (who is a taxi driver) on their land. His dad taught him a traditional way of farming. He wants to play this game because he wants to farm more efficiently.

This is an example of a user. It is also possible that someone who is a lot older than Sabo or from a different background is going to play the game.

2.3 PROFILE OF UGANDA

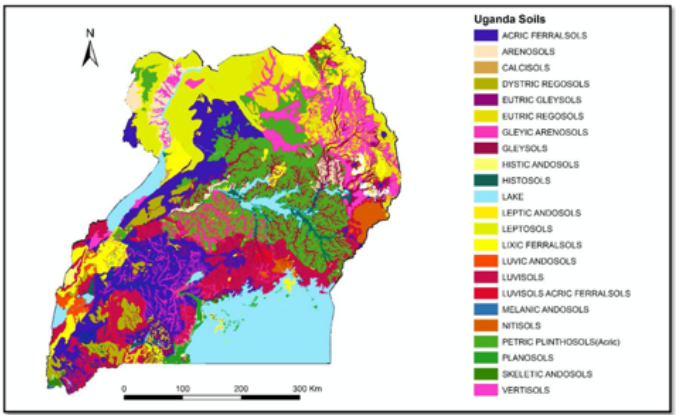
GEOGRAPHICALY

Uganda is a landlocked country located in East Africa. Uganda is 241,550km2 big. 15% of this surface are open waters and wetlands, the other 85% of the country is land. Uganda is divided into four regions: lowlands, plateaus, highlands, and mountains ranging between 900 and 2,200m above sea level (Minai, 2005).

SOIL

Uganda has deep, red or brown, loam or clay loam, pediment soils and volcanic ash soils (Kaizzi, 2020). These have also been depicted in figure 1 (Minai, 2005).

Figure 1 – Soils of Uganda



Source: Minai, 2005

CLIMATE

Uganda has a warm tropical climate, with average temperatures ranging from 25 to 32° C in central Uganda, while ranging from 4 to 25° C in the highlands (Minai, 2005). The hottest months are December to February. Uganda has two rain seasons, one between March and May, and the other between September and November.

TYPICAL CROPS

The most common crops grown in Uganda include the following crops (listed in order of importance): maize, finger millet, sorghum, rice, pearl millet and wheat (Kaizzi, 2020).

Figure 2 – Picture of Maize

Source: Unknown, 2020

WHAT PROBLEMS CAN OCCUR?

Uganda's soils were once considered the most fertile in Africa, but soil erosion and soil nutrient mining have led to soil degradation and declining agricultural productivity. This has increased poverty and food insecurity among Uganda's rural smallholder farmers. Lack of environmental awareness among farmers, traditional agricultural practices, minimal inorganic fertilizer use, and little to no use of improved crop varieties all contribute to continued soil degradation (Minai, 2005). More problems that contribute to soil degradation can be found in appendix 3.

2.4 TIMEFRAME AND SETTING OF USE

The estimated time it takes to play the game is approximately 7 hours. This includes all steps of the game; the introduction, the start quiz, the actual game, the end simulation and the end quiz. Players will be able to choose between a basic and an advanced level. The advanced level will take longer to complete, because this level is also focusses on investment reasons on top of the rest of the game. The approximated timeframe is exemplified in table 1 below.

Table 1 – Timeframe of the game

PART OF THE GAME	TIMEFRAME
Introduction	Approx. 30 min.
Start Quiz	Approx. 30 min.
Playing the Game	Under 5 hrs
End Simulation	Under 2 hrs
End Quiz	Approx. 30 min.

The game can be played in class. When playing the game in class, there is a better possibility to start discussions among the students, which can increase their learning. The students can also play the game at home if they have the required resources to do so. A computer is needed to play the game, internet is needed to download the game, but playing the game can be done offline.

2.5 OVERVIEW OF THE CONTENT

Main topic: How to keep soil healthy?

The numbers represent the dots on the different soil layers in the game. In figure 3, an overview of the content is provided.

Figure 3 – Overview of the content of the game

LAYERS IN THE GAME	CONTENT	EXTRA ELABORATION
1	1. What is soil? 2. What does soil consit of? 3. Think like a root (if you were a root, what would your ideal soil conditions look like?)	Mineral matter Organic matter Water Air Microorganisms
2	1. What is healthy soil? 2. Why is healthy soil important? 3. Soil ecosystem	Soil ecosystem
3	1. What problems can occur? 2. Natural problems 3. Manmade problems 4. Climate change	Natural problems Land degradation Contamination
4	1. How do we keepour soil healthy? 2. What are fertilizers? 3. Problem à play the 'bad' cards 4. Solutions à play the 'good' cards + ISFM (Integrated Soil Fertility Management)	
5	1. For the advanced level: investment reasons and further work-related aspects	

2.6 LEARNING OBJECTIVES

In table 2, the learning objectives of the game are presented. They are explaining what theoretical and practical competencies the player will learn during the game.

Table 2 – Learning objectives behind the game

LO	CONTEXT	LEARNING OUTCOMES
LO1	Layer 1 of the game - Mineral matter - Organic matter - Water - Air - Microorganisms	Understand what soil is, what it consists of and how you can manage to create optimal soil conditions LO1.1 Analyse and apply the theory to real life or simulation situations.
LO2	All layers of the game. Through playing the game, the players will understand the importance and factors surrounding soil fertility	Understand the factors behind soil fertility and the importance of such. LO2.1 Analyse and apply the theory to real life or simulation situations.
LO3	Layers 1-4/1-5 pose problem cards for the players.	Understand and solve problems with soil.

LO4	Layer 4 of the game	Understand and apply the theory behind fertilizers, to soil fertility management.
LO5	Layer 4 of the game	Understand Integrated Soil Fertility Management. LO5.1 Analyse and critically reflect on ISFM and assess why and how to manage it in real life.
LO6	Throughout the game and with the help of the problem cards, critical thinking will be stimulated on all topics of the game.	Analyse and critically assess issues which occur with soil regarding health, fertility, regional aspects, soil types, natural problems, etc. and generate insights on how to manage those issues more effectively.
LO7	The content about soil fertility and health will give the input, while especially the problem cards and try-out cards help deepen the understanding of such and trigger holistic thinking.	Understand and critically reflect on the complexity of soil health and the impact effective soil management can have.
LO8	Layer 5 of the fame focuses on all topics of investments, reasons for investments, long-term perspective farming etc. However, throughout layer 1-4, this long-term approach to farming. will also be part of the curriculum.	Understand and reflect on the importance to think and plan with a long-term perspective. LO8.1 Understand the implications of long-term thinking to the approach of soil fertility management. LO8.2 Understand and reflect on investments and implications of e.g., ISFM on working hours, produce, time, expenses, etc

3 DETAILED EXPLANATION OF THE GAME

3.1 THE VARIABLES

VARIABLES OF DESIGN

The variables of design – as shown in table 3 – outline how specific details or e.g., how specific pages in the game could look like. They are not aiming at presenting a complete guide for what the game must look like, but rather act as a suggestion. This suggestion is, however, at times also based on requirements the design must meet for the game to fit to Uganda (e.g., the colour of the soil).

Table 3 – Variables of the design of the game

VARIABLES	DESCRIPTION
The Soil	- Four or five different layers and shades - Colour: variations of red (the deeper into the earth, the darker)
The Plant	- Green stem and leaves (example plant: maize) - Can display different colours in case of e.g., drought or malnutrition - White roots
The Cards	- No specific colouring for knowledge, interactive and practical card Suggestion: make problem card e.g., red for it to stand out
The Playing Path	- Red line walks the player through the game - Red dots on the line indicate an action step Level 1: 2 dots Level 2 – 4: 3 dots Level 5: 1 dot

AGRICULTURAL INTERNAL VARIABLES

These variables are discussing more the agricultural side of the game content and present interlinkages of different aspects. While the deficiency issues with plants are exemplified in table 4, a guide to its symptoms can be seen in figure 4.

The leaves of the plant

- Green
- Needs to be able to display changes due to nutrient deficiency, diseases, etc.
- Size: The leaves will grow throughout the game. Issues with e.g., nutrition can result in the e.g., discolouring described above and therefore also in smaller growth

Nutrition

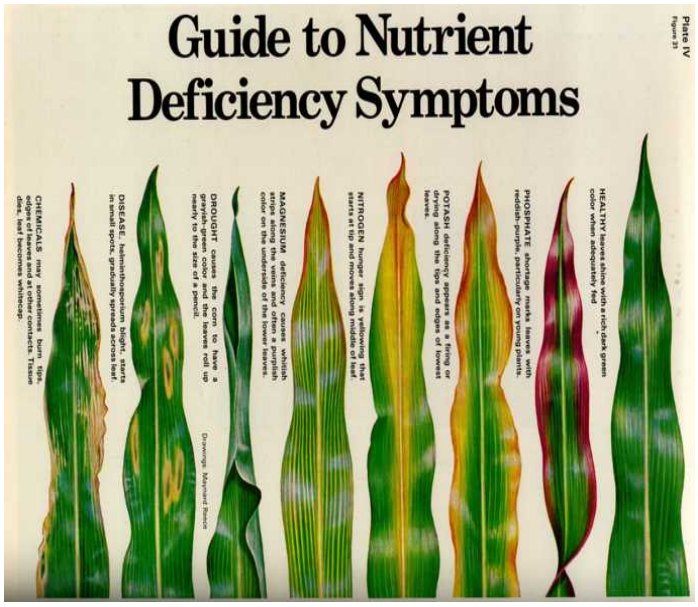
- Healthy plant: displays green leaves without spots, discolouring or breakage
- Nutrition deficiencies (table 4 is not aiming at completeness but is an example of important aspects):

Table 4 – Deficiency/nutrient issues with plants

DEFICIENCY/ ISSUES WITH	RESULTING IN
CHEMICALS	Burn tips and/or sides, tissue dies
DISEASE	Usually resulting in e.g., yellow spots spreading on the leaves
DROUGHT	Greyish-green colour and leaves role up
MAGNESIUM	Causes whitish stripes along the veins and often a purplish colour on the underside of the lowest leaves
NITROGEN	Yellowing starting from tip to middle of the leaf

POTASSIUM	Appears as a firing or drying along the tips and edges of lowest leaves
PHOSPHATE	Leaves display reddish-purple marks

Figure 4 – Guide to nutrient deficiency symptoms of plants



The above-described issues that can occur when it comes to plant nutrition are also displayed below and must also be made visible to the player of the game. Especially because the appearance of the plant will – in the end – also be a factor for the point system and for who will 'win' the game.

Crops

- Colour: depends on the type of plant (in the game: maize will be used as example)
- Size: the fruit of the plant will grow step by step, and when the student treats the plant right, a maize crop with a maize cob will be visible

Stem

- Colour: rather green, depending on the type of plant chosen for the game
- Size: will increase according to how far along the player is in the game

Roots

- As described in table 5

Table 5 – Description of optimal conditions

DESCRIPTION OF OPTIMAL CONDITIONS	
COLOUR	- white
SPACE	- Needs space to grow, will get thicker etc.
NUTRITION	- As described above, as well as water and air (balance is key!)
SOIL	- A biologically active soil > microorganisms - Healthy and abundant soil matter - A lot of soil layers as protection from e.g., the sun burning the roots
PH	- Optimal range for optimal growing circumstances
SURFACE	- Rocks, etc. and other soil and organic matter layers restricting the growth of roots downwards

AGRICULTURAL EXTERNAL VARIABLES

These external variables are usually causing the most issues since those concern e.g., land degradation, the way of farming etc. In the following table (table 6), as many of those factors are listed, as well as what effect they have on the soil and the plant itself.

Table 5 – Agricultural external variables

TYPE	EFFECT ON PLANT AND SOIL
LAND DEGRADATION	➢ Extreme Weather Conditions ➢ Climate Change (Manmade) - Suboptimal conditions for the soil and the plant - Plants dying - Soil fertility depleting drastically - Extreme form: desertification > nothing can grow there any longer - Costs: high expenses needed to combat land degradation
EROSION	- Soil fertility decreases - Plants dying ➢ Learning goals: - How can erosion destroy plants and soil fertility? - What are possible causes of erosion? - How can erosion be preventing as well as managed?
DROUGHT	Since Uganda experiences a lot of sun, with long hours of sun-light and extreme heat, farmers have to protect the soil as well as their crops sufficiently. ➢ Learning goals: - How can drought be prevented and managed? o E.g., planting of trees - What effect does the drying up of soil and crops have, looking at soil fertility and produce? - What other effects can drought have? - What practical steps can I take right now to prevent drought from affecting my crops?
HAIL	Hail is a very big problem in Uganda, which has a devastating effect on agriculture. ➢ Learning goals: - How can I protect my soils and plants? - When does hail occur? - Are there preventative steps I could take looking at long-term solutions?
WIND	Extreme weather, such as extreme wind or hail, can be very harmful for especially young, developing plants. ➢ Learning goals: - How can I protect my soils and plants? - What effect does wind actually have on my plants? - Are there preventative steps I could take looking at long-term solutions? o E.g., planting trees as natural barrier
	While water is life-giving and essential for the soil and crops, an out-of-balance amount, can be very harmful. → Too much (e.g., flooding) rotting roots, soil erosion, destroyed plants (washed ways or died etc.) → Too little (e.g., drought) drying up plants, eventually dying, drying up of the soil

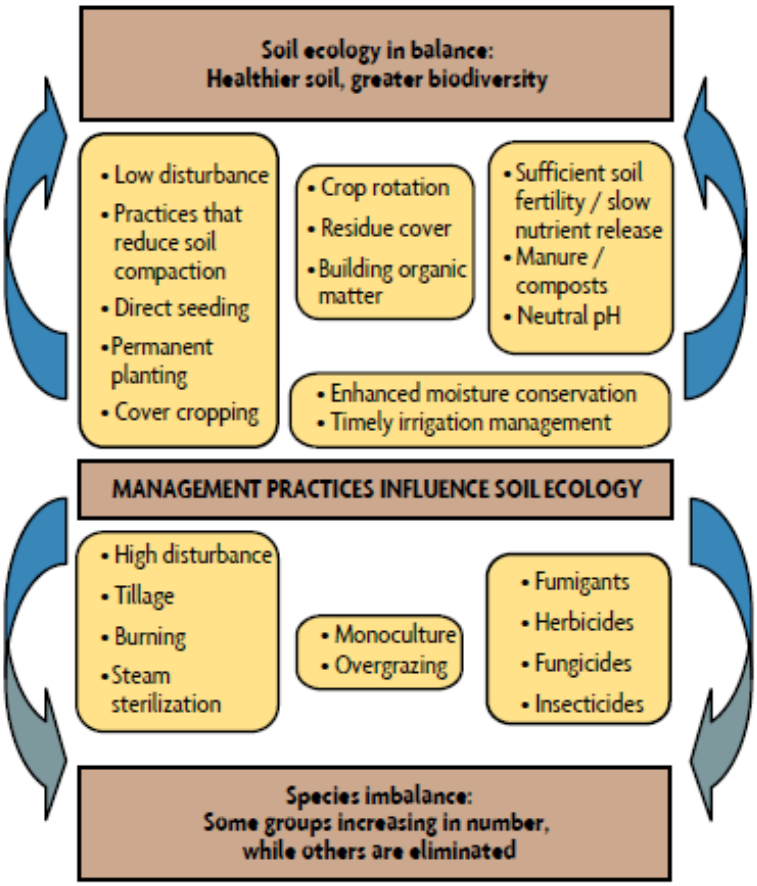
WATER	➢ Learning goals:
	- How can I protect my soils and plants?
	- What effect can water actually have on my plants?
	- Why water is still so crucial for plants and soils?
	- Are there preventative steps I could take looking at long-term solutions?
	  o E.g., planting trees as natural barrier
	  o Polyculture farming

FERTILIZER	As with sun and water, fertilizers are also best used in balance. Fertilizers are oftentimes very expensive and do not only have positive effects on soil fertility or amount of produce, looking at long-term focused farming. However, a mix of the right amount of both chemical and natural fertilizers are one possible, and good solution.
	
	➢ Learning goals:
	- What are fertilizers?
	- What is the difference between chemical and natural fertilizers?
	- What are the drawbacks and advantages of both types?
	- How and why would you combine both?
	  o Amounts of each?
	  o Effects of different mixtures?
	- What are the costs of both individually and mixed?
	- Why would you invest in fertilizers in the first place?
	- What are long-term effects, advantages and drawbacks of different types and mixtures?

SURROUNDING CROPS	Broken down very simply:
	- Monoculture leads to an increase in quantity regarding produce on the short-term
	- Polyculture cannot compete with that in the short-term, does, however, give a more sustainable and healthier option, resulting especially on the long-term in a more abundant produce
	- Polyculture increases soil fertility, microorganisms, organic matter, etc.
	
	➢ Learning goals:
	- What are these different types of approaches to farming?
	- What are the drawbacks and advantages of both types?
	- Why would you choose for the sustainable option – polyculture – looking at time, labor costs, investments, etc.
	- How does polyculture work?
	  o What impact does it have on both plants and soils?
	  o Can it prevent e.g., natural disasters from affecting my crops to some extend?
	- What effect does it have on the environment?

CLIMATE CHANGE	This is the cause of a lot of natural disasters affecting agriculture. It can result in land degradation, global warming, etc.
	
	➢ Learning goals:
	- What is it and why does it influence farming?
	- What can I contribute to fighting climate change?
	- Are there steps I can take to help prevent it of getting worse through my own actions?
	  o E.g., investing in planting trees (to prevent e.g., erosion, drought etc.)
	  o E.g., changing to polyculture to maintain biodiversity

Figure 5 – Soil ecology in balance



In figure 5, a balanced soil ecology management is presented. It is referring to healthier soils and a greater biodiversity.

3.2 THE GAME

EXPLANATION

The title of the game is S.O.I.L., which is standing for 'Sustainable Options in Life'. The game starts with posing the players the option to choose between basic and advanced level (including financial and investment reasons). The players are always able to replay the game, meaning that if they finished the game on basic level and they want to play it on advanced level later, this is possible. The next step of the game will be the start-quiz, assessing the prior knowledge of the players in order to be able to assess the learning progress of the students.

Within the game itself, there are 4 to 5 layers, representing the different layers within the soil. Depending on the choice between basic or advanced level, the player will either play 4 (basic) or 5 (advanced) levels. The first layer is: what is soil? The second one is: what is healthy soil? The third one is: what problems can occur? The fourth one is: how do we keep our soil healthy? And the optional, the fifth one is: investment reasons.

Within each layer, there are 1-3 red dots the player has to play through. Each dot gives the player 4 different kind of cards: a knowledge card, an interactive card, a problem card and a practical card. This will be explained later in in the document. The player needs to try-out all these cards, they can choose the order in which they are picking the cards. The players' choice will have an effect on the soil health and the simulation maize plant, which will be shown on top of the soil layers. In that way the player is able to e.g., see what effect drought has on the maize plant and its soil fertility, as well as how this changes when one is trying to combat drought. Through simulations, they can run through all seasons and grow stages for the simulation plant. As well as see how a e.g., smart investment into e.g., fertilizers, can help to generate a more healthy and abundant produce long-term. This represents how the choices the players make, will influence the plant. Pictures of the game will be shown in appendix 1.

THE DIFFERENT TYPES OF CARDS

To come back to the cards used in the game, here an explanation:

- The *knowledge card* gives information about the soil type or topic at hand. Each layer has a different topic to cover, this card will change with every dot and layer to test the knowledge about different topics amongst the players.
- The *interactive* card gives the players the space to have a discussion about that particular topic. They can share knowledge with other players.
- The *problem* card is there to show a problem that can occur with the soil, and the players have to solve that with different approaches or mixed methods. For instance, the plant is malnourished and needs fertilizers:
    - What fertilizers do you give the plant?
    - What effect does that have?
    - User can choose from a list of fertilizers and combinations
    - The user can apply the fertilizers and see results on plant that is on top

  The goal here is to exemplify the player how actions taken do or do not affect the plant and soil fertility, and that solutions are rarely black and white. Oftentimes, a mixture between e.g., chemical and organic fertilizers can actually result in a higher fertility and yield, on the long run.
- The *practical* card is there to get the users outside the classroom and experience the soil in real life. More about that in the next section.

PRACTICAL CARDS SUGGESTIONS

This is how the practical cards could look like. The sequel of the cards can change, however growing the seeds activity must be in the beginning to be able to see the seeds growing. Especially for the developing suitable examples and activities for the practical cards, vocational trainers from Zone.college – who have already been informed about this game and who showed great enthusiasm about it – can be consulted. The contact to these very helpful people can be made through Pieter Temminck.

Layer 1 → Study the soil through a magnifying class and examine the sample:

- What can you see?
- Which micro-organism and small plants can you see?
- What colour is the soil?
- Write down what you can see in your soil notebook.

The next step is to study the texture of a soil sample, which mainly depends on the size of the soil particles, proportion of the various particles and on the peculiar and specific arrangement of these particles. For this activity you need a soil sample, a magnifying class and this table to identify the different soil designations (figure 6).

Figure 6 – Soil particles size and their designations

Table 4.9. *Soil particles size and their designations.*

S.No.	Designation	Diameter of particles (in mm)
1.	Gravel	2.00 upward
2.	Coarse sand	2.00 – 0.20
3.	Fine sand	0.20 – 0.02
4.	Silt	0.02 –0.002
5.	Clay	below 0.002 mm

Layer 2 → Growing seeds in different types of soils. This experiment allows students to hypothesize which types of soil are adequate for growing and which are not. Run-through the process:

Let each student gather dirt or soil from their backyards or provide a variety of samples for the class to use. You will also need to provide disposable cups with a few holes in the bottom and seeds. Then, have students:

- Fill their containers with one of the soils
- Plant seeds in their cup
- Water the soil until saturated and then place the containers in a sunny location

Furthermore, have the students record their hypothesis for which soils will grow the best and the worst and record their observations as the seeds begin to sprout. Students can watch an engaging video lesson on soil types before this activity.

Layer 3 → Demonstrate how soil acts as a filter:

- Fill the first 5 oz cup a quarter of the way full of sand.
- Add a layer of topsoil until the cup is half full.
- Place the 5 oz cup inside the 3 oz cup, using two toothpicks along the side of the smaller cup to allow air to escape.
- Pour some of the Kool-Aid into the top cup and allow it to filter through.

Once the top cup is removed and examine how the liquid in the bottom cup looks. Using the second set of cups, repeat the same procedure as above, except use only sand. In the end, compare the results from using a mix of soil and sand to those from using only sand.

Layer 4 → Make a colour crayon out of soil. Soils vary in colour depending on material make-up and location. The steps to take are the following:

- Take a sample of soil with a colour of your choice.
- Dry the soil overnight in air.
- After the soil is dried you can put the dried soil on a paper and crush it with a hammer (The soil needs to be crushed into a fine powder).
- Put the powder in a paper cup.
- Put a nylon hose over the top multiple time.
- Turn the cup upside down over a piece of paper and gently shake to sprinkle out the finest powder onto the paper.
- Then we need to take the wax in a Ziplock bag and crush in with a hammer gentle.
- Heat up 2 inches of water in a saucepan and while the water is heating, place enough small pieces of wax into a centrifuge tube.
- Place the centrifuge tube with the wax into the rack or beaker in the saucepan and wait for the wax to melt.
- When the wax is completely melted, place the glass funnel into the top of the centrifuge tube and spoon in approximately 1 teaspoon of prepared soil.
- Remove funnel.
- Stir melted wax and soil mixture with a wooden stir stick.
- Continue stirring while removing the tube with the wax and soil mixture to an ice bath and remove stick.
- Let the centrifuge tube sit in the ice bath about 15 minutes.
- Take the tube out of the bath and scrape the inside of the tube to remove any excess soil or wax along the rim edge of the crayon to help release it.
- Turn the centrifuge tube upside down and gently tap on counter to release crayon.

Layer 5 → Soil Glue activity.

For this activity you need 2 wide-mouthed glass jars, 2 pieces of ¼ inch wire mesh about 1 ½ x 6 inches, 2 clods of soil (each about the size of an egg from the top two inches of soil from two different areas). Some examples of areas to sample are: a lawn, a construction site, a farmer's field that has been ploughed, an orchard, a pasture, a forest. The following steps are required:

- Shape two wire mesh baskets to site about 1 ½ inches below the rim of each jar.
- Fill each jar with water to within ½ inch of the top.
- Place the soil clods from two different sources into the baskets and lower gently into the jars.
- Observe the results.
- Answer the questions in this document. The document shows the experiment in more detail as well. https://www.soils4kids.org/files/s4k/soil-glue-lesson-plan.pdf

ELABORATION ON THE DIFFERENCE BETWEEN BASIC AND ADVANCED LEVEL

The difference between the basic and advanced level is that the advanced level has the extra 5th later. This layer goes more into depth about the financial aspects behind farming, talking e.g., about the consequences of a bad yield, a good yield and how much it will gain if they invest in proper (organic) materials to keep the soil healthy over a longer period. This level will show the effects of actions that are better for the short run, but worse for the longer run. This to give the players more insight into what effects their yield positively over a longer period, so that they know why they should invest on these methods and how it will impact their earnings short- and long-term.

THE START QUIZ

The purpose of the start quiz is to test the knowledge of the players at the beginning of the game. Through this start-quiz – in combination with the end-quiz – the prior to the game knowledge can be assessed and later on compared with the learning outcomes after the end quiz. The quiz will consist out of a few questions about soil.

THE SIMULATION

The purpose of the simulation is to visualize to the players what effects the above named internal and external variables, as well as their own actions can have on the soil fertility – depicted in the soil layers in the game – and the health and growth of the maize plant – also being visualized in the simulation. This gives the players right away knowledge about what actions do and which do not have a positive effect on their plant and soil, because they will be able to see the plant thriving as well as suffering and in the worst-case scenario even dying. It is one of the most interactive parts of the game, stimulating the players to keep the plant as healthy and green as possible.

THE END-SIMULATION

The purpose of the end simulation is to test the knowledge that the players have gained during the game. The difference between the simulation during the game and this one is, that now all different problems can occur and they are not sorted by layer and by topic anymore. The player has to, therefore, really apply his/her acquired knowledge and use it as a tool to combat problems occurring or to nurture the simulation plant. The learning outcome is to show that an integrated approach is oftentimes the most holistic and beneficial option.

The end simulation is a test on a bigger plant. When the user clicks on starting the simulation, a variety of e.g., 10 ‘problems’ or options is shown. The problems will be focused on everything the players have learned. They will have e.g., problem ‘erosion’. Then they will have different approaches and options for how to deal with e.g. erosion. They will choose one or a combination of options. They can then see, what this choice would do to the plant. They have multiple tries. The correct one is clearly indicated, once chosen, however, not too obvious to the player. The plant can, in fact also die, which would result in the player not receiving the points possible to earn in the end-simulation.

THE END-QUIZ

The purpose of the end quiz is to test if the players gained knowledge during the game. The learning outcome is that the players feel accomplished when the outcome of the quiz is correct and learning outcomes can be measured. This can be done through looking at the difference between their start-quiz and the end-quiz results. The end quiz includes a series of questions on the content of the game.

POINT SYSTEM

To give the players an extra incentive to play the game, a point system will be introduced to the game. After the game, the players can compare their scores with each other. The point system will then work as follows:
Per layer of the game (either four or five layers), there will be points given. Furthermore, the players can earn points per dots in the layers. In layer 1, the players can earn 10 points per dot, in layer 2, 20 points per dots, and so on. Table 7 shows the maximum of points, which can be earned per layer in the game.

Table 7 – Point system of the game

Layers of the game	Points earned
Layer 1	2* 10 points
Layer 2	3* 20 points
Layer 3	3* 30 points
Layer 4	4* 40 points
Layer 5	3* 50 points (only players of the advanced level, will get this layer)

For the basic level, a maximum 330 of points can be earned, whereas for the advanced level 480 points can be earned. After having played the main part of the game, the points that the players have already earned will be the base for the end-simulation. During this phase, the players can earn 10 points per problem, which arose and was solved in a good way. However, there will not only be one correct answer, since there is not a straightforward way of how to approach a complex problem such as e.g., erosion. Furthermore, because the simulation, is dealing with difficult issues, the 'correct' solution to the problem will not be as clear to the player, because the player is not supposed to only choose for an option thinking this is the correct one, which will give him/her the points needed.

The players will be able to compare their scores and will therefore strive to get as many points as possible. If the players fail to keep the plant alive, they will lose the game. This is an extra form of motivation, to keep the players enthusiastic for winning the game and thus keep the plant healthy and alive.

The purpose of increasing the amount of points given per layer in the game, is that this will engage the players to stay in the game and it also relates to an increase in difficulty per topic.

4 OPTIONS FOR THE FUTURE

The goal of the game is that in the future more people around the world have access to it. We developed a plan for an online version of the game, however, it would be amazing to see a physical version of the game in the future as well. Furthermore, through possibly expanding to different countries, the player will be able to choose a country and a language, which would affect e.g., the colour of the soil since that differs greatly between countries and regions. The knowledge taught to the player would therefore also have to adjust, differing from country to country. In the future, all the variables of the different countries could be collected, so that students in for instance the Netherlands are also able to play the game.

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6 APPENDICES

APPENDIX 1 – Pictures of how the game can look like

Figure 6 – Start page

Figure 7 – Introduction page

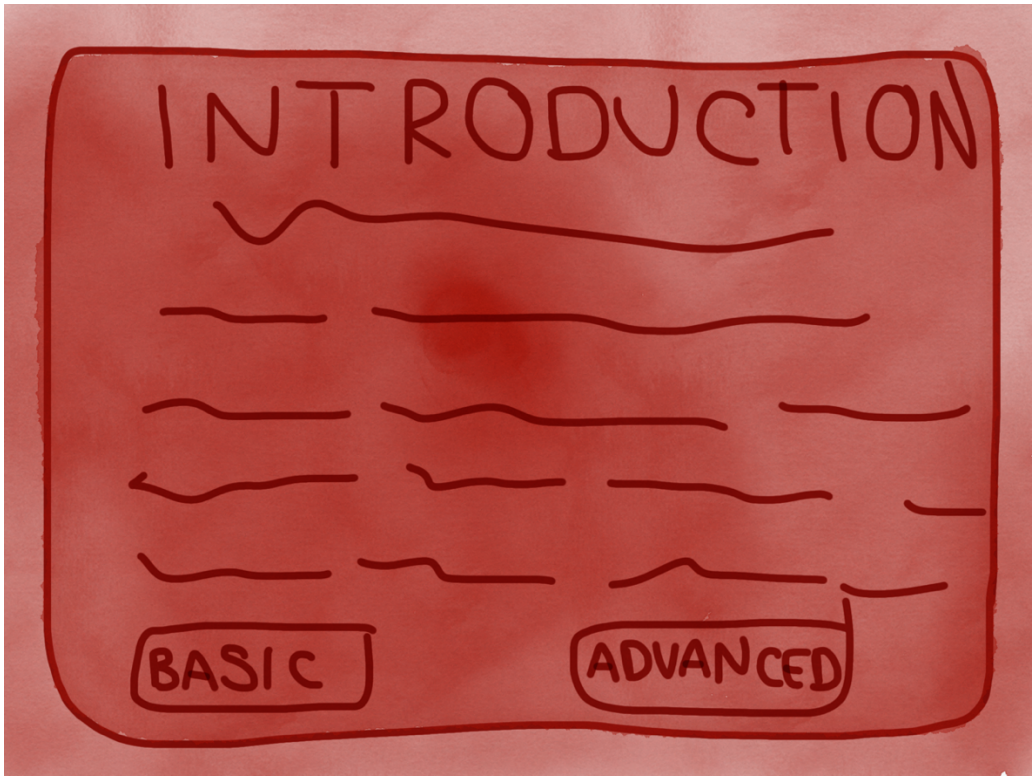


Figure 8 – Start quiz page (end quiz would look the same, however with a different title above)

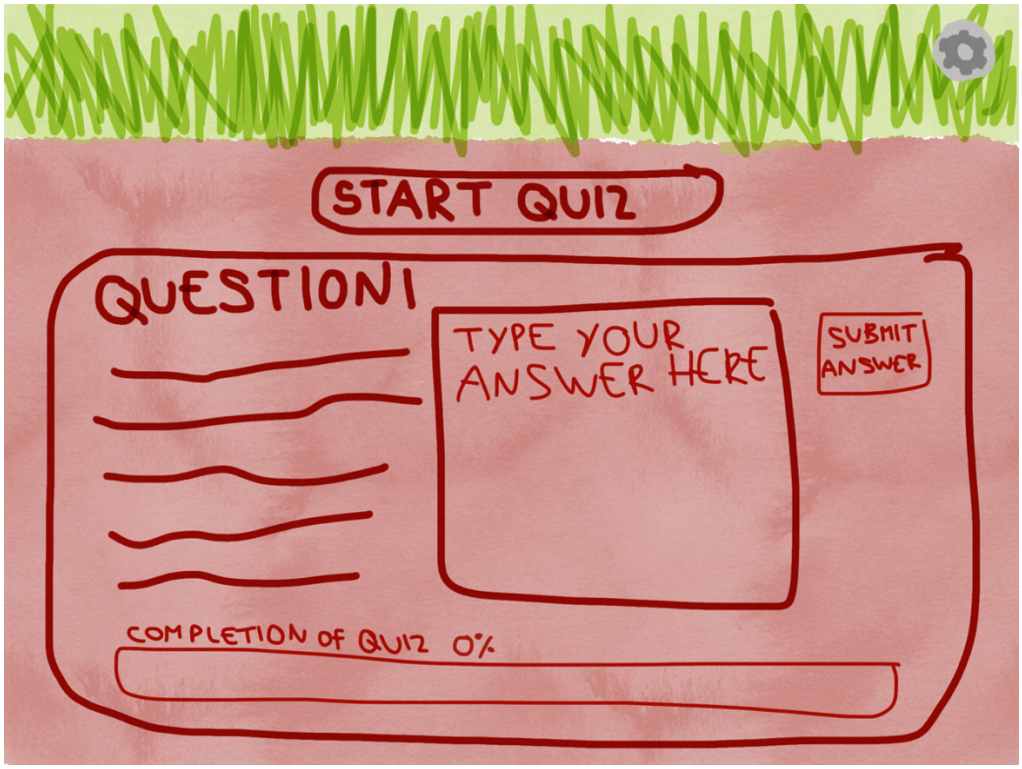


Figure 9 – Overview soil layers and game stages

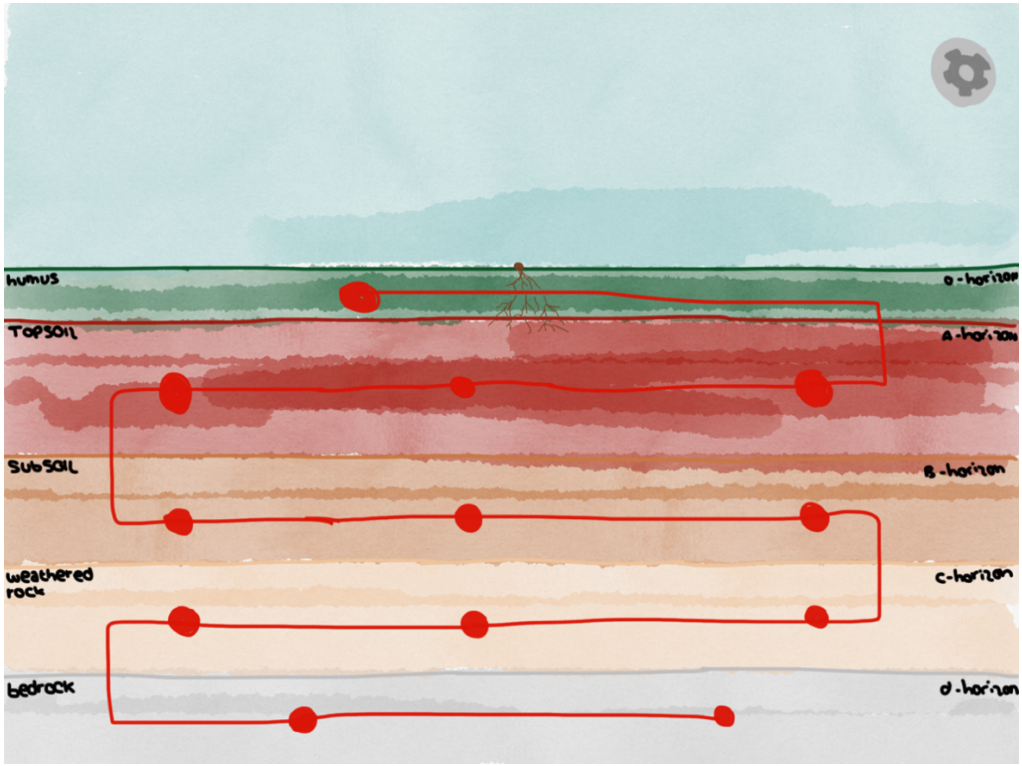


Figure 10 – The different cards

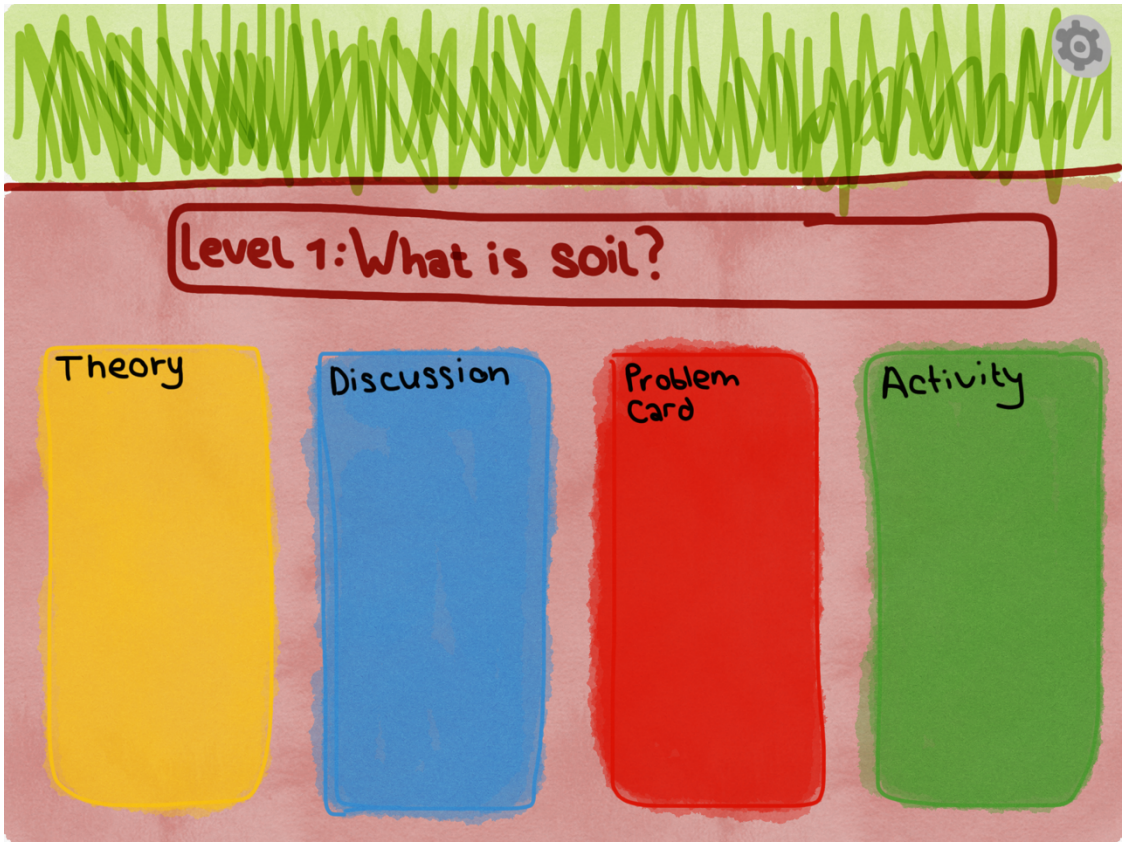


Figure 11 – End simulation page

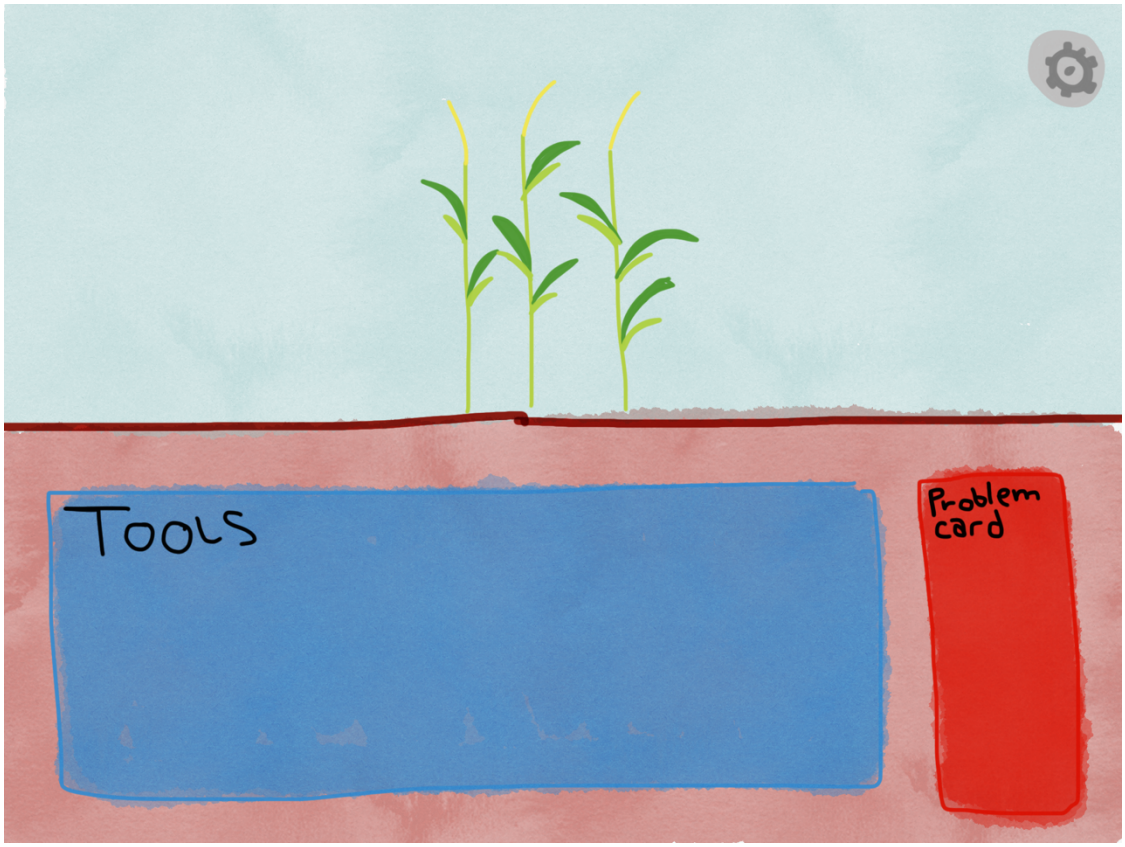
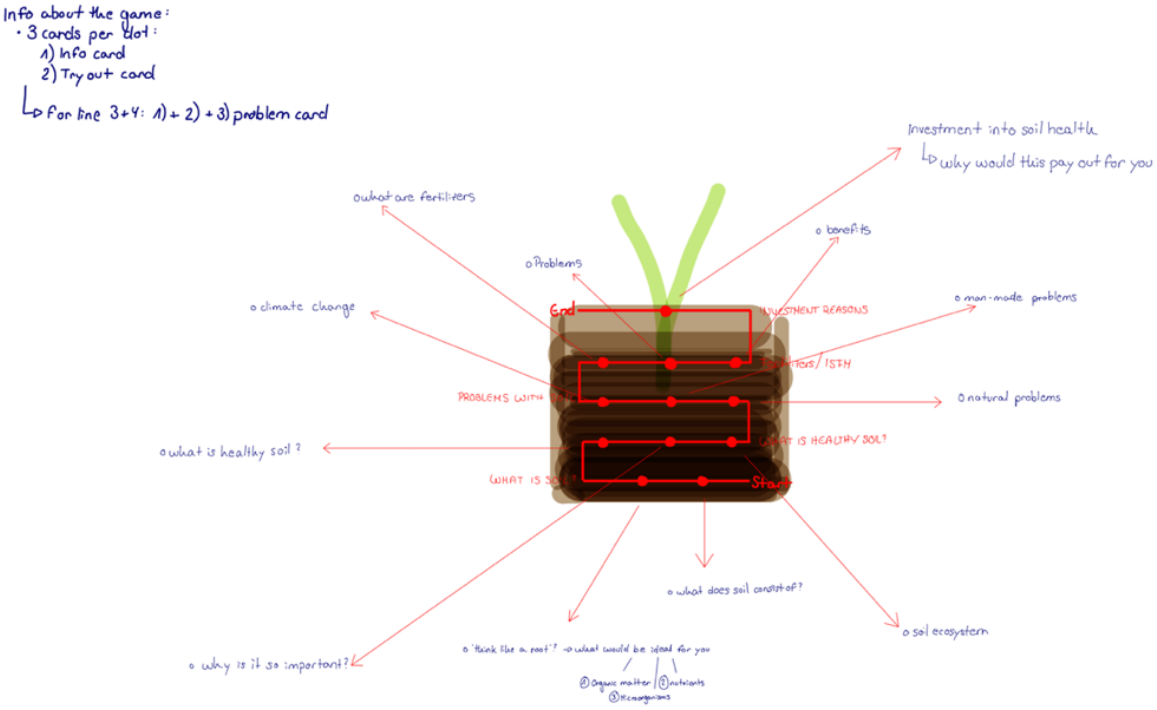


Figure 12 – Detailed page with the layers and content



APPENDIX 2 – Data used to base 'user profile of typical player' on

Total inhabitants Uganda: 42,72 million (2018)[1]

Economic

GDP per capita: $1,909 (2016)
Share of children aged 5-17 years engaged in labour: 13.2% (2017)
Share of children in employment: 36.7% (2012)
Share of population living with less than 3.10 int.-$ per day: 64.95% (2012)
Arable land use per person, hectares per person: 0.17 (2015)

Education

Duration of compulsory education: 7 years
Gross enrollment ratio in pre-primary education: 11.01% (2013)
Gross enrollment ratio in primary education: 109.89% (2013)
Gross enrollment ratio in secondary education: 27.61% (2013)
Gross enrollment ratio in tertiary education: 4.48% (2011)
Net attendance rate of primary school: 88.24% (2011)
Official entrance age to compulsory education: 6 (2014)
Official entrance age to pre-primary education: 3 (2016)
Primary school completion rate: 52.61% (2016)
Primary schooling: Adjusted net attendance rate: 88.79% (2011)
School life expectancy, from primary to tertiary education: 10.01 (2011)
Share enrolled in private institutions at the primary education level: 16.18% (2013)
Share enrolled in private institutions at the tertiary education level: 46.66% (2011)
Share of the population with at least some secondary education: 24% (2012)
Share of youth not in education, employment or training: 5.91% (2013)
Total net enrollment rate in primary education: 93.8% (2013)

Electricity and internet

Mobile cellular subscriptions: 58.21 (2017)
Number of internet users by country: 9.08 million (2016)
Number of mobile cellular subscriptions by country: 16.57 million (2013)
Number of people with access to electricity: 11.08 million (2016)
Percentage of individuals using the internet by country: 17.71 (2014)
Share of the population using the Internet: 21.88% (2016)

Demographics

Adult literacy rate, population 15+ years, female (%): 66.78% (2015)
Adult literacy rate, population 15+ years, male (%): 80.95% (2015)
Gender parity index (GPI): Literacy rate of young people (ages 15-24): 0.95 (2012)
Life expectancy: 59.58 (2015)
Median Age: 15.8 (2015)
Youth literacy rate, female: 86.57% (2015)
Youth literacy rate, male: 87.43% (2015)

APPENDIX 3 – Soil problems in Uganda

Land degradation

- Soil erosion esp. in hilly and mountainous areas
- Soil fertility decline
- Nutrient loss
- Changes in crops
- Compaction (occurs when soil particles are pressed together)
- Reducing pore space between them)
- Contamination (the occurrence of pollutants in soil)
- Declining fertility
- Cutting old trees which lead to more erosion
- Erosion is creating ravines/ holes
- The siltation of lakes and rivers associated with erosion is leading to problems of eutrophication and reductions of fish populations.

Climate change

- Drought due to climate change
- As rainfall increases in intensity (downpours) because of climate change, landslides are becoming more common

Low knowledge

- Inadequate knowledge on proper soil/land use practices
- Poor land management practices leading to unsustainable use
- Inability of small holder farmers to invest in sustainable land management practices (e.g. very low fertiliser use)
- Deforestation
- Unsustainable farming
- Mining of sand for brickmaking
- Road construction
- Poorly designed drains
- Population pressure leading to continuous cultivation