

A Taxonomy of Minecraft Activities for STEM

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1. Minecraft: Popular and relevant for education

With over 110M players, 241M logins per month, and 2B+ hours played on Xbox alone¹, in 2016 the video game *Minecraft* ascended to be the second most popular game in history, passing Grand Theft Auto V but still well behind Tetris (Peckham, 2016). One way to think about its reach and appeal is that millions of children worldwide decide on a daily basis to interact deeply and meaningfully with a game that is essentially a simulation of the natural world. We believe it is likely that this vast amount of time spent playing *Minecraft* is influencing the way children think about science, technology, engineering, and math (STEM), and are engaged in a research project that explores this question.

Because of its flexibility, appeal, and inherent connections to STEM learning, *Minecraft* has seen a dramatic rise in its adoption by educators worldwide who are using it as a platform for student projects, sharing, and learning (Schifter & Cipollone, 2013; Schwartz, 2015). Interactions in *Minecraft* involve a broad range of educationally relevant content (Lane & Yi, 2017):

- Exploring and investigating different biomes and climates that match those on Earth, including deserts, forests, jungles, taigas, and many others.
- Navigating in and around different types of terrain, such as hills, mountains, caverns, caves, oceans, and more.
- Interacting with a wide variety of wildlife and agricultural content, including animals, fish, birds, wheat, grass, fruits, vegetables, and a long list of fictional content.
- Searching for, mining, collecting, and combining many different resources such as different kinds of wood, stone, metal, dirt, and more.
- Building electrical circuits, switches, complex machines, and automated farms.

Players have even reconstructed world wonders, many of which can be found online (e.g. YouTube, dedicated servers). For example, the Taj Mahal is a popular project, as are fictional places, such as Westeros from the *Game of Thrones*. To achieve such feats of engineering, players often work collaboratively by planning and coordinating their tasks. They assume roles (e.g., mining for resources, planning a base/fort, crafting tools and weapons, etc.), work iteratively to refine their creations, and of course, share their work with friends, family, and the online community. Thus, not only is there a need to better understand how *Minecraft* may frame STEM learning generally, there is also a need to provide research-based support for its use in specific contexts and educational settings.

2. Top level categories of Minecraft activities

Soon after its release in 2009, educational uses of Minecraft quickly appeared online via teacher blogs, YouTube videos, and in educational technology news sites. Arguments for its appeal for STEM learning were often intuitive and compelling (Short, 2012), and its rapid adoption ultimately led to Microsoft's release of *Minecraft: Education Edition*, a version of the game that comes prepackaged with tools specifically for teachers and classroom uses.² However, despite the success and rapid rise of *Minecraft* as a learning environment, very little effort has gone into formalizing its various connections to STEM. If the game continues to be popular in educational settings and we are to work towards evidence-based practices, it will be important to provide a substrate for the activities learners perform while playing. The goal of our taxonomy is to act as one possible foundation for more rigor in

¹ <http://www.wired.com/2015/05/data-effect-minecraft/>

² <https://education.minecraft.net/>

examining *Minecraft*. We seek a thorough, although certainly not comprehensive, overview of everything you can do in *Minecraft*.

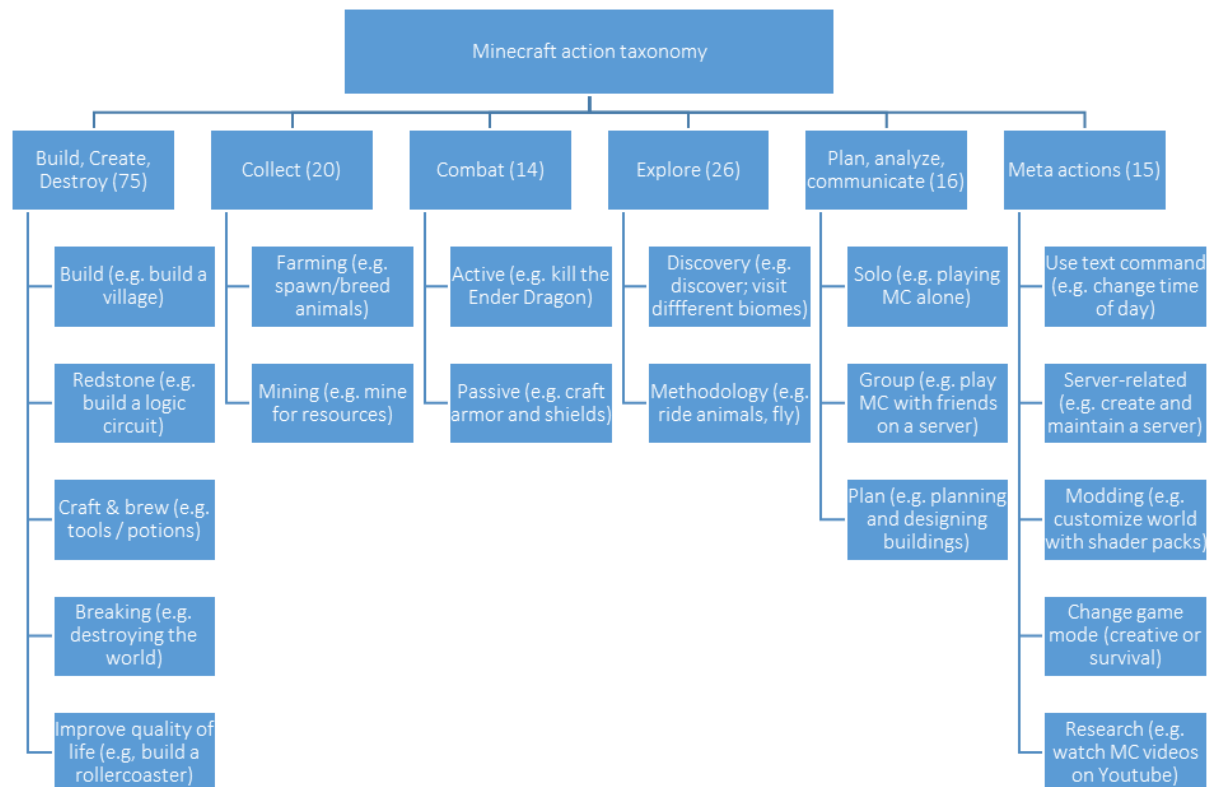


Figure 1. Top two levels of our *Minecraft* taxonomy. The number of actions in each top level is shown in the figure, with 166 total distributed across the sub-categories.

To begin, we reviewed documentation, research literature, discussion boards, *Minecraft* wikis, and interviewed expert players to create a master list of actions. The first three authors independently organized the actions into groups, then came to consensus on the overarching structure showing in Figure 1. Six major categories emerged, showing in the top row of the figure, followed by 2-5 subcategories for each. Common but significant in-game actions were selected for inclusion in the taxonomy, as well aspects of the game that may technically be more as a “way” of playing, rather than a specific action. For example, we have very common activities like “Exploring a new map” as well as “Playing with friends”. Some additional examples are shown in Table 1, along with their corresponding sub-categories and hypothesized STEM relevance codes (assigned by the authors; see section 3).

3. Linking Minecraft to STEM

To map Minecraft actions into STEM, we leveraged the 2010 Classification of Instructional Programs (CIP) Codes from the US Department of Education and National Science Foundation.³ CIP codes provide structure for STEM fields, skills, and professions, also in the form of a taxonomy. The purpose of the CIP is to support the tracking and reporting of fields of study and program completions activity. When combined with our *Minecraft* action taxonomy, the resulting tags become our claims of relevance to those STEM fields. The links trace each action taken to specific STEM fields. For example, building a functioning clock from scratch in *Minecraft* requires an understanding of circuitry, the ability to make the appropriate calculations, and the ability to craft and design a model. Therefore, in accordance with our taxonomy, building a clock would relate to electrical engineering, mathematics, and mechanical engineering (from the greatest to the least significance). Other examples are in Table 1. Furthermore, as the table reveals, some actions are not directly related to STEM, but have important roles to play, whether it be with 21st century skills, or as important mediating roles to play for pathways into STEM.

³ <https://nces.ed.gov/ipeds/cipcode/>

Table 1: Example actions in the taxonomy with STEM codes.

Action / activity (leaf node)	Sub-category	STEM codes
Build structures that can be found in the real world (e.g., Taj Mahal)	Build	ARCH (architecture); CIVE (Civil Engineering)
Build and use a piston	Redstone	MECHE (mechanical eng)
Brew a water breathing potion	Craft	CHEM, MBIO (marine bio)
Plant seeds and harvest a crop	Farming	AG (agriculture); PLS (plant sci.)
Explore caves and undergrad structures	Discovery	GEOL (geology)
Play Minecraft with friends	Group	n/a
Create and maintain a server	Server-related	CS (computer science)
Watching YouTube videos about building	Research	n/a

4. Evaluation of the taxonomy and future work

The most debatable aspect of our approach lies in the accuracy and utility of the STEM tags. For example, does interest in Redstone genuinely mean a learner is drawn towards mechanical engineering? Thus, we view our current set of tags as a set of claims worthy of evaluation. In ongoing work, we are collecting data that seeks to show correlation between STEM interest and Minecraft play, working first with surveys (based on the taxonomy) and in the near future with logs of Minecraft play. In other words, we pursuing the question “To what extent is *Minecraft* a proxy for identifying player STEM interests?”

In addition, we are also pursuing the use of *Minecraft* as a vehicle for *triggering* and *sustaining* interest in STEM (Renninger, Nieswandt, & Hidi, 2015). Specifically, our approach involves the creation of unique maps and “mods” (which are variants on the basic game) that invite learners to explore scientifically valid, but hypothetical versions of Earth. Known as “What-if? Scenarios (Comins, 1993), our approach involves using Minecraft to allow learners to explore and explain the science behind observed differences. For example, if they are on a map modeling earth with no Moon, they may see different terrain than usual, creatures, plants, and more. Support for making observations will be accomplished via signs and educator facilitation (e.g., in summer camps). Also, building on the search for exoplanets that might sustain human life, we also discuss how different variations could or could not support life. The work reported here is intended to provide a substrate for further exploration.

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References

- Comins, N. F. (1993). *What if the Moon Didn't Exist?: Voyages to Earths That Might Have Been*. Harper Collins.
- Lane, H. C., & Yi, S. (2017). Playing with virtual blocks: Minecraft as a learning environment for practice and research. In F. C. Blumberg & P. J. Brooks (Eds.), *Cognitive Development in Digital Contexts* (pp. 145–166). Amsterdam, Netherlands: Elsevier.
- Peckham, M. (2016). “Minecraft” Is Now the Second Best-Selling Game of All Time. *Time*. Retrieved from <http://time.com/4354135/minecraft-bestelling/>
- Renninger, K. A., Nieswandt, M., & Hidi, S. (2015). *Interest in Mathematics and Science Learning*. American Educational Research Association. Retrieved from <https://books.google.com/books?id=F5KRrgEACAAJ>
- Schifter, C., & Cipollone, M. (2013). Minecraft as a teaching tool: One case study. In *Society for Information Technology & Teacher Education International Conference* (Vol. 2013, pp. 2951–2955).
- Schwartz, K. (2015). For the hesitant teacher: Leveraging the power of Minecraft. *Mind/Shift: How We Will Learn*. Retrieved from <http://ww2.kqed.org/mindshift/2015/09/28/for-the-hesitant-teacher-leveraging-the-power-of-minecraft/>
- Short, D. (2012). Teaching scientific concepts using a virtual world—Minecraft. *Teaching Science-the Journal of the Australian Science Teachers Association*, 58(3), 55.