Designing Minecraft-based Learning Activities on Sustainability
Guidelines for Teachers

1. Intro

In this document, we guide the teacher in designing an activity for students with Minecraft. We will do this according to a method we have developed, based on guidelines, examples and activity prompts, aimed at writing a Learning Story focused on a specific topic, which in this case is Sustainability. This method has been tested and refined over three years of piloting in Italian schools, involving over 300 teachers and their primary and secondary school students, in both humanities and scientific subjects.

The foundation of the method is the belief that using Minecraft in school should introduce a certain degree of discontinuity compared to how students use it at home. The objectives change, of course, but so do the methods.

And speaking of methods, we immediately say that the method we propose always involves using the creative mode of Minecraft. As you may know, there are two main game modes in Minecraft: "survival" and "creative":

- In the Survival mode, there are enemies to defend against, materials to procure for building what is needed, and so on;
- In the Creative Mode, there are no enemies, all the building blocks are already available in the inventory, and Minecraft thus becomes a bit less of a game and a bit more of a laboratory.

At home, kids are mostly used to playing in survival mode, while at school you will ask them to play in creative mode, setting aside monsters and predetermined missions to focus on missions set in class. At first, this might be a bit disorienting for them, but experience tells us that it won't take long for them to adapt to the new mode and devote themselves exclusively to the task without distractions.

And here is a second element of discontinuity in this methodology: before building in Minecraft, students will have to design on paper what they intend to do. A bit like architects or designers, for whom the building stage comes only after studying various possibilities on paper. This way, in their building, students will be guided by their previously defined ideas. A sort of declaration before action, which is very different from how students are used to do things at home for leisure, where they generally decide what to do while… they are already doing it!

Finally, a third element of discontinuity: students will work in teams of 3-5 students. This might be new for them, and perhaps for the teacher as well. The goal is to support the **social development of skills**. Disciplinary skills but also 21st-century skills, starting precisely with team working.

At first, it might not be easy, neither for you nor for them. For example, conflicts might arise between students of a same team (not to mention students from different classes of different countries) maybe because each of them has his own idea of how the work should be carried out, and it will be important to help students manage and resolve these conflicts. After all, knowing how to deal with conflict is a skill itself.

2. Guidelines for writing a 'Learning Story'

As we have already mentioned, the method we propose is aimed at writing a *Learning Story*, which is a narrative description (approximately a couple of A4 pages) written in *first person* by the teachers involved (the narrators) about the activity to be carried out by the students. The format is *a story*, the story of an event that has yet to happen and which the students will bring to life. To get an idea, you can skip ahead and see an example of Learning Story (Building a Sustainable City).

As you will see, the Learning Story is not intended for the teacher to lead the students' activities: rather, it should serve to create the context in which students can then exercise their creativity and make their own decisions autonomously.

A Learning Story always begins with specifying:

- who the teachers are (for example, "I am a math teacher, teaching at a scientific high school");
- who the students are (for example, "The class for which this activity is intended is a fourth grade with the following characteristics: …");
- why the teachers consider it useful to undertake a certain activity: what are the educational opportunities (or the difficulties you have encountered in addressing a certain topic with traditional methodologies) and why he thinks the activity with Minecraft could be a good approach.

The Learning Story should be possibly designed to fit the existing curriculum and class schedules. When focusing on the educational opportunities related to **Sustainability**, you will find helpful the Activity Prompts we propose later (section 3).

To be a good-formed one, the Learning Story will have to respect some **constraints**, namely **five** *constants* and **seven** *moments*.

2.1. The 5 Constants

Whatever Learning Story you'll choose to write, it is essential that it will respect the following five constants.

1. The activity will be oriented towards the students building one or more artifacts in Minecraft. **The students will be the ones building (not the teacher)** based on a goal provided by the teacher (for example, "Design and Build a Sustainable City in Minecraft").
2. The building stage in Minecraft will always be preceded by a stage in which the students produce a **paper-based plan** of what they intend to build. For example, before building a sustainable city in Minecraft, the students will draw it on graph paper. This stage is crucial to ensure that the students' *acting* (that is building) will be based on a declared plan (a project) and to address problems primarily during the design-on-paper stage, before the building stage occurs (we discuss this in detail in the next section, "Seven Stages"). The students' sketches will serve as a framework guiding and directing their subsequent activity in Minecraft, in line with the objectives initially set by the teachers. Without this preliminary stage, it is likely that the students' building activity in Minecraft will go out of control (as well as the time planned for the implementation).
3. It is important to allow students **a good degree of autonomy** in their activity. One of the strengths of Minecraft is that it allows students to unleash their creativity and enterprising spirit. Past educational experiments have shown that students loose interest in Minecraft when teachers tell them what to do step by step. The Learning Story you'll write and your conduct of the classroom activities should aim for a **balance between constraints** (necessary to guide students and prevent the activity from going out of control) **and degrees of freedom** (allowing students to be creative and autonomous in their decisions).
4. It is expected that the students **work in teams** (small groups of 3, 4, at most 5 students). Within the team, each student should have a different role/responsibility. For example, one could be the spokesperson for the group, another the person responsible for scientific accuracy, and another the technical expert (a role usually filled by students who already have a good knowledge of Minecraft and whom the teachers will ensure are evenly distributed across all teams). Teamwork implies that the involved classes will be divided into a number of teams. Each team will work on its own product, distinct from the others but related to the products of the others. This opens up several possibilities. For example, if the task is to reconstruct a solar energy system, the teachers (or the students themselves) could decide between:

   - assigning different parts of the system to different teams;
   - assigning the same part of the system to all teams (but each group creates its own version);
   - assigning distinct parts of the system (if it is a complex system composed of various parts) to different teams.

   Teamwork also means that it is not necessary to have a Minecraft license (and a PC) for every student: one station per team may be sufficient, ensuring students take turns at the station.
5. Playing Minecraft—and playing in general—can be a very time consuming activity and, as we all know, time at school is precious. Therefore, it is important that you **establish time limits** for Minecraft activities in your project: students need to know how much time they will have to complete a given task, to prevent the Minecraft activity from dragging on indefinitely.

2.2. The 7 Stages

These are the elements that will guide the narrative structure of your Learning Story. In other words, your story should contain the following seven stages:

1. The description of the **starting lesson** (usually one hour), in which the teacher (you, in first person) introduces the students to the topic and goals of the Minecraft activity, forms the various work teams, and establishes a general calendar for the expected design and implementation steps.
2. The description of the **definition stage** (approximately 1 or 2 hours), in which the teams, autonomously but with the support of the teachers, document and delve into the topic on which the activity is focused. For example, if the topic is biodiversity, it will be important for them to gather all the necessary information and knowledge. This stage is important because, before designing, planning, or building anything, it is essential for students to acquire a minimum level of mastery of the thematic context within which they will operate and, at the same time, start to get an idea of the technical and other difficulties involved in achieving the goal.
3. The description of the **ideation stage** (1 or 2 hours) in which each team begins to imagine (for example, by debating and making freehand drawings) various approaches to tackle the project. In fact, there is never only one way to complete a task, and the skill of the designers lies precisely in coming up with and comparing multiple ideas, then choosing the best one.
4. Once the students have chosen the best idea, the **planning stage** follows (one or more hours), where the teams develop the idea by writing or drawing a project (for example, on graph paper) of the object they will then build in Minecraft. This stage is crucial because this is where the first problems should emerge (for example, choosing an incorrect scale, too small or too large, when making a construction).
5. The **implementation stage** is where the students build in Minecraft (the number of hours can vary greatly depending on the size and complexity of the project). The students must adhere to what was previously planned on paper. On this aspect, the teams must be responsible: it is important for them to understand that autonomy and creativity do not mean doing anything that comes to mind *on the fly*. Some variation from the plan can always happen, but it must be justified, and the plan should be updated accordingly.
6. The description of the **evaluation stage** (1 or 2 hours), aimed at verifying the quality of what has been built and its relevance to the objectives initially set by the teachers. The evaluation can be carried out by the teachers, but it could also be done by the students themselves, based on previously self-established criteria; or peer evaluation could be considered, where each team evaluates the work of the others.
7. The story concludes with the description of the **feedback stage** (1 or 2 hours), in which each team presents the product of their work to the other teams, or perhaps to an external audience, with particular attention to describing the design/implementation process (what difficulties they encountered, what they learned, what they would do better next time).

2.3. An example of Learning Story

The example provided below draws inspiration from one of the activity prompts mentioned in the following section and incorporates and adapts the guidelines described in these pages into a specific Learning Story.
We suggest you identify in this example the five constants and the seven moments of the story, as well as the purpose of this activity.

In this particular example, the activity is carried out by students of 2 classes from two different schools/countries. However, it could also be carried out by more than two classes/schools/ countries.

Your personal Learning Story surely would differ from this example, perhaps because you teach a different subject or because your students are of a different age. But most importantly, we would like it to be your own Learning Story, conceived by you, tailored to your needs, and integrated into your (or interdisciplinary) curriculum.

Building a Sustainable City

We are teachers from two schools, a Finnish secondary school and an Italian technical institute, embarking on our first educational experience with Minecraft. Together with my colleague, we have planned an activity for two fourth-year classes. We believe that designing and building a sustainable school in Minecraft is an excellent way for students to explore and solidify some topics related to sustainability, which otherwise risk remaining somewhat abstract.

We plan for the two classes to work together for 2 hours a week simultaneously. The classes will be divided into teams of 4 to 5 students each, with each team comprising students from both schools. We have also decided that each team will work with a single Minecraft license/PC. This way, they will be, in a way, *forced* to work together, a situation they are not very accustomed to. There is also a more practical reason: I have 5 laptops available for use in our usual classroom. If we were to have each student work on a different PC/license, we would have to move to the Informatics Lab every time, which is not always available. Besides Minecraft, students will also use Skype to video call between the different schools. In order to better support the activity, we decided to install the 'Environmental Energy' mod (See Appendix: Minecraft Mods On Renewable Energy and Sustainability).

Building an entire city in Minecraft is no small feat, so we will ask the students to focus on specific buildings/neighborhoods (the hospital, a residential area, the park…). Different teams will be responsible for the design and construction of different sectors of the city, meaning everyone will be working in the same Minecraft online world.

The other teacher and I will present the activity to our respective students (starting lesson). We will make it clear that the use of Minecraft will be tied to a specific goal and that construction in Minecraft will come only after some preliminary design work on paper. Some of them (about half) already use Minecraft at home, and 6 consider themselves "real experts." We decided to let the students form their teams but with one condition: the 6 experts must be distributed among the teams and act as "technical experts." We will also ask each team to designate a spokesperson, a role that will rotate among all members each week. Additionally, each team must have a scientific supervisor to oversee the scientific accuracy of the solutions adopted, along with other roles decided by the students themselves.

We think it would be useful, before starting the activity, to have a recap lesson on all the sustainability topics previously studied that will come into play, and to introduce some topics not yet covered but necessary for tackling the task. To inspire them, we will show some videos presenting examples of sustainable cities, so they start getting an idea of what they will need to do and how. We don't want to guide them too much,

to dictate what they should do: we want them to figure out the problems involved in the task (definition stage). Rather than guiding them, we aim to support them. For example, if we notice they are not considering some aspects of sustainability, we will ask them stimulating questions to prompt reflection on these aspects.

When we think they have a clear enough understanding of the topic, we will support them in moving to the ideation stage: it is essential for them to understand that there is no single way to create something and that many decisions need to be made before starting construction.

The first decision is who does what, meaning the division of different sectors of the city among the teams. Then we support the teams in agreeing on strategies to coordinate with each other. We do not expect the students to make the right or best decisions immediately; in fact, we foresee many initial wrong decisions, which we will then help them reflect on, without replacing their decision-making process.

Once a strategy is defined, the students start sketching ideas on paper (such as freehand drawings) to explore various approaches and choose the best one. After choosing, each team will draw their city sector on a different graph paper sheet. We set a maximum of 2 hours for this work.

Now the eagerly awaited construction stage in Minecraft (Implementation) can finally begin. For some, it is a completely new experience. The expert students take the lead: in each team, they explain the main functions to their classmates, who start getting familiar with building small objects. We make it clear that the Minecraft activity must adhere to the technical drawings. They will have a good degree of autonomy, but we will not allow them to "forget" about the project. It is hard to predict how much time it will take to build the city, but after the second morning of construction (2 hours each morning), we start to get an idea and realize that much will depend on their organizational skills. We want to avoid a situation where only the expert student does all the building in each team, so we ask them to share the computer time equally among members.

Communication between the different teams is handled by the students who are acting as spokespersons at that moment.

Once the reconstruction is complete, we dedicate 1 hour to evaluating the activity, which will also serve as a feedback session. We want the students themselves, one team at a time, to assess their work: what decisions were right, which were wrong, what and how they could do better next time, and most importantly, what they believe they have learned.

3. Activity Prompts

Here are some Activity Prompts that could inspire in writing your own Learning Story about Sustainability.
Remember: you can also decide not to follow one of these prompts, and start from a different/ personal one.

1. Sustainable Buildings and Their Surroundings

Objective: Design and construct eco-friendly buildings and communities.

Activities:

- Green Architecture Challenge: Students create buildings using sustainable materials (like bamboo, wood) and incorporate green technologies (solar panels, wind turbines).
- Eco-Village Project: Collaborate to build a self-sufficient village with shared resources such as community gardens, rainwater harvesting systems, and energy-efficient homes.
- Smart City Planning: Use redstone and command blocks to create automated systems for energy management, waste disposal, and water conservation within the city.

2. Sustainable Energy Solutions

Objective: Implement and manage renewable energy sources.

Activities:

- Renewable Energy Park: Construct a park showcasing different types of renewable energy sources (solar, wind, hydro, geothermal).
- Energy Management Simulation: Set up a city powered by renewable energy and simulate energy demands. Students must balance energy production with consumption.
- Solar Car Racing: Build and race solar-powered cars, teaching the principles of solar energy and engineering.

3. Sustainable Traffic Solutions

Objective: Develop eco-friendly transportation systems.

Activities:
- Electric Vehicle Network: Design and build a network of electric vehicle charging stations around a city.
- Public Transit System: Create efficient public transportation systems, including electric buses, trams, and bike-sharing stations.
- Traffic Flow Optimization: Use redstone circuits to create traffic lights and manage traffic flow to reduce congestion and emissions.

4. Sustainable Food Solutions

Objective: Promote sustainable agriculture and food systems.

Activities:

- Urban Farming: Develop rooftop gardens, vertical farms, and community gardens within the city.
- Farm-to-Table Simulation: Create a food production and distribution network that emphasizes local and organic farming.
- Aquaponics and Hydroponics: Build and manage aquaponic and hydroponic systems, teaching students about alternative farming methods.

5. Sustainable Recycling Solutions

Objective: Encourage recycling and waste management practices.

Activities:

- Recycling Center: Construct a recycling facility where students sort and process different types of waste materials.
- Upcycling Workshop: Create new items from recycled materials, promoting creativity and sustainability.
- Waste Management Challenge: Develop an efficient waste collection and disposal system for the city, minimizing landfill use and maximizing recycling.

6. Sustainable Nature Surroundings and Supporting Biodiversity

Objective: Enhance natural surroundings and promote biodiversity.

Activities:

- Biodiversity Park: Design and maintain a park that supports various plant and animal species, incorporating features like ponds, birdhouses, and native plants.
- Wildlife Corridors: Build corridors that allow wildlife to move safely through urban areas, connecting green spaces.
- Forest Restoration: Replant deforested areas and manage forest ecosystems to support biodiversity.

7. Sustainable Free Time Possibilities

Objective: Develop eco-friendly recreational activities and spaces.

Activities:

- Eco-Parks and Playgrounds: Design parks and playgrounds using natural and sustainable materials, with activities that promote environmental awareness.

- Green Festivals: Organize in-game festivals with themes of sustainability, featuring educational exhibits and eco-friendly games.
- Nature Trails: Create and maintain nature trails for hiking, cycling, and bird-watching, encouraging outdoor activities that connect with nature.

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8. Sustainable Schools

Objective: Build and manage sustainable educational institutions.

Activities:
- Eco-School Campus: Design a school with sustainable features such as green roofs, solar panels, rainwater harvesting, and energy-efficient classrooms.
- Environmental Clubs: Establish in-game clubs where students work on sustainability projects and share their progress with other classes.
- Sustainability Curriculum: Integrate sustainability into the Minecraft school curriculum, with lessons on renewable energy, waste management, and biodiversity.