

EXPLORING MINECRAFT AS A TOOL FOR GEOSPATIAL EDUCATION

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Abstract

The advanced technology of video games is considered to promote motivation, excitement and participation of users, and this kind of interactive engagement is proved to improve learners’ understanding and outcomes. As Minecraft is a world-famous game widely known as an educational platform, the aim of this paper is to investigate what is unique about it and how it can be utilized by geospatial education. Thus, it is made a general overview of the game, its specific features and versions, and the place it takes in the world of video games. This research is followed by a solution developed for the environment of Minecraft, and the main steps, benefits and challenges are presented. It is extended with an questionnaire on audience approval of game-based learning, gamification and Minecraft in particular.

Keywords: geospatial education, Minecraft, game-based learning

INTRODUCTION

While traditional learning is based on teacher-student interaction, this focus changed during the last decades. The contemporary technologies, including internet, virtual reality (VR)/augmented reality (AR), and video games, are gaining growing popularity. Their applicability in the classroom has been a subject of studies for a variety of academic researches since 1970s, when educational researchers felt there’s a need to have a different instructional design in the classroom [18]. The traditional teaching methodologies have failed to invoke learning interest, especially in hard disciplines like mathematics and sciences. On the other hand, regarding to modern education perspective, video games seem to be the needed tool to advance cognitive development, creativity, innovativeness and organization.

MINECRAFT

The current paper focuses on the use of Minecraft as an educational tool, which is not a new idea. Created and published by Mojang in 2009, and bought by Microsoft in 2014, it becomes one of the most popular sandbox games in the world. The term ‘sandbox’ refers literally to sandbox, emphasizing the great degree of creativity within this kind of video games.

Its applicability for education are studied and presented in [4], discussing its capability ‘to benefit the learning process in scientific or social way’, containing ‘amazing opportunities for development in field of scientific education’, and concludes that ‘despite the game limitations, possibility of usage in educational field education is limitless’. Today, 7 years after this paper was published, not only Minecraft’s popularity has grown but its opportunities for the purposes of education.

Regarding to [15], by September 2019, 112 monthly users play Minecraft, and its versions, on games consoles, computers, mobile devices. The average age of a Minecraft player is 24 years old. At first sight it might be difficult to propose what makes Minecraft such a hit, but the given explanation by [14] sounds reasonable at last: ‘It’s a system for fitting pieces together to create something — sometimes amazing somethings — from nothing. "Minecraft" provides endless building blocks and a blank canvas; it’s up to you to create something incredible, or silly, or referential, or whatever else using the tools it provides. The tools are blessedly user-friendly, as are the systems for employing those tools.’

The choice of Minecraft as an educational platform, opens the door to a large community on which one can rely. The access to it is available through its official website [13], containing four main sections:

- Games – links to Minecraft, Minecraft Dungeons, Minecraft Earth and Minecraft: Education Edition;

- Community – including news, streams, official Youtube channel, community creations and discussion and help;
- Merch – the official store of Minecraft;
- Support – the help center.

Some Applications of Minecraft in Education and (Geo)spatial

Regarding to [10], gamified learning tools, like Minecraft, give students 21st century skills (creative thinking, reading and writing skills, computational thinking), job preparedness and STEM, and social-emotional development, as well. 98% of teachers who use Minecraft in their classroom mark problem solving as the main skill their students learn from Minecraft, and 71% of teachers using digital games reported improvement in computational thinking and numeracy skills.

In [2] is described a study on the effect of video games on the development of generic skills like problem solving, communications, resourcefulness and adaptability in higher education students. The games used in this pilot project were selected with the assistance of professionals from industry and academia and included 8 titles, one of which was Minecraft. Regarding the conclusion ‘playing video games can have a positive effect on communication ability, adaptability and resourcefulness in adult learners’ and ‘also suggests that graduate skills may be improved in a relatively short amount of time [...] over a period of eight weeks and representing just 14 h of game play’.

Minecraft is also a game that promotes creativity in players. Considered as ‘digital LEGO’ [17], in [8] a participant in the study shares his opinion ‘I enjoy molding it [Minecraft], so adding things that weren’t in there originally. And I am fascinated by automation systems, so I’ll have mods that allow me to instead of building my own stuff, I’ll start a factory that will build the stuff for me.’

The study presented in [11] is focused on how VR can assist architects at the early stages of ideation and design. Compared to conventional CAD systems, which offer many design functionalities, but require long time to master and seems not so suitable to support initial architectural design concepts, Minecraft allows players to creatively build virtual objects with textured cubes in worlds made from voxels, and this inspires a designing system based on a simple set of operations.

In [1] LiDAR technologies are used to measure the 3D urban greenspace which data was being a subject of experiment on new methods for mapping by Geographic Information Systems (GIS), Minecraft, 3D printing and Computer Numerical Control (CNC) milling processes. Minecraft was applied for visualization of GeoTIFF images on Raspberry Pi. Being presented on several exhibitions it raised discussion on both the data and the visualization itself as a tool to ‘be in’ the model allowing to see it and understand it in a new way.

Spin-off games

There are four different versions of Minecraft. Here is what each of them represents:

- Minecraft – described as “an adventure of limitless possibilities to build, mine, battle mobs, and explore the ever-changing Minecraft landscape”. It can be played in two different modes: “Creative Mode” to build a dream world based on personal imagination and the limitless resources of the games; “Survival Model” to explore the landscape, construct shelter and fight night creatures. It can be played single or multiplayer. It is available for computer (Windows, Mac, Linux), mobile (Android, iOS), console (Xbox One, Xbox 360, Nintendo Switch, PS4, PS3, PSVita, Wii U, Nintendo 3DS) and other platforms (Fire, Fire TV, Gear VR, Oculus). The single license price is affordable low (about 30 dollars but could be found for less on sale).
- Minecraft Dungeons – a brand-new dungeon crawler game coming in spring 2020. It is available for up to 4 people playing together. Supported platforms include Windows, Xbox One, Nintendo Switch and PS4. It is currently available on pre-order at the price of about 20 dollars.
- Minecraft Earth – another brand-new game announced in 2019. Based on augmented reality (AR) technology it offers experience to create, explore and survive on the overworld map. Allows collaborations between players. The supported platforms include Android 8+ and iOS 10+. It is free to play.
- Minecraft: Education Edition – regarding to [13], it is ‘a game-based learning platform that promotes creativity, collaboration, and problem-solving in an immersive digital environment’. The supported platforms include both Windows and Mac. It is available via early subscription of 5 dollars. Without a license, M:EE is

still available for use but for a limited number of logins – 25 for educators and 10 for students. In order to login and purchase it, an Office 365 Education account is required.

Among this variety Minecraft: Education Edition stands out as a platform for learning. Therefore, a special overview of it will be made in the following lines.

MINECRAFT: EDUCATION EDITION (M:EE)

Regarding to [15] the number of Minecraft: Education Edition users is more than 2 million (by 14 November 2017). The number of countries of M: EE users is 115 users (by 14 November 2017).

In the section of M:EE on the official website of Minecraft there are several subsections:

- How It Works – description, key features and impact on classrooms;
- Class Resources – educator resources, starter kits, world library, coding lessons and challenges;
- Community – global Minecraft educators community represented via forum, blog and social media (Facebook, Twitter, Youtube, Pinterest);
- Support – help center, contact and download;
- My Classroom – sign-in to personal account.

Though some of them remind of the main section mentioned above, these are specifically dedicated to this particular edition of Minecraft. All of them are useful for their purpose but for new users it is advisable to take the available ‘My Minecraft Journey course’ in Class Resources – an introductory course for educators who want to integrate M:EE in their classroom. The learning topics starts from ‘Why M:EE?’, followed by others including building community, basic Minecraft mechanics, designing learning experience, etc. with complete duration of 8.5 hours.

Class Resources

There is a number of starter worlds available for download through the website and use in classroom. The list of featured worlds can be viewed or searched by keyword, type and game mode.

There is also a large amount of lessons available both on the app and on the website. They can be filtered by age – 3-5, 6-7, 8-10, 11-13, 14-18, 18+ and all ages. Another criterion is taught subject. Categories include math, science, languages, government, visual art, tech, geography, language arts, animals, business, environment, digital, theater, gaming, history, music, health, religion, safe schools, social good, security in e-learning, computer sciences, careers, special education and leadership.

In terms of current report of greatest interest are the available lessons for 18+ / all ages students in math, science, tech and geography. The currently available lessons relevant to a search by these criteria include topics like ‘Moon Craft 2.0 Lunar Learning’ about ethics of the Moon use, NASA’s Lunar Orbital Platform Gateway, Lunar living, mining the Moon and Lunar transport; ‘History Blocks’ aiming to guide teachers through an activity in which students reconstruct UNESCO world heritage sites; ‘Renewable Energy Sources’; ‘Map the Journey’ for practice in finding locations on a map of United States; ‘Building a refugee Camp’ for planning and creating a refugee settlement, etc.

An interesting example is the ‘Coordinate System Tutorial’ (Fig.1, a)) dedicated to users of all ages who want to get familiar with 3D coordinate system. The guiding ideas of this lesson raise questions on what a 3d coordinate system is, what coordinates mean, map use and navigation. The lesson consists of three activities including exploring and learning about 3d coordinate systems, practice on finding coordinates and practice teleporting. More on it can be found in [3].

‘The City of Florence (Italy)’ (Fig.1, b)) is another example of a lesson for all ages in subjects including art and design, geography and history [19]. The amazing thing about it is that it gives the chance to explore real-life historical and cultural sites from Florence represented in the world of M: EE.

‘Pipe Dreams’ (Fig.1, c)) is about an engineering task on building an oil pipeline from one village to another considering safety, lifestyles, cost and landscape beauty [12]. Learning objectives include students pipeline route planning as a team, engineer a safe, non-intrusive and cost-effective pipeline from the oil source to the processing town, employing critical thought when adding extra safety aspects near rivers and mountains.

‘The Island’ (Fig.1, d)) is another interesting lesson in the field of science, technology and geography [21]. It is about mining from the island and building innovative islands in a world that offers ocean side villages and plenty of coastal

space. Performance expectations include students' collaborations as village teams to mine materials needed for island development, designing an innovative pattern for the islands, focusing on safety, beauty and maximizing land space and determination a purpose for the islands and build of appropriate structures.

'The Eiffel Tower' (Fig.1, e)) is a challenge for students to read a comprehensive description of the Eiffel tower and built it according to the provided specifications [20]. Presuming one Minecraft block equals 1 meter cubed, they have to use a range of mathematical skills to reproduce it according to the provided information.

Most of the mentioned lessons are considered to develop critical thinking, and collaboration as they involve not single students but whole teams. Other mentioned skills include creativity, communication and citizenship.



Figure 1. Examples of M: EE lessons dedicated for students of all ages in the fields of mathematics, science, technology and geography

Registration

The process of registration as a Microsoft educator includes a few simple steps. Being a registered educator is a joint a community of fellow educators and earn badges, as well. The second is a sign of being an active supporter of Minecraft and game-based learning. Each level is unlocked after completing different task, including the My Minecraft Journey course. The final step is application for Minecraft Mentor.

SOLUTION

Choice Software

While ME:E seems a logical choice when it comes to teaching, its usage is limited to educational institutions. As the basic Minecraft remains the most popular, and accessible one for everybody, as well, it was chosen for core solution of the current case study. In order to create own worlds Java edition is required.

Then came the question of how geospatial education could benefit from it. There have already been released tools like GeoBoxers [6] and Geocraft [7] dedicated to geospatial education in the environment of Minecraft and integration of real-world data, modelling, GIS, for dealing with issues in water management, land use, urban planning, etc. As key features for the choice of solution outlined versatility, as well as ease-of-use and affordability which eventually led to Safe Software's FME.

FME's key capabilities include data integration, transformation, conversion and validation, as well as application integration. The supported data types include 3D, big data, BIM, CAD, GIS, LiDAR, markup languages, raster and imagery, satellite images, sensor data, web services, database and data warehouse integration solutions, and business intelligence. Google, Microsoft, Esri ArcGIS and Autodesk are among the technologies of over 450 integration options. Minecraft is the first gaming format added to this list allowing users to bring real-world data from vector layers, rasters, point clouds and 3D models into the world of Minecraft.

Its official website [5] contains extensive information on the following topics:

- FME products – FME Desktop (a subject of the current study), FME Server and FME Cloud; release notes, downloads, licensing.
- Why FME – industry and data type solutions, customer stories, data management.
- Community – forums, ideas exchange, blog, etc.
- Support – training materials, technical support, etc.

FME pricing is divided to subscriptions for organizations, and individual license purchase. However, a few free-license opportunities are also available including: 30-day trial for anyone, 1-year home use, 4-month student license, 1-year license for recent graduates, as well as free ongoing licenses for instruction and unfunded research.

FME Desktop is supported on Windows, Linux and Mac operating systems. Recommended hardware requirements include Pentium 4, AMD Opteron or newer with 8 GB or more of RAM and 20 GB available disk space.

There are some examples of how FME works for creation of Minecraft world, available for download on the FME Community section. The list include the Easter Island (Fig. 2 a)), LAS of a Norway landscape (Fig. 2 b)), vector/raster of Bowen Island (Fig. 2 c)), BIM of Arboleda (Fig. 2 d)), a Vancouver railway (Fig. 2 e)), and even game withing the game represented by a maze (Fig. 2 f)). In addition to them are available extensive explanations on their creation [9].

Workflow

Blocks are the basic units of structure in Minecraft and can be directly placed in the game world [16]. They are arranged in a three-dimensional grid, typically of 1 m size. The textures on their faces are 16x16 pixels, but both of them can be changed using resource packs (APIs which makes it possible to customize textures, models, music, fonts, etc. without code modification).

FME can both read and write Minecraft worlds. In the environment of FME this data exists as a point cloud with 3D coordinates complemented with blockID and blockData. Basic workflow in FME (Fig. 3) include the following steps:

1. Data import – drag and drop data from file browser to an empty FME canvas
2. Data visualization – run workspace to view data

3. Transforming data + modify transformer parameters – a data transformer is added by simply typing on the canvas; double clicking on it allows change of its parameters
4. Data output – a writer is added in order to write data in a chosen output format; running the workspace writes it to disk

To create a Minecraft world from LiDAR measurements it is enough to read the available point cloud information, and write it in the relevant format (Fig. 4). Tested with a simple XYZ file, columns' content is defined through a component map at the data import. Other import parameters like lines to skip, maximum lines to scan, etc. can be also specified, as well as to choose the coordinate system.

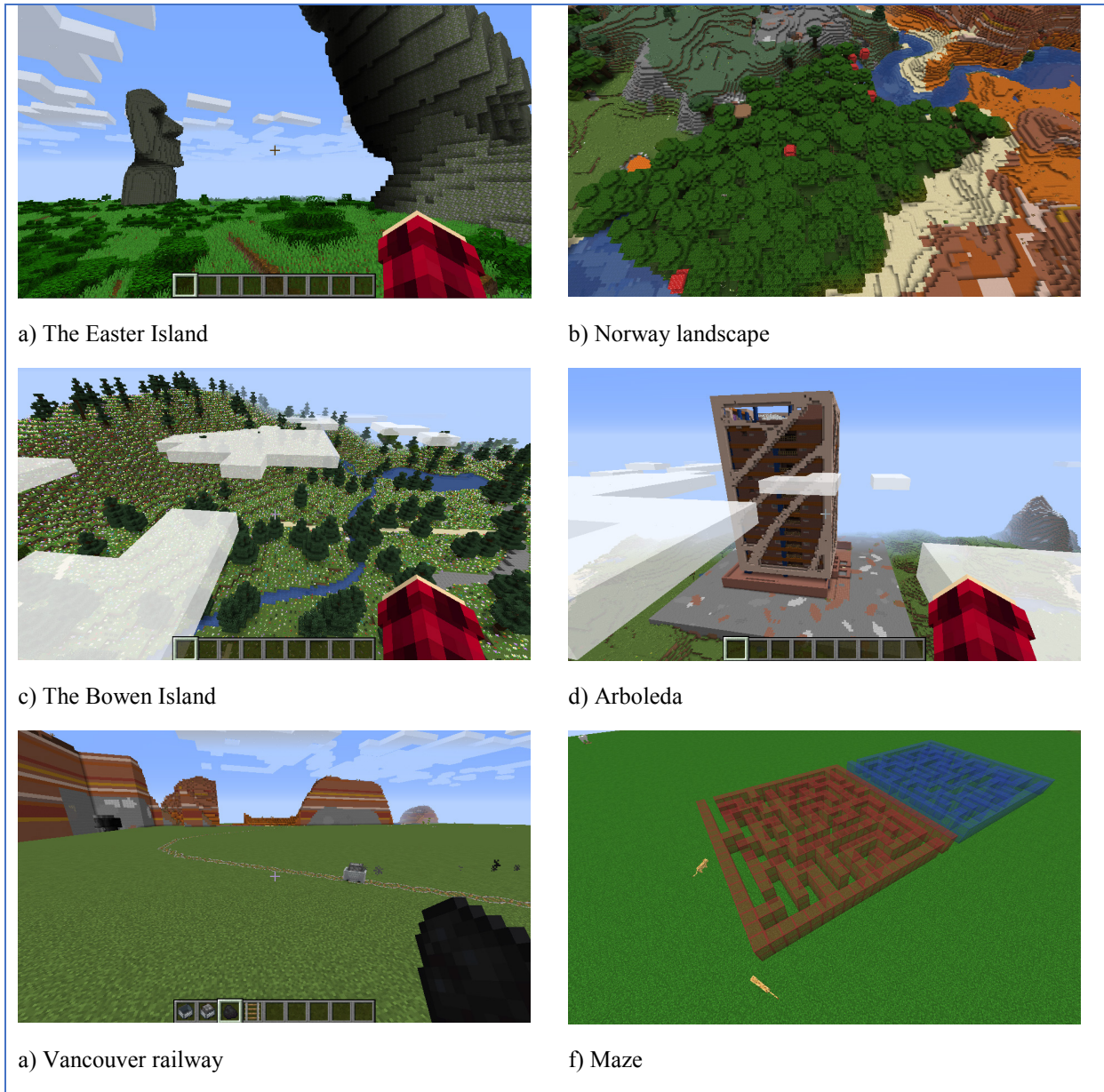


Figure 2. Real-world sceneries in Minecraft



Figure 3. Basic workflow in FME

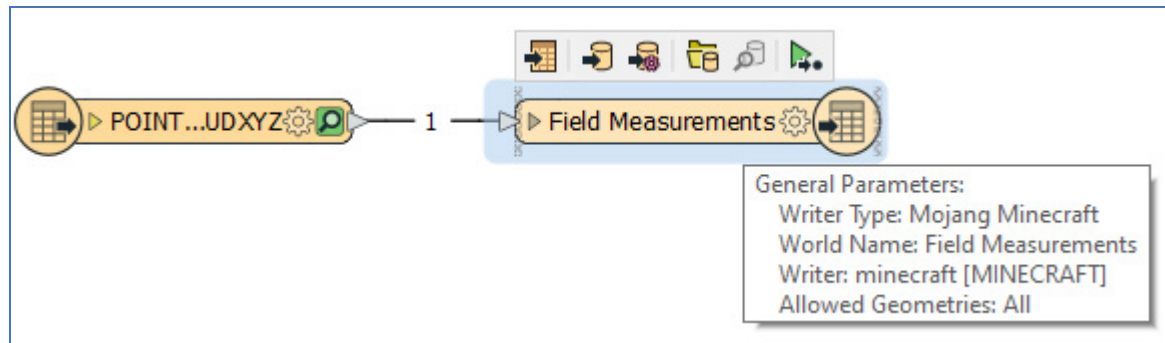


Figure 4. Simple read&write workflow to transform field measurements into a Minecraft readable format

Once the data is transferred into the format of Minecraft, it must be put in the folder of Minecraft's worlds. ".minecraft", or "minecraft" in macOS, is the folder which Minecraft creates to run from. Its location on Windows is "%APPDATA%\minecraft", on macOS is "~/Library/Application Support/Minecraft", and "~/.minecraft" on Linux. The newly generated data must be copied into the "saves" folder there. If there are any other worlds created previously on Minecraft, they can be seen there stored in their own folders.

Regarding to [9] a few essential things to bear in mind when making a Minecraft world are:

- Size: the scale must be considered so it won't take too much time (as if in the real world) to walk the Minecraft world. Also, the heights are limited to values between 0 and 256, and the sea level is at 63, so the altitudes and bathymetry must be scaled to these.
- Blocks: blocks are defined by their blockID and blockData which plays a role in building realistic world both in terms of visual appearance and logic. But for some cases, i.e. creation of a physical map, these components are not important.
- Irregularly spaced input data: direct writing of such data to Minecraft will lead to holes in the world.

AUDIENCE APPROVAL

A questionnaire was held among students in Mine Surveying and Geodesy in the University of Mining and Geology 'St. Ivan Rilski' (Sofia, Bulgaria). The aim was to study the application and approval of gamification and game-based learning, and Minecraft in particular. The number of people who took part is 16, 12 women and 4 men, at the age of 20. Their answers are presented in Fig. 5.

Regarding to the given answers, most of them play video games, although not as an educational tool. Just a few have ever played Minecraft but it is a popular name among them. Most of them think that game-based learning could improve educational process, and it is followed by gamification – the introduction of game elements (passing levels, earning badges. etc.) into the learning process; one student suppose that neither game-based learning nor gamification could enhance education.

In one last, optional question, students were asked to propose a game which they found close to their specialty. Six of them gave their proposal, and half of them gave Minecraft as an answer.

SUMMARY AND CONCLUSIONS

Game-based learning is a contemporary way of gaining learners' attention and enhancing their results, and Minecraft is a worldwide popular video game known for his creativity features, educational capabilities and large community support you can rely on. Both basic Minecraft and Minecraft:Education Edition are affordable and applicable in geospatial. But while the use of M:EE is limited to educational institutions, Minecraft is accessible for anyone.

Creation of Minecraft worlds is much similar to geospatial tasks. With the presented software solution for bringing real data into Minecraft, it turns into simple and yet spectacular modelling tool.

Students also see game-based learning and gamification as methods which could enhance their education, and recognize Minecraft as an appropriate tool. Regarding to previous studies on these topics, as well as the solution and attitude presented above, it is reasonable to integrate it in geospatial education.

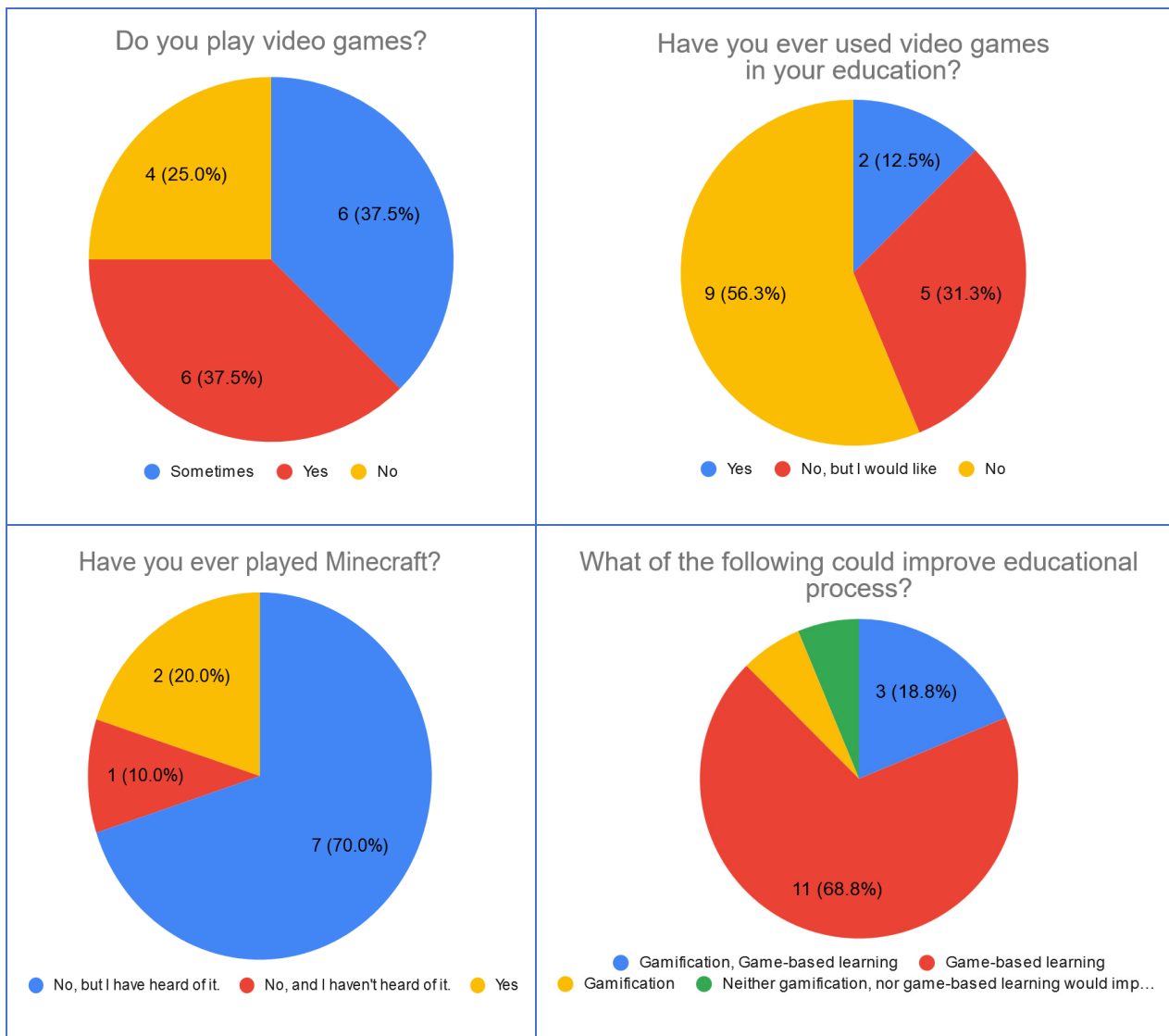


Figure 5. Audience approval

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BIOGRAPHY



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