Teaching about Raw Materials and Geology at school: the BetterGeo Mod and the engagement of youngsters as Young RM Ambassadors

Luca Giorgio Bellucci[1], Silvia Giuliani[1], Renata Łapińska-Viola[2], Alberto Zanelli[2], Armida Torreggiani[2]

[1] ISMAR-CNR of Bologna, Italy
[2] ISOF-CNR of Bologna, Italy

Abstract

With an increasing population requiring new technologies demanding larger quantities of a wider array of minerals, our society is increasingly reliant on minerals and metals. To help raise awareness about these issues and Geology, the use of games as learning tools can be a valuable way to help pupils learn while having fun. BetterGeoEdu, an European project funded by EIT RawMaterials, was designed to support formal and informal educators in teaching and learning about mining issues by using Minecraft, one of the most popular video games in the world where the player has to survive in an open 3D world by collecting raw materials to create tools and buildings, and by mining for metals and minerals to advance in technologies. By altering Minecraft's base functions with realistic Geology, the BetterGeo modification (mod) adds multiple new rock types, including corresponding ores along with realistic locations for them in the virtual world. What was called "stone" in the original version is now gabbros, limestones, banded iron formations, shales, gneiss, etc. In addition, educational materials (exercises and relative instructions) targeted to children from 8 to 12 years old, were developed by using the mod and were proposed to teachers, museums, geoparks, and activity centers thanks to train-the-trainer programs as well as freely available exercises and instructions on the website. In order to involve teenagers in the dissemination action towards society, high school students from 15 to 18 years old, in collaboration with another European Project called RM@Schools, were asked to act as "ambassadors" of raw materials (Young RM Ambassadors) and involved in activities at primary and middle schools, by tutoring younger students during the game phases and the execution of the exercises in class. The combination of skills by young tutors, their ways to communicate, and the experience of teachers and researchers helped to bridge the generation gap that often separates adults (including teachers) from the world of gaming, which instead attracts and fascinates children and teenagers. This contribution describes the experience attained during the school year 2021-22 in the framework of mandatory work-related learning activities for secondary school students in Italy.

Keywords: *Serious Games, Raw Materials, Minecraft, Circular Economy, Young RM Ambassadors.*

1. Introduction

Nowadays, societies are increasingly reliant on raw materials (specifically minerals and metals) due to population growth and the need for new technologies The European Union (EU) is committed to the development and sustainable use of raw materials through "The European Green Deal" action plan [1] that aims to boost the efficient use of resources by moving to a clean, circular economy, restoring biodiversity, cutting pollution, fighting climate change and encouraging citizens to work towards a greener and more sustainable Europe. Education of younger generations plays an important role in addressing these key challenges, equipping students with skills and knowledge necessary to face the climate emergency and biodiversity loss [2].

Games and videogames are effective in the way they catch the interest of the gamer, whether it is by completing different scenarios, getting to the top of the scoreboard, or telling a captivating story. Gamification takes these aspects, such as feelings of achievement, cooperation, competition, and storytelling, and uses it in new contexts, which are not games in themselves [3].

2. BetterGeo Mod – better geology in Minecraft

Minecraft is one of the most played video games in the world. It revolves around surviving in an open 3D world by collecting raw materials to create tools and buildings. Mining for metals and minerals is a big part of the game and allows the player to advance in technologies, reaching new environments quicker and more efficiently. It can be altered by players who want to create their own modification (Mod) to satisfy their imagination by adding new items, blocks or features. The BetterGeo Mod was developed by programmers, communicators, and geologists, in order to introduce more realistic geology in Minecraft. Indeed, while the game is undeniably hugely popular, and does teach the player something about different raw materials and where they come from (i.e. from the bedrock), the geology in the game is very simplified and encourages ideas of mining being a low-tech field, built on manual labour, searching for minerals in deep tunnels under ground [3]. The BetterGeo Mod adds multiple new rock types, including corresponding ores along with realistic locations in the virtual world (Figure 1). The new rocks are given a realistic stratigraphy with everything from magmatic, metamorphic, and sedimentary rocks, along with intrusions of different kinds. Even the surface has changed, with soil types now modelled after quaternary deposits of different tills, pebbles, clay, etc., instead of the original soil that was just called “dirt” [3].

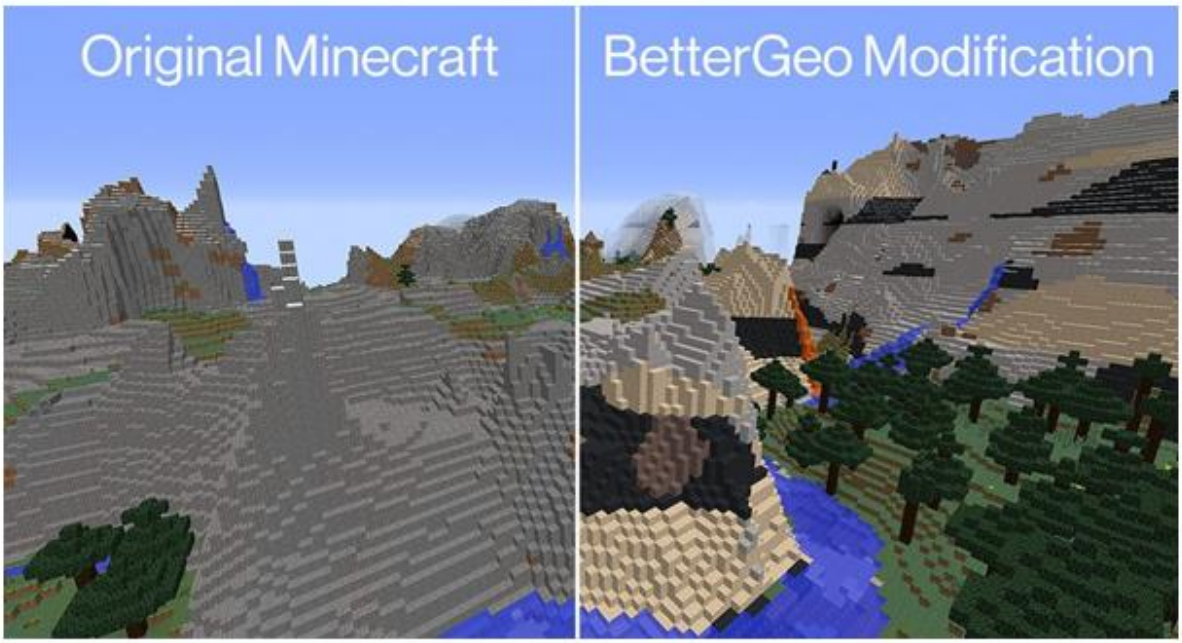

Figure 1: The diverse geology of BetterGeo in comparison with the original Minecraft world generation.

In order to provide primary school teachers with material to teach about raw materials, circular economy, and sustainability with Minecraft and BetterGeo Mod, exercises and related educational materials were developed/tested by an European Project, BetterGeoEdu [4], funded by EIT RawMaterials, and involving a strategic consortium of 7 EU partners for two years (since 2020). These exercises can be now used either “online” with computers, letting students actively play the game, or “offline” by using game elements and inspiration without using computers. Teaching resources, installation guidelines and step-by-step instructions are freely available in the project website [4].

3. Engagement of youngsters in geology communication

Student engagement is an important predictor of choosing science-related careers and establishing a scientifically literate society. Studies suggest that learners chose whether to seek a career in science, or not, as adolescents (12 to 16 years old) and those who report more positive experience with school science are far more likely to continue to pursue science after this age. Due to its pervasive positive influence, fostering student engagement is a prime objective for interventions aimed at improving student outcomes [5]. Thus, with the aim of encouraging an active learning on the sustainable use of raw materials and geology-related topics at school, some students from high schools were involved in

Figure 2: Top: a scheme of the exercise "Rocks and Minerals" with Play-Describe-Recognize steps. Bottom: some picture of the "in class" activities.

using BetterGeoEdu Mod-related exercises and in communication of some contents i.e. to children at primary and middle schools or to general public during open-access events. Students engagement with society was possible thanks to the link with another EU project called Raw Matters Ambassadors at Schools (RM@Schools) [7], which aims to transform students in Science Communicators (Young RM Ambassadors).

The learning path was set up by following three steps:

Phase 1 - Knowledge content and students' training: Students are introduced to relevant content knowledge on raw materials, rocks and minerals and their uses as well as in the BetterGeo-related educational exercises and the BetterGeo methodology.

Phase 2 - Plan and collaboration: Students then engage in planning the communication action with society outside of their school and in collaborating with experts for all the organising aspects

Phase 3 – Implementation out of high school: Students acted as tutors during the game phases and the execution of the exercises in classes at primary and middle school or during public events.

The learning paths' implementation consisted in 4-5 sessions that occurred during 3 months of 2022 and involved one class from Liceo A. Righi of Bologna (IT). The combination of skills by young tutors,

Figure 3: Top: map of the BetterGeo Hunt exercise. Bottom left: a picture of the "in class" activities. Bottom right: scheme of the circular path of raw materials.

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heir ways to communicate, and the experience of teachers and researchers helped to bridge the generation gap that often separates adults (including teachers) from the world of gaming, which instead attracts and fascinates children and teenagers. This strategy aimed at obtaining two results: on the one hand, it offered high school students the opportunity to deal with educational and dissemination aspects related to scientific issues and problems; on the other hand, it provided younger children some reference figures close to their age in which they can identify with.

The following sections describe the activities tutored by students in schools.

3.1 Rocks and Minerals at Primary School

The exercise "Rocks and Minerals" takes the students through 6 rooms in the virtual world of Minecraft, in a special map made for the exercise. The map is filled with instructive signs. In the first 3 rooms, students examine 3 rocks and sketch them on paper while trying out hardness and other features (colour, texture). To get to the last 3 rooms students need to answers some questions about

the rocks they just saw. When the students have chosen the right answer, they are presented with a mineral in a display case that they have to sketch and write down the name. When all rooms have been completed, students try to identify real samples of rocks and minerals by comparing them to the sketches and experiments they made during the game (Figure 2). After the exercise, the Ambassadors introduced students to the rocks and minerals, to their use and what metals can be extracted from them in the real world.

3.2 BetterGeoHunt at Middle School

BetterGeoHunt is an exercise that develops orientation skills, teaches about the importance of circular economy for our society and improves the students' ability to work in a team (groups of 4-5 members). To successfully find the hidden treasure, the teams had to complete an orienteering route and solve various tasks. They had to find points with the help of a map (Figure 3) and a compass in the game. The tasks touched every step in the raw material circular economy scheme, and, in the end, each team had to answer three questions related to the tasks they performed. During the exercise, the Young Ambassadors explained and discussed with the students all the different phases of the circular path of raw materials (Figure 3, bottom right) connecting them to the points of the BetterGeoHunt path. The concepts of reuse, sharing, repair, refurbishment, remanufacturing and recycling were explained to create closed systems that minimize the consumption of material and energy resources and the generation of waste, pollution and emissions.

3. Conclusions

The use of BetterGeo has proved to be an effective way of interesting children to topics related to raw materials exploitation, circular economy, and sustainable development. Its use during classroom activities can help teachers and educators to engage students in discussions around future societal changes and issues they will face in their adult life. In addition, the involvement of high school students as tutors for younger children is to be welcomed and encouraged with the inclusion of such activities in specific after school programs, for example the Italian “Percorsi per le Competenze Trasversali e l'Orientamento”, (Italian for Paths for Transversal Skills and Orientation, or PCTO) that are mandatory for Italian school curricula.

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