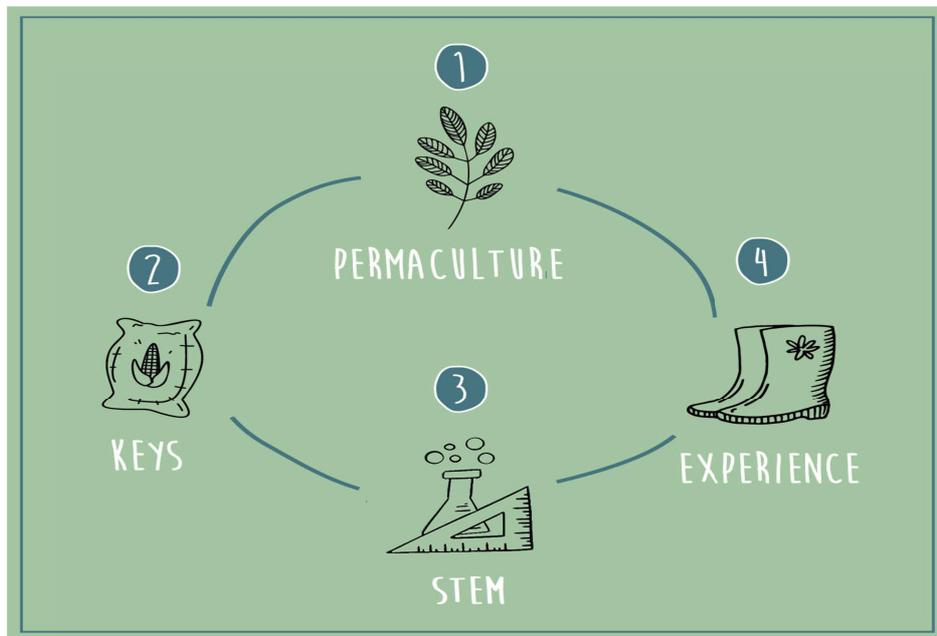




THE IDEAL KITCHEN GARDEN GAME

BOOKLET FOR EDUCATORS



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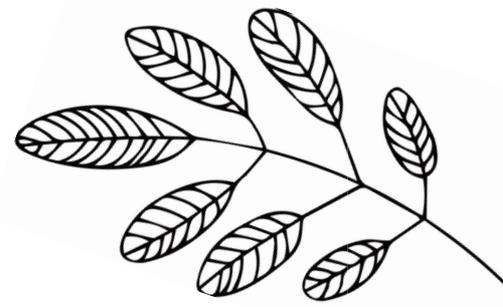
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Introduction

The Ideal Kitchen Garden is an educational multi-challenge Game with 4 interlinked phases. Its overall aim is to transfer to students how to design a vegetable garden with the interdisciplinary approach of STEM combined with the applied methods of Permaculture design.

All the phases of the game should be played by the same teams, which formally collect scores and non formally basic knowledge about Permaculture design.

The final outputs of the game will be: a game board which can be used with the Living STEM deck of cards and a micro-garden cultivated in a box following the permaculture principles and applying solutions observed during the experience in the farm.

Planting the ideal kitchen garden outdoors (if an outdoor space or a garden is available next to the school) is a possible follow up activity of the game!

The Educators will be introduced to the game and its rules in Chapter 1. In Chapters 2 and 3, the educator will find useful information on how Permaculture and STEM can be integrated through the game in a non-formal setting. How the Deck of Cards helps the process of arranging the permaculture garden in terms of plant associations and locations within the garden will be then explained in chapter 4.

The last chapter is devoted to recommendations for teachers and educators, along with some possible game variations and suggestions in order to transform this game in a real permaculture experience.

The Ideal Kitchen Garden Game is the Intellectual output 4 (IO4) of the Erasmus+ Living STEM project and has been developed by the joint work of Génération Bio - Belgium, Logopsycom - Belgium, CIP - Cyprus and EDUlab - Italy.

Each partner has developed one chapter of this booklet and one phase of the game but everyone has contributed to the final version of all the contents through a cooperative/collaborative fruitful work.

1. The Game Description

The **Ideal Kitchen Garden** is a multi-challenge game divided into 4 phases carried out in the classroom and outdoor.

It is played in teams which should be defined at the beginning of the game and held through all the phases. At least 2 teams are needed.

In each phase of the game each team earns points. The sum of the points earned in the individual stages represents the final score in the game.

The 4 phases are propaedeutic to each other and they are:

- A Treasure hunt:** A journey into the Magical World of Permaculture
In the first phase A, pupils play a treasure hunt in a permaculture farm/garden with the aim to discover the treasures of a permaculture environment

- B The Kitchen Garden on a Game Board:**
In the second phase B, pupils are asked to design a parcel canvas that will become a game board for playing in the next phase

- C Let's play with the Cards ... in the Garden:**
In the third phase C, pupils "virtually" cultivate the parcel designed in the phase B using the deck of cards

- D Micro Kitchen Garden Lab:**
In the fourth phase D, pupils plant a small garden in a box applying the knowledge achieved in the previous phases.

Phase A

Treasure hunt: A journey into the Magical World of Permaculture

Where:

Permaculture Farm/Garden

Duration:

2-3 hours

Main objective:

To identify the natural elements in the farm/garden and their interconnections, as well as the Permaculture principles applied.

Description:

By immersing in a permaculture farm/garden, pupils will be able to observe, some of the basic concepts of the discipline. A playful experience in the farm will help them in their comprehension of its principles and understand how permaculture offers sustainability. Through the treasure hunt game, the pupils will then learn to identify elements within an ecosystem, the functions of the identified elements and the relationships of those functions.

Materials:

A block notes and a pen for each team

Rules :

- 1 Ask to observe and note down what pupils need to “hunt” :
 - o The elements (1 point each) of the plant and animal world. Which plants and animals are pupils able to name or identify in this permaculture farm/land (or garden)? When a team finds and names the plants and animals, for example, tomatoes, comfrey, chickens, ducks, marigold, apple tree, bees, basil it gets 1 point for each.

- The functions of the identified plant or animal (5 points). What beneficial things does the plant or animal do? To identify the functions, pupils can consult the Deck of Cards for clues. They can also ask the permaculture experts in the farm about the plant/animal they see and why they are planted or placed where they are on the farm. Pupils will be invited to note down the different functions of the plant or animal. Here an example about the points system. Let's identify the different functions of comfrey: Fertilises the soil as it contains N, P and K (5 points); its flowers provide nutritious food for people, the bees and other insects (5 points); the leaves serve as medicine to the people (5 points), the large leaves are great for mulching (5 points), prevents weeds (5 points), leaves can be fed to chickens (5 points), etc. So the more functions they identify, the higher the points they get.
- The relationships of the functions (10 points): How does the function/s of one element benefits/ another organism? A team can further earn more points when it succeeds to cite the relationships between the functions of the plants or animals. For example: the fertilising function of the comfrey enriches the garden soil and therefore benefits the other plants (10 points). The colourful marigold flowers attract bees & beneficial insects (5 points), and they also attract them to the comfrey. (10 points). The comfrey provides natural mulch for tomatoes, so the tomatoes do not need much watering, the comfrey nourishes the soil. (10 points). The tomato plant's primary mission is to reproduce (5 points for function), and this serves the people a lot for the world's favourite vegetable (botanically considered as fruit) is tomato. The tomatoes feed the chickens (5 points) + the chicken poop fertilises the tomatoes (5 points) = 10 points..

2 Each team, after the observation and the notes, is asked to identify some plants for a micro kitchen garden and to interview the permaculture farmer or the responsible person of the place, about them for receiving suggestions for its cultivation. The recording (audio or video) of the interview earns 10 points.

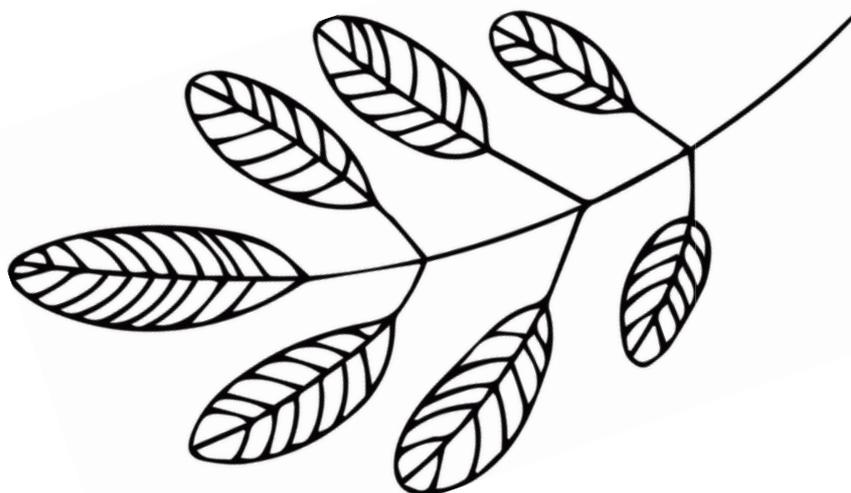
It is time to assign points to each team: use a table for each team like the one in annex I.

... but the **TREASURE?**

The winning team will be given a reward to share later with the other players. The nature of reward depends on the permaculture land, farm, garden where phase A of the game will be played and the local products available. It may be, for example, a basket of vegetables collected by the winning team under the supervision of the gardener, a honey jar, or another processed local product offered by the farmers, as agreed in advance with the Teachers and the Educators.

The treasure will be given to the team with the highest score, but it must be shared with all the members of all the teams!

Back to school, the Educators will stimulate the class to discuss the treasure hunt experience and to decide the use of the reward/treasure gained!



Phase B

The Kitchen Garden on a Game Board

Where:

in the classroom

Duration:

3 h

Main objective:

To design a Parcel Canvas representing a kitchen garden following the permaculture basic notions and applying STEM knowledge: the result will be our Game board Garden

Description:

Pupils will be challenged to apply what they learnt in phase A, "Treasure hunt: A journey into the Magical World of Permaculture", to design an ideal kitchen garden. Before starting teachers will introduce different scenarios:

- **Threatened Biodiversity** (garden design must create biodiversity)
- **Insufficient Food for everyone** (garden design should contribute to food security)
- **Water shortage** (garden design have to offer water conservation solutions)
- **Greenhouse effect** (garden design should consider the reduction of CO2 emission)

The garden is designed on paper using an empty poster board as the basis of the game and a series of elements to be placed on the billboard (sheets annexed: Basic, Fixed and Problem-solver Elements).

Materials:

- Blank poster board (70x100cm)
- old magazines
- newspapers
- print outs from the samples provided in this game
- Drawing pens to draw directly the elements on your poster board.

Rules:

- 1 Divide the pupils in teams: remember those defined in phase A
- 2 Assign to each team one scenario or choose with pupils only one scenario for all the teams.
- 3 Ask each team to define the size of the ideal kitchen garden to design
- 4 Ask to measure the poster board and scale according to the size chosen for the garden..
- 5 Draw the attention to the “**Basic elements**” (see Annex II and III); Pupils have to:
 - Identify the cardinal points and indicate them on the poster.
 - Determine how much sun, rain, wind etc. do they get in the area throughout the year (when necessary, ask to do some research and look for real data referred to the scenario). Put the data at the bottom part of the game board such that the team will design according to this. Ask to always take into account the assigned scenario and its specific goal when the “basic elements” will be insertedEach Basic element positioned gives 3 points
- 6 Ask to determine “**Fixed elements**” (see Annex II and III) they plan to put so to adapt the position of the garden vis-à-vis these elements.
For example if there is a building or a river very near the garden they are designing, draw the attention of the team that has to take it into account when they design the garden. Ask to always take into account the assigned scenario and its specific goal when the “fixed elements” will be inserted (see Annex III).
Each Fixed element positioned gives 1 point
- 7 Ask to draw/highlight shadow zones if there are parts of the garden that could be in the shade during most of the day, due to the presence of some fixed elements like buildings or trees. This will give also 1 point

- 8 Ask to choose the basic design of the garden from: linear geometric shapes and curved shapes. Show the patterns you see in nature (see also figure below) for inspiration, you can also show the suggested shapes (see annex IV) and ask to draw them on the poster . A Design Inspired by natural/geometric shapes gives 10 points.



(https://en.wikipedia.org/wiki/Patterns_in_nature - <https://ecstep.com/natural-patterns/> - <https://www.smithsonianmag.com/science-nature/science-behind-natures-patterns-180959033/>)

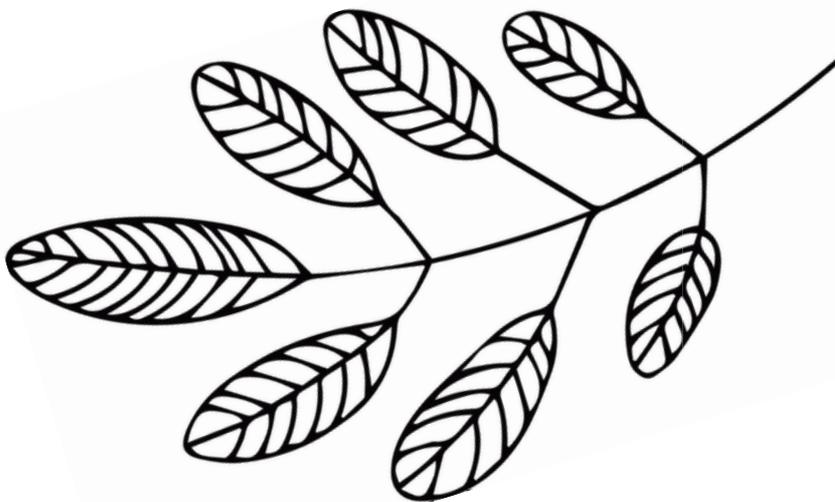
- 9 Educators will ask pupils to make the necessary changes moving the elements on the poster until they are satisfied.
- 10 Now it is time to ask to choose and place wisely the “**Problem-solver elements**”: i.e. to apply some solutions through the elements (see Annex II and III). Ask to keep in mind the scenario and its main aim. Ask which element can help to face the challenge given from the chosen scenario. Which elements help, for example, to improve biodiversity, food security, water conservation or CO2 emission reduction. For each “element” properly placed to face each specific scenario, the team earns 10 extra points!

11 The Educators will ask to pay attention to: Don't forget walkways in between the garden beds to be sure they are reachable and accessible to friends or people who have motor disabilities(1 point each walkway)

Now the resulting game board representing the ideal kitchen garden is ready to be cultivated using the cards!

It is time to assign points to each team using the same table!

After calculating the score, a reward will be consigned to the team with the highest score: a mysterious bag containing... some soil to be used by all the members of all the teams in phase D! (Teachers/Educators should prepare the mysterious bag in advance)!



Phase C

Let's play with the Cards ... in the Garden

Where:

in the classroom

Duration:

1 hour

Main Objective:

learning the basic principles of a sustainable agriculture interconnected to all the species involved by Cultivating through the deck of cards

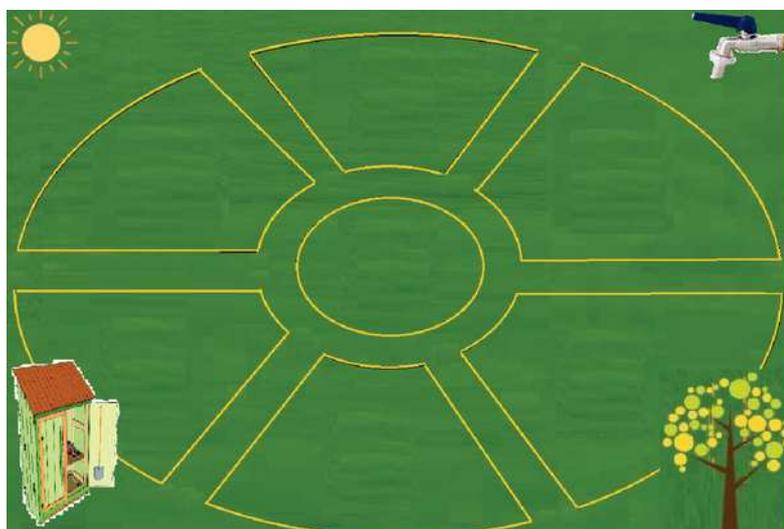
Description:

Now that the pupils have some notions about Permaculture (phase A) and that they have been guided in the parcel canvas design in different scenarios (phase B), it's time to play with the deck of cards. Through the use of the cards, the pupils will start learning how to cultivate an ideal kitchen garden, they will identify the plants suitable for each specific scenario and will be able to grow food for each parcel canvas. The idea here is to allow them to interconnect different kinds of information in order to organise their cultivation in the most efficient way. Sun exposure, watering, soil, seeding and growing months will play an important part.

Rules:

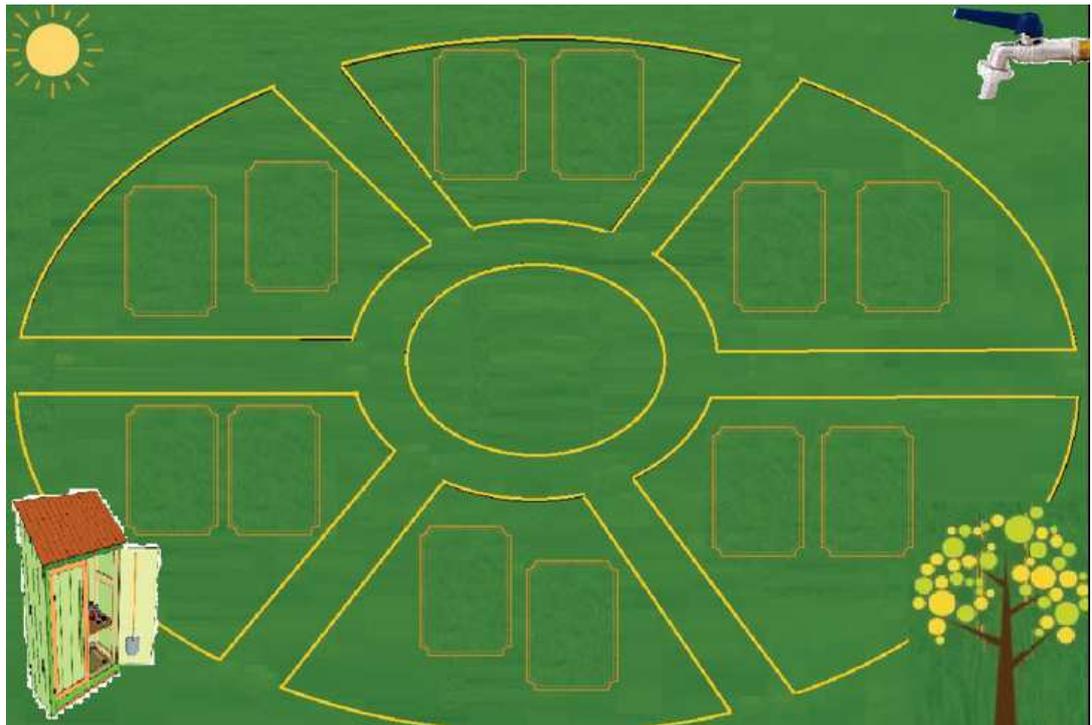
1 Divide the pupils in teams: remember the same as in phase A and B

Each team has its own original board designed in phase B and its own deck of cards for cultivating its garden. Let us imagine that we have a gameboard like this:



2 Create the spots for cards

On each board, a certain amount of card spots will be drawn by the pupils in order to lay down the cards in each garden. Educators will take into account the ideal kitchen garden size decided in the previous phase: one card plot is roughly equivalent to one square meter of garden bed. For example, they can choose to divide their parcel like this:



3 Cards Settings

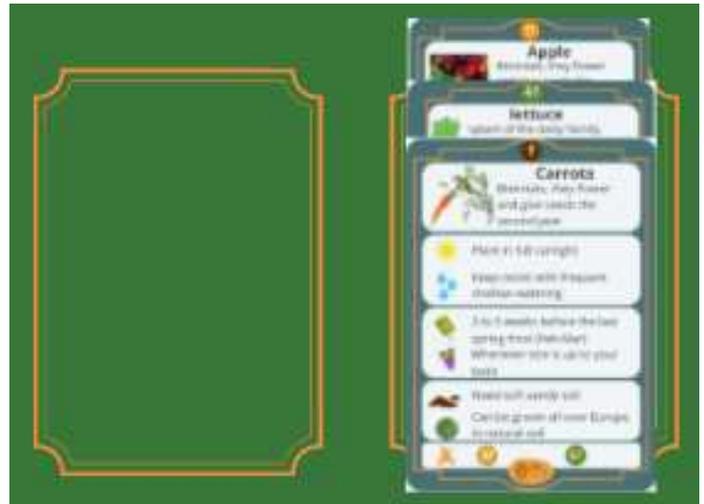
Once the game board is set up, pupils can use the cards in different ways.

Each spot can hold several cards layered on top of each other, to do what is called “companion planting”.

We foresee 3 levels, High, Medium and Low in consideration of the suggested position of the plants to be cultivated.

Each spot represents a plot of land on which several plants can be planted in intercropping and all year long, depending on the time of the year in which the plant develops as well as its nature (high- example: peas, medium height - example: lettuce; low- example: carrots) and the chosen scenario.

For example: here is a visualization:



which corresponds to:



High Level:
stem plants
(like peas)

Medium level:
Ground plants, bushes
(like lettuce)

Low level:
Roots, bulbs, tubers
(like carrots)

Each space can contain different cards for each level depending on their month's of seeding, development and yield.

For practical reasons and for purposes of the game, Educators would advise to limit the associations to 3 cards per level maximum.

Each plant properly cultivated earns 1 point.

Should the plant be planted in a place that has not the ideal conditions; for example it requires ample sun exposure but is right on the shadowest zone, the card will be set down horizontally by the teacher to indicate a not appropriate planting and no point is gained.



Best Buddies rules:

In Permaculture, we have the concept of “Best Buddies” which is the basis of companion planting.

Indeed, plants are a little bit like people: they grow/stay better when they have good relationships with some special friends!

Simply put, some plants bring benefits to others (mulch, nutrients, support, shade, deterrent of insects, etc), while some plants compete for the same nutrients in the ground for example and so, are not very compatible.



In this deck of cards, we have indicated some of the “Best Buddies” relationships inside of the cards.

You will see in the bottom of the production cards / the production side of the cards, some numbers.

Those correspond to the card’s plant best buddies.

Which means that if pupils plant them together or next to each other, they will thrive!

In this game, planting best buddies together, or next to each other will bring you more points than simply combining crops.

There are two types of combinations that the pupils may do:

Neighbours’ combo(on different plots but next to each other’s)

or

Plotmates combo (within the same planting plot)

Neighbours' best buddies combo

Here is how pupils can combine them. Either they can plant them in card spots next to one another, in which case they earn 2 additional points per best buddies relation.

Example: in this picture, you have 1 best buddies relationship next to each other.

This means that they get 2 points in addition to the points gained with both sets. Here, as there is only one card per plot, (one point per plant properly cultivated), it makes a total of 4 points. $(1+1) + 2$.



If there is one best buddies' relation next to each other, you gain +2 points.

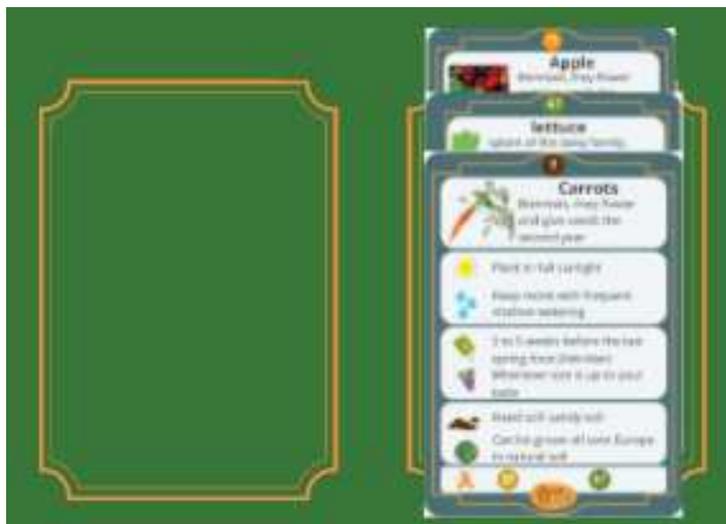
Plotmates Best Buddies combo

Pupils can also plant them inside the same spot. In which case, you add up the cards that are best buddies in the same spot, and you square the result.

In this example, Carrots and Lettuce are best buddies.

So you have one point for carrots + one point for Lettuce = 2 points.

But as they are best buddies in the same planting spot, you get to square the result.. $2^2 = 4$ points.



(Don't forget to add the point of the pees card as well at the end, which makes 5 points total)

If pees had been best buddies with carrots and lettuce, you could have made: $1+1+1 = 3$ (original set of cards) + 3 best buddies relationships in the same planting spot $\rightarrow 3^2 = 9$ points total.

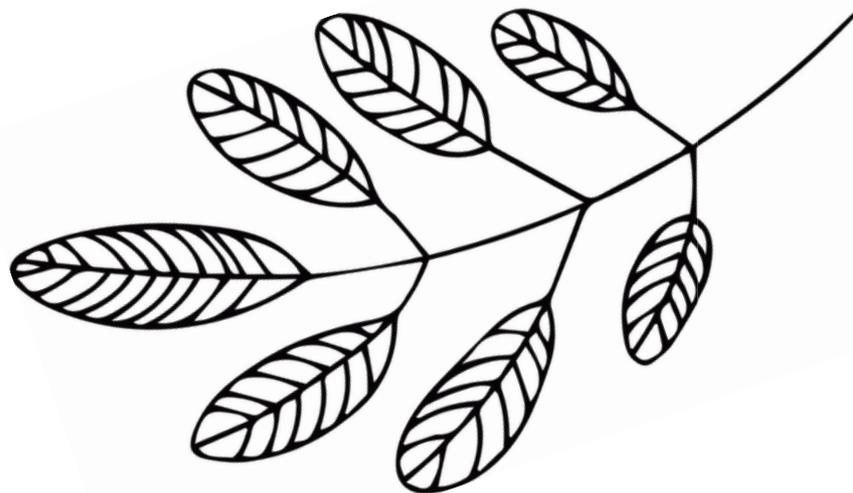
Strategic cards which face the scenario's challenge

The players may point out a combo of cards they placed as strategic cards. This means that these cards face somehow the challenge given from the scenario and achieve its main aim (improving biodiversity, or food security, or water conservation or CO2 emission reduction). If the team identifies at least one strategic combo of cards, it earns 20 extra points!

It is time to assign points to each team: use the same table!

After calculating the score, **all teams will choose some seeds to be kept for phase D**. The team with the highest score will choose first. (Teachers/Educators should organise this in advance)!

It will be interesting to combine the choice of the seeds to plant by each team with what learned.



Phase D

Micro Kitchen Garden Lab

Where:

in the classroom

Duration:

Approximately 3 hours for all tasks depending also on some choices

Description:

In this phase of the game, pupils will grow their ideal kitchen garden in a grow box. They will put in practice what they observed in the farm (phase A), planned in the parcel canvas (phase B) and learned by playing with the deck of cards (phase C).

Main Objective:

For students to apply what they have learned on Phases A-B-C aimed ultimately in growing and taking care for a period of time their own grow box in school.

Rules:

1 Divide the pupils in teams: remember the same as in phase A, B and C.

2 Remind the seeds

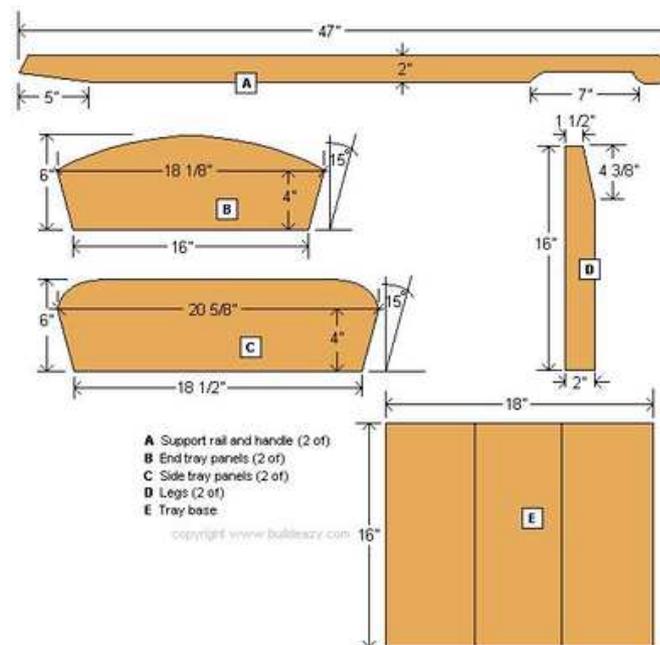
It is necessary to give a look to the notes and to watch the video, or listen to the audio, of the interview done during Phase A. Ask each team to visualize the plant world elements found through the treasure hunt and to read those identified to be cultivated in a real grow box. Let them search for further information about the space each element needs, the water requirements, sun exposure, companion plants... recall with your students which elements were put together in Phase C and stimulate a brainstorming on the size of the box needed for the seeds cultivation.

3 The Micro Garden Box

Find through internet suggestions for creating a garden box (see the example below) or find a ready made box e.g recycling and reusing dismissed materials (like wooden fruit boxes, jute bags, wine box etc).

Do not forget that it should be water resistant (small tricks may be sufficient).The construction of a box for your garden earns the team 10 points.

Recycling Reusing and Readapting a dismissed box gives to the team also 10 points because this Reduces wastes!



Source: <https://www.pinterest.com/pin/552042866794157745/>

4 Be Creative!

Ask the teams to decorate the box based on a sketch.

5 Cultivation Calendar

Find through the internet or create your own calendar showing of when your garden will need water or care and make sure you divide the work equally within the team. It can be as simple as:



Source: <https://www.pinterest.com/pin/60306082499321097/>

6 Choose the location

Stimulate a discussion on the decision of the best place for the micro garden boxes. Each team chooses a location. The position of the micro garden should take into consideration the sunlight and other peculiarities linked to the chosen seeds. A good choice gives 5 points.

7 Gather soil, seeds and equipment

It is time to get the mysterious bag containing soil and the seeds received after phase B and C and to gather what else is necessary for the cultivation (grower kit) . To be ready earns 10 points.

8 The cultivation

It's time for the teams to plant the seeds putting the appropriate soil and water as much as needed.. Remember to pupils to keep on with the calendar for helping the seeds grow and ask to take pictures of the progress.

The microgarden ready and placed where decided previously earns 10 points!

9 Be responsible!

Teams are now parents of the garden boxes. They should never forget them!

It is time to assign points to each team: use the same table!

Conclusion of the game!

Each Phase has been completed!

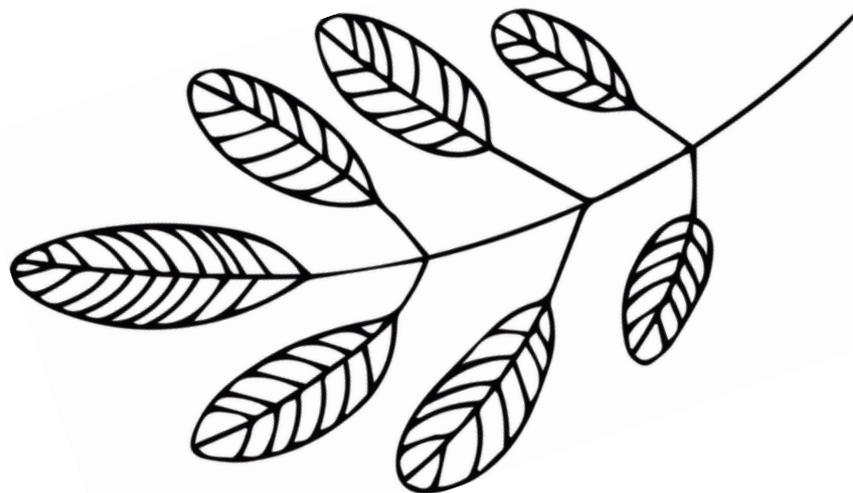
ASK PUPILS TO CALCULATE THE TOTAL SCORE: SO WE HAVE A WINNING TEAM!!!!

The reward will be consigned officially to the winning team, but as in the previous phases, the reward must always be shared with all the players. The nature of reward depends on the teacher but should be something meaningful and related to the game topics. May be, for example, a small FRUIT TREE to be planted in the schoolyard, or in a close public park accordingly with the local authorities.

The tree-planting ceremony will be a celebration for the whole class!

The winning team will be responsible for choosing the place where to plant it and if it cannot be planted at school then another place will have to be properly chosen.

The choices will be then explained and discussed with the class.

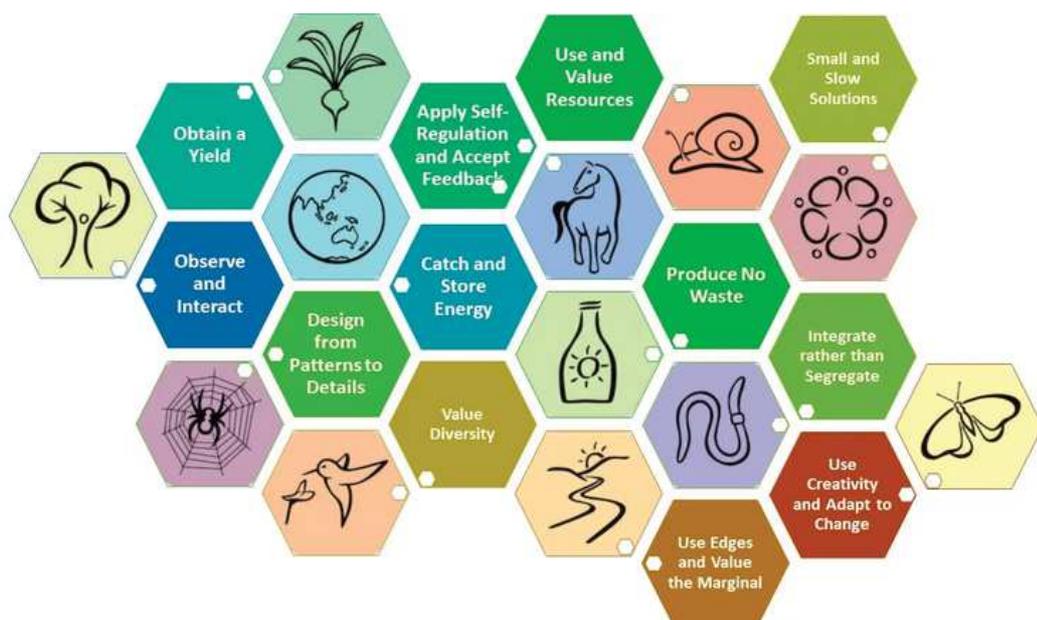


2. How to teach Permaculture through the Game

"Permaculture gives people a place to be part of the solution" - Rosemary Morrow

Permaculture helps us face most of the world's biggest problems by enabling us to see ourselves and the world through the patterns, systems and cycles of natural ecosystems. From these, we begin to comprehend how their natural designs render them resilient. Permaculture teaches self-responsibility by giving people the tools that empower them to find their own solutions. And this is what this game is about, to foster divergent thought process that will help the learners generate creative ideas and dare to explore many potential solutions to a given problem.

The Ideal Kitchen Garden Game uses inquiry-based learning where the principles of permaculture are interlaced with the application of scientific methods, as well as mathematical and creative skills. The students will apply these to engineer solutions to successfully reach the goals of the games by using their interpretation of the Permaculture principles that they learn at the very start. The multi-challenging phases of this game will help them have a deeper understanding of Permaculture by seeing, measuring and concretely realising the results.



The 12 Permaculture Principles

source: <https://hilltownfamilies.org/2015/05/11/learning-landscapes/>

Teaching permaculture through gamified lessons always centres on making the learner feel (s)he is a co-creator and a co-shaper of the world around her/him. Therefore, the Ideal Kitchen Garden game is designed to help the students to think differently all through the four phases. In Phase A - Treasure Hunt: A journey into the Magical World of Permaculture - the students are encouraged to engage with nature in a way that they will find fun. Visit and games in a permaculture farm or land will make them directly see Permaculture in practice. They will come to terms with the knowledge that alternative ways of growing food exist and that there are agroecological practices that can replace intensive agriculture. It is probable that they may have come across in their other lessons the fact that intensive agriculture heavily uses pesticide and fungicide and other methods that are destructive to the environment.

They will learn anew that intensive mono-culture produces one-third of the greenhouse gas emissions (<https://www.nature.com/news/one-third-of-our-greenhouse-gas-emissions-come-from-agriculture-1.11708>) and destroys the diversity and quantity of microorganisms that help keep the soil fertile. The game will help them learn or relearn how interrelated things are, how intensive agriculture leads to soil erosion, increased pollution and declines in fish and other species. However, by learning heavy concepts in a gamified way backed by permaculture tools, they will be more focused in their capacity to find solutions.

In this project that contains series of challenging and knowledge-laden phases, they will be hands-on in the activities that will allow them to imagine how to solve global issues and then realise a garden in harmony with nature. They will find hope in the idea that regenerative farming practices such as Permaculture can build communities that live in cooperation with one another. Through collaborative working models, the students will uncover how permaculture lands or similar initiatives regenerate the planet and offer food security with very little use of fossil fuel.

In Phase A, the students will see the importance of their lessons on ecosystems in their Biology class and understand more tangibly the significance of biodiversity in a sustainable world. They will view from a different lens the surprising and intricate interconnection of everything in the world and even in the universe. Deep learning of biology can inspire future physicists among them who might be motivated to pursue the search for the formula of the unified field.

After all, history tells us that most life-changing discoveries by renowned scientists are driven by their curiosity to understand nature.

Observation is critical in permaculture design and by showing the students the bigger picture will help them to understand how the smaller details work. When they hunt for the elements in the permaculture farm, the students will obtain knowledge of the functions of those elements and discover the relationships of their functions. With that, they will slowly be equipped to face the final challenge of the Ideal Kitchen Garden game, which is to grow their own garden in Phase D.

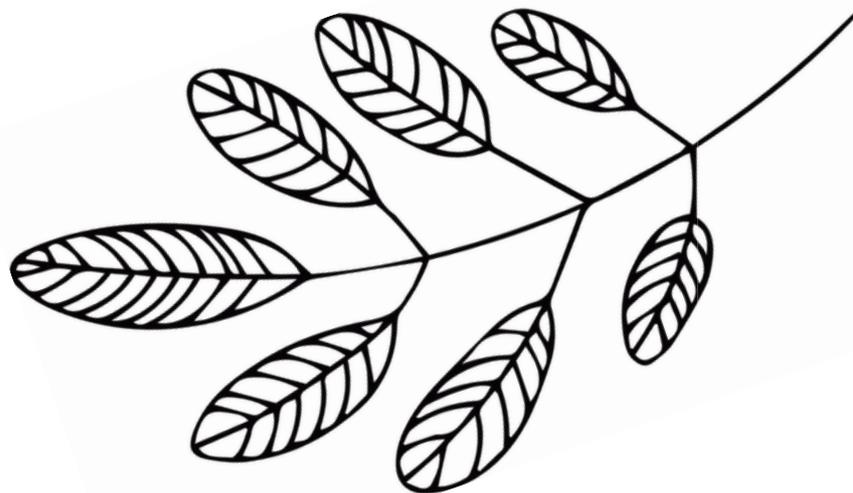
In Phase B - The Kitchen Garden on a Game Board - the parcel canvas design underlines the students' potentials and empowers them to address global concerns by starting with the creation of an ideal garden that they will design. This is where their creativity and divergent thinking will be exercised. Using different elements that they can choose and play around in creating their game boards, they will become more familiar with the functions of the elements and their relationships to each other. They will be given goals in designing their game boards. The goals are reflective of real-world problems: Protection of Biodiversity, Water conservation, Food Security and Solution to Global Warming. The challenge is for them to find solutions through the combination of the elements and the application of as many permaculture principles as they can. Ultimately, the students will realize that in the interwoven web of life, solving one of these goals also bring solutions to the others.

Permaculture is about rebuilding our lost connection to the land or the earth, how it feeds us and how it sustains biodiversity if we take care of it. Without reference to the land we have no reason to take care of it. It is therefore essential for the students to identify plants and be fascinated with the power in and of the plants.

In Phase C - Let's play with the Cards ... in the Garden - simulating the Cultivation through the Deck of Cards, they will be able not only to identify the plants but also discover their health benefits as well as learn how to cultivate them. Learning how to grow plants is one step closer to addressing the imminent threats of food security. Understanding the dynamics between plants through the Deck of Cards will help the students complete their Parcel Canvas design or game board. The teaching of Permaculture through the Ideal Kitchen Garden game also aims to bridge the gap between the garden book or internet research and the real garden.

Emphasis on hands-on gardening in Phase D - Micro Kitchen Garden Lab - is therefore ideal for the students to learn practical skills for resilience. They will not only learn to grow their food but also have a meaningful understanding of the impact of this in resolving climate change and food security.

STEAM education is promoted to prepare 21st-century skills. With Permaculture integrated into STEAM as presented in this four-phased multi-challenge game, the students are honed to think scientifically, ethically and creatively. These are the kinds of competencies that will be resilient to the fast changing world ahead of them.



3. How to teach STEM through the Game

As stated by Burke (2017) Permaculture is usually to be found in the educational setting as a description of its philosophy, as a design tool and the like. It is rare to be found as a pedagogy per se or as an educational design tool. The whole LivingStem project and the Ideal Kitchen Garden Game (Intellectual Output 4) is intending on changing this status quo. The game presents both the dimensions of permaculture that identify the existing collaborative aspects between living species and its concepts rooted in food justice. This was aptly expressed by Elizabeth Henderson, a long-time sustainability activist as:

“the belief that healthy food is a human right, so everyone has an inherent right to access healthy, fresh food” (Henderson, n.d.).

And Hayes and Carbone (2015) who take it a step further saying that:

“The concept of food justice aligns itself with the goals of social justice, which demand recognition of human rights, equal opportunity, and fair treatment” (Hayes & Carbone, 2015, para. 1).

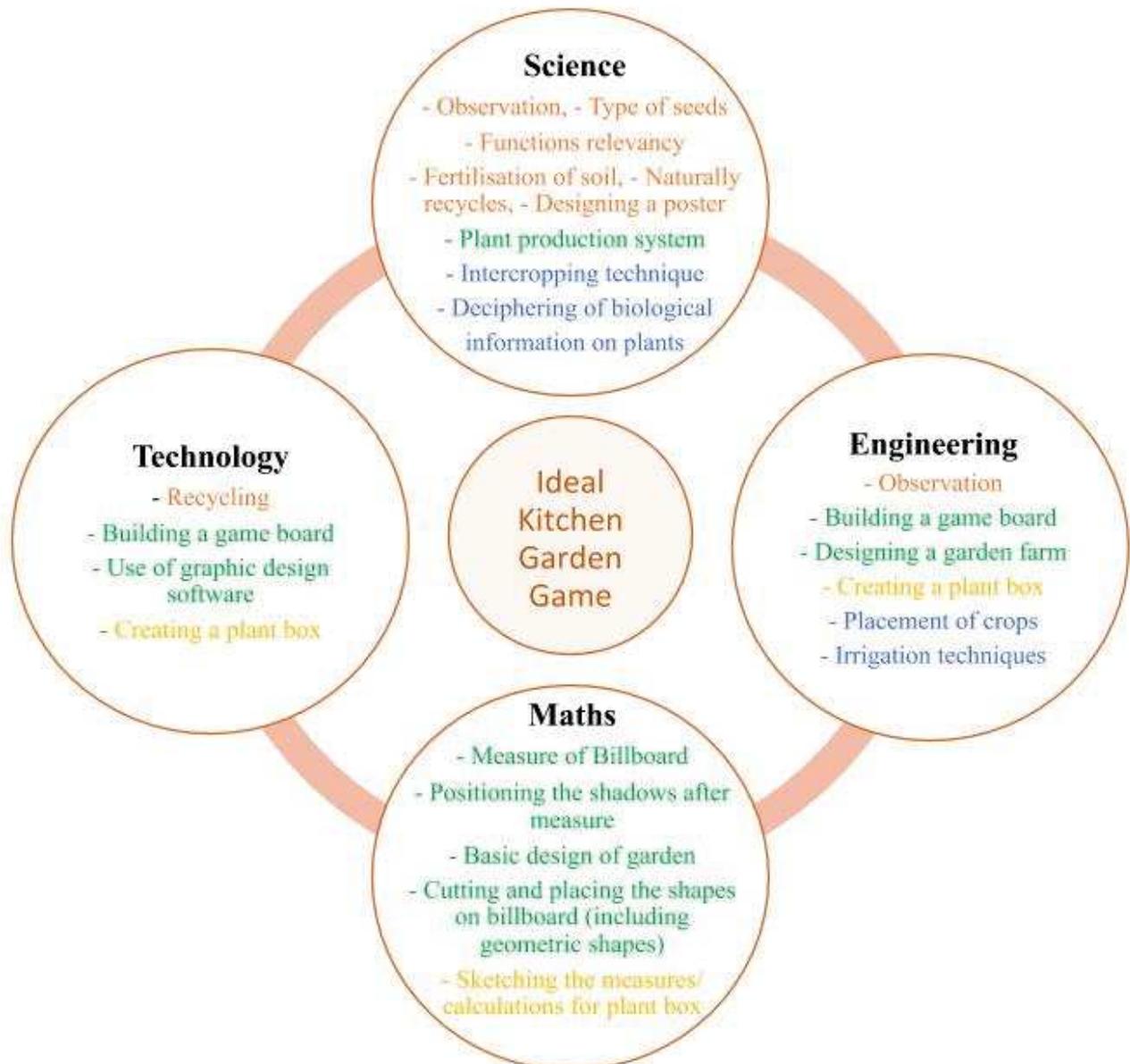
In a recent case study by Luna et al (2018) considering the above and implementing an urban permaculture/ agriculture project they conclude that boundless curricular opportunities arise when investigating the reasons for the pedagogy of permaculture though we should bear in mind the project was within college level.

The ‘Ideal Kitchen Garden Game’ for ages 10-14 with all its Phases A-D as described earlier is inducing the pupils in a playful way to steps such as being thorough, being critical observers and able to record systematically in an organised way, what has been observed to come up with conclusions.

These are basic, fundamental, initial steps in most of the experimental methods entailed in some of the STEM related sciences such as Engineering, Technology and Science and to a lesser extent Maths. Below, we are giving in a graphic form what STEM related activities promoted throughout the phases of the game. In the following graph some learning activities are repeated in the STEM subjects.

This is reasonable and most welcome as it is within the essence of STEM curriculum reformation; founded in the interrelationship between subjects. Science, Technology, Engineering and Maths are joined in STEM education in conducts that show the 'functional relationship between each' (Kuenzi, 2008; McNeil, 1990).

The different colours indicate which activities are advanced through which Phase:



*Orange for Phase A, *Green for Phase B, *Blue for Phase C, *Yellow for Phase D

Evidently, the game through the related STEM activities advances in parallel the pupils' soft and hard skills including problem solving, creativity, critical thinking and cultivates pupil curiosity through observation and hands-on activities; increases awareness and knowledge of the importance of everyday life skills like time management and self-organization.

All the aforementioned can only blossom in an environment where education professionals welcome innovative teaching methods.

Skills and competences:

<i>HARD STEM SKILLS</i>		
Mathematics essential	Mathematics applications	Design
Building & Construction	Plant production systems	
<i>SOFT STEM SKILLS</i>		
Problem solving	Collaboration	Creativity
Critical thinking		

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4. How the use of the cards will support the realisation of the Ideal Kitchen Garden

In order to understand the use of the Deck of Cards and its role in this game, it is important to understand which process it supports. The Deck of Cards is a tool that is used primarily in the process of arranging the permaculture garden in terms of plant associations and locations within the garden. This is part of the Permaculture design.

Permaculture design

Design is one of the most important aspects of building a permaculture garden. Indeed, it is through the emulation of natural systems that we can organize the garden in the most efficient way possible. The idea is to use natural resources and natural mechanisms to help us produce a bigger yield and a healthier garden instead of going against nature to order crops artificially as is done in traditional mass-producing agriculture. Diversity and multiplicity of small ecosystems, as well as favouring natural symbiotic relationships are key into making a powerful, resilient ecosystem.

This design is based on the observation of the elements we want in our garden and how to best arrange them for them to be benefiting the most from each other and from natural resources such as irrigation, landscape, soil, shade or sun exposure, other plants, support, etc.

The design of this ideal kitchen garden is basically the same process on a smaller scale. It also necessitates a visualisation of the different components that can be put inside the garden and their interactions in order to design the most beneficial and efficient combinations of plants. Identifying mutually beneficial pairs of elements is crucial if we want to construct a thriving system that is as self-sufficient as possible.

But all of this seems like such a great enterprise with so many elements and factors to consider, that it can seem intimidating to do, especially for a student.

This is why we created a tool for them to have a physical visualisation of plants, their needs and their benefits.

Why the deck of Cards?

The deck of card is a gamified way to be able to visualize the potential garden in its simplest form.

Each card will supply information that can be useful for the choice of cultivation. Each of those production cards is also paired with its consumption companion. This way, pupils may learn how to cultivate their favourite food, but also what benefits these foods can bring them.

The information contained in the production side of the cards is as follows:



The image shows a sample card for Carrots. The card is numbered '1' in a dark circle at the top. It features a carrot illustration and the text: 'Carrots', 'Biennials, they flower and give seeds the second year'. Below this are sections for 'Plant in full sunlight' (with a sun icon), 'Keep moist with frequent shallow watering' (with a water drop icon), '3 to 5 weeks before the last spring frost (Feb-Mar)' (with a calendar icon), 'Whenever size is up to your taste' (with a bunch of grapes icon), 'Need soft sandy soil' (with a soil icon), and 'Can be grown all over Europe in natural soil' (with a globe icon). At the bottom, there are two circular icons with numbers '37' and '41', and a 'LIVING STEM' logo.

At the top, we can see the number of the card, as well as the colour which gives us the family of the element (seed, fruit, etc.)

Then we have a section with an image of the plant, their latin and common name, and a small description of the type of plant it is: Biennials, annuals, etc.

Then comes all the information about where, how and when to seed the plant: Sun exposure, watering, seeding months, yielding months, type of soil needed, and type of regions where it thrives.

At the bottom of the card, we can see a section holding the numbers of the best buddies' cards. Meaning the plants with which this plant will most thrive if planted together or near each other.

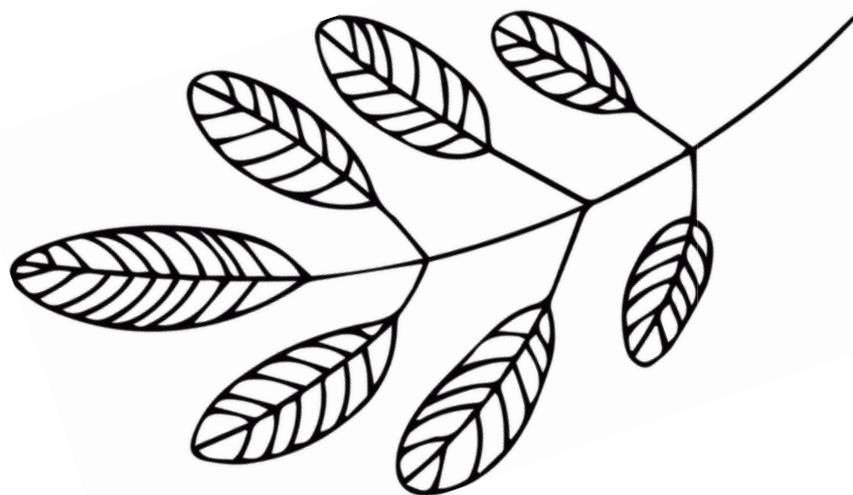
All the basic information necessary to be able to choose where to plant a specific plant is available in a summarised way in the cards.

These cards will allow for a simple, visual, and gamified way, to try out different combinations of plants within a specific space. They will also serve as a basis to understand the way that different elements are linked to one another in the garden and how they may benefit one another.

The pupils will be able to organise the cards/plants as they think is useful and they will also have different ways of working as a team in order to combine cards and imagine new designs.

Of course, real Permaculture design on a big scale necessitates experience and a lot of information. A lot of factors come into this kind of design and it is also important to realise that a design might need revision, and that this is a long process of observation, trial and errors.

The LivingSTEM deck of cards are fun and useful tools in building the knowledge of the students around plants from practical, scientific and nutritional perspectives. They can be useful not only in their learning of Permaculture but also for many other STEM educational activities that can find reinforcement from creative & visual tools.



5. Recommendations to correctly implement the Game

A Communication tips

It is important to communicate to the pupils that they will be involved in a multi-challenge game, not in school activities or laboratories! Like most respectable games there will be teams always made up of the same components from start to finish. The team will have scores based on what they do! The organisation of the game should be planned in one or two months, each phase a week or two. Then Educators will find it useful to record the points gained by the teams on a scoreboard !

B Competition or empowerment?

Competition is part of the games and it is certainly a stimulus to engage the players. Our game also has a scoring system. Of course, there must be healthy competition in which players challenge themselves to find the best solutions, not to assert themselves over the other, but to do things in the best possible way.

Each phase will then have a prize for all teams. The award must be organized in time by the teachers. The reward for phase A will depend on what the treasure hunt venue offers. Some suggestions have already been given, but the teacher can agree other solutions with the owner/manager of the place. Similarly, after phase B and phase C, where - respectively - soil and seeds to be used in phase D will be given, the teacher should organize in time what to be distributed, taking into account the quantities that will be needed in the micro gardens that they will prepare. The final prize will also depend on what the school can organize. The winning team will be called to be more responsible, to do something more, in order to get the message across that to be committed is positive! It is very important not to make anyone feel a loser but all winners because they have completed all the challenges!! It will also be nice to have an awards ceremony. Even if the winning team will have a different role, the ceremony belongs to everyone, all the teams should be asked to show and talk about what they have experiences and realised!

C Indoor and outdoor recommendations

Phase A will be outdoor, so it will be important to organize it on time, also checking the weather forecasts, and following all the indications and recommendations contained in the Living STEM project manual, especially with regards to scheduling and safety. Indoor activities will follow the internal safety rules of the schools!

D Partners and stakeholders involvement

It could be of great impact for the schools to cooperate with external partners with specific competences to better implement the game especially the Phase A where the involvement of an association that manages a Permaculture land is more than welcome. Considering that it is not obvious for a teacher to have permaculture skills, the involvement of an expert can be of great utility both in introducing the game to the class and in underlining the main concepts to be transferred through such a game. Additionally, consider that the Phase A can be participated in by the parents of the pupils.

E Refresh background on Permaculture

In the absence of a competent external support, the educators are invited :

- to provide a refresher or background course on the topic of ecosystem in order to integrate the pupils' STEM learning in this game.
- to follow lessons on the 12 principles of permaculture (see annex V) adapted to their age.
- to put emphasis on the 8th Principle: INTEGRATE RATHER THAN SEGREGATE to facilitate the link of permaculture design to their lesson on the ecosystem. The 8th Permaculture principle focuses on the importance of biodiversity. It tackles the different types of relationships that draw elements in an ecosystem together, focusing on how plants, animals and people can gain benefits from these relationships.
- to profoundly comprehend and be able to explain that by the correct placement of plants, animals, earthworks and other infrastructure it is possible to develop a higher degree of integration and self-regulation without the need for constant human input. The educator may also seek the help of the permaculture host in the farm where the treasure hunt will happen.
- to be able to provide relevant examples: like the chicken connection (see Chapter 1 of the LivingSTEM Manual), the three-sisters companion planting explained in IO6 Video Concepts, other examples can be learned from the permaculture farm.

F Doing the game in an “indoor” situation

In case this game is played indoors (including during the Covid19 lockdown), it can also be exciting for the students to play phase B, C and D in their homes with the participation of siblings and even with the input of their parents. That, will invite a family reflection about climate and social issues. It is also possible to use a software application where the students can co-create their project virtually.

G Game variations

The phases of the game can also be implemented with some variations.

- In general you can add time frames: Set deadlines but allow flexibility in the time the students need in every step. Avoid being rigid with time to ensure “Inclusion” practices for “dys” students or students with different learning ways who often need more or less time to process the instructions.
- The Treasure Hunt can continue with Hunting for the permaculture principles. If pupils have been previously introduced to the 12 permaculture principles, the challenge is to find them in actual use or application in the permaculture or organic farm (or garden if no accessible farm). Once the students/pupils are able to identify them and explain how they work, their team gets 25 points.
Example: Principle 6: Produce no waste Can you find how nature naturally recycles? How does it do it? Who participates in the process? A clear explanation of this is worth 25 points! OR In this permaculture farm, how do the permaculturists apply this principle? Do you see rainwater captors? Do they have swales? Ask them what these are and how they work. How about in the vegetable garden? How do recycling, reusing and reducing happen? Clue: Does the mulch of the comfrey reduce the watering needs, or eliminate the use of external fertiliser for the vegetables in the garden?
- In Phase B a variation can be introduced in the design of the garden that can also be done using a graphic design software. In this case, students will have to reproduce both the billboard and the elements to be placed within the software environment.

- Phase C can also be played in different settings:
 - Solo: Either each pupil has a deck of production cards and the opportunity to have their own board game. (All pupils have the same board game in order to favor the number of clever associations) They have access to the whole deck and at the end of the hour, they count the points. The pupil that has the highest number of points wins.
 - All in: All the pupils participate in the creation of a single boardgame. There is only one deck of cards. The pupils may choose to divide the board game in zones where they will build the garden by teams. They need to coordinate with other teams in order to select the best combinations. The number of points of each team is calculated. Extra points are given to both teams if they manage to have best buddies' relations in between zones.

- For phase D:
 - before starting teachers can propose to pupils to:
 - watch some videos for inspiration taking notes on the material necessary: <https://www.youtube.com/watch?v=j8ljkjwlwes>
 - Examine the ideal kitchen garden developed in Phase C, and justify orally the grouping of those specific plants which were considered suitable
 - further difficulties can also be added to the rules also including to create the micro garden in X hours (teachers should take into account the presence of students with difficulties before establishing that X number). For instance pupils can be asked to :

(Rule 2)

 - Visualize the elements from the plant world found through the treasure hunt and name at least 8-10 to grow in the micro garden box within 10 (or more) minutes and with no mistakes in naming them.
 - Name all the requirements for each of the elements within 20 (or more) minutes (e.g sun, soil, water etc).
 - Summarize at least one function for each element and at least 3 relationships between the elements selected within half an hour (or more).
 - Be able to justify orally within 15 minutes (or more) the grouping of plants considered as suitable from phase C and reconsider the ones selected.

(Rule 3)

- Be able to sketch the grow box, the steps to be followed to build it making no mistakes in calculations within one and a half hour (or more).
- Discuss with peers the ideal size of the box

(Rule 5)

- Be able to create a realistic calendar showing the tasks, dates and the person of the team responsible for the development of the plants/ vegetables/ and/ or fruits etc. Or be able to find one ready made from the internet even if it needs modification within 1 hour (or more).

(Rule 7)

- Discuss with peers where to find what necessary and not yet available with spending minimum or no money within 10 minutes (or more)

(Rule 8)

- Be able to plant the seeds within 1 hour (or more)

(Rule 9)

- Be able to assess the work so far (all previous steps) in terms of realistic timeframe, realistic resources, applicability of sketch and combination of the plants, offering the best solution to the challenge your team chose to resolve
- Be able to take care of their grow box until it yields fruits.

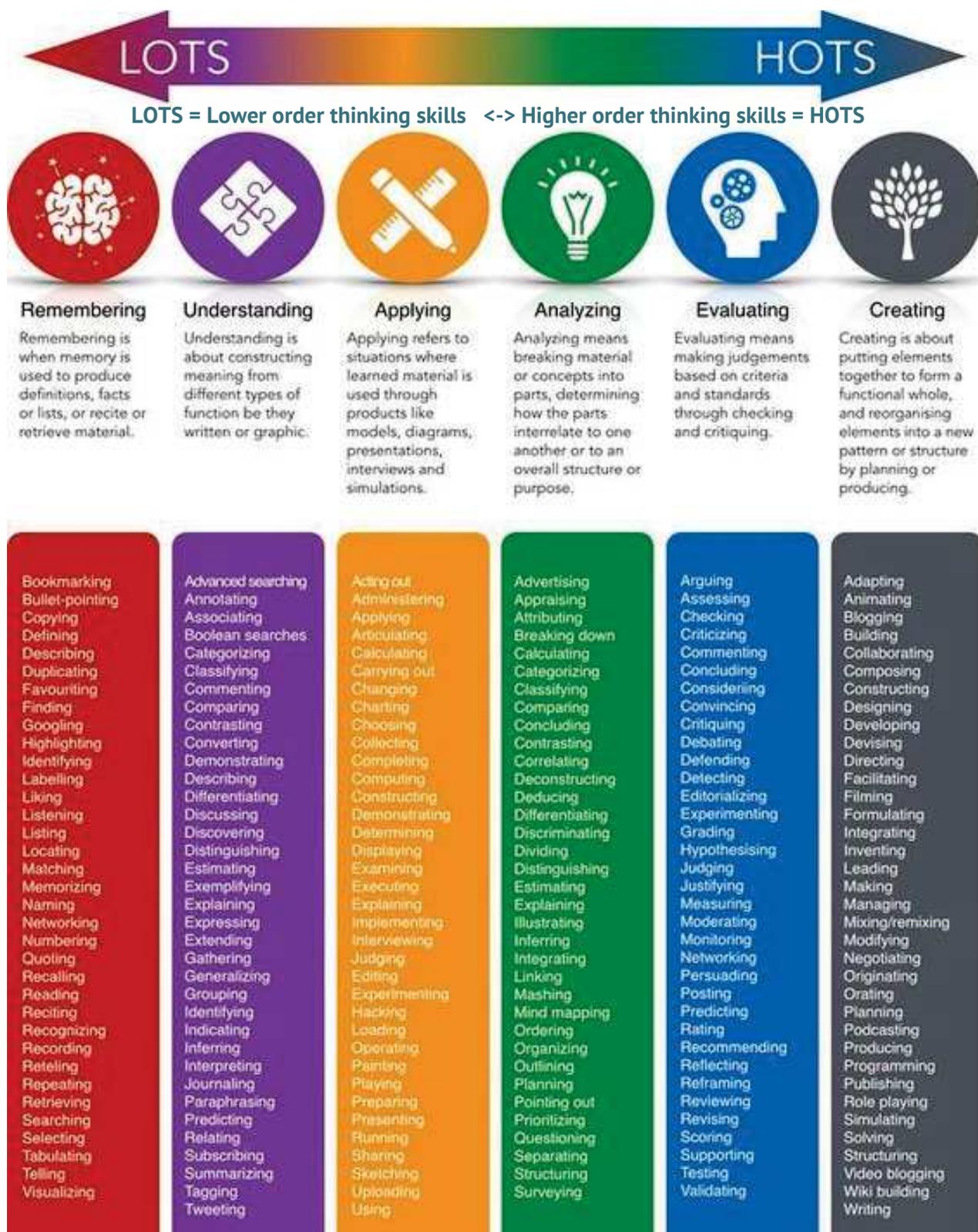
H Reinforce learning

It would be a worthwhile exercise to follow up the phases and deepen the pupils' STEAM and Permaculture learning. For instance:

- Provide the time for the class to discuss their treasure hunt experience after a few weeks to determine learning retention and cultivate the knowledge obtained. There can be open-minddiscussion or impromptu presentations or even planned presentations to allow the pupils to articulate what new information or knowledge is gained and retained. Be curious at the science, math and natural wisdom they may have to derive from it. Example: "Nothing in nature is ever wasted". To holistically comprehend this also translates to enjoying science because the pupils then discover the microorganisms that make this happen. Ethic-wise, they, at the same time learn the power of the small; understand, appreciate and respect all beings regardless of size, colour or looks. Mathematically, they will realise that a handful of healthy soil has trillions of life/organisms in it.
- At the end of Phase B or Phase C, let the teams present their game boards in class and explain how it offers to solve the chosen "scenario/s".

I Educational Learning Objectives

Take into consideration the latest Bloom's taxonomy as shown below (here from the visual of the Bloom's digital taxonomy). It was considered as meaningful for phase D which combines all knowledge, skills and competences obtained from the previous phases A, B and C



Source: <https://wabisabilearning.com/blogs/literacy-numeracy/20-blooms-taxonomy-infographics>