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It Takes A Village: a Collaborative Online Game Supporting Inclusive Teaching and Learning of STEM

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Abstract

Modern engineering, in solving society's pressing problems, requires collaboration. In addition to employing multi-disciplinary teams of engineers, the needs of a diverse set of stakeholders also must be considered. It is therefore essential that engineering students learn to value and consider diverse perspectives on an engineering problem, realizing that there is not necessarily just one right answer.

The iSTEAM project has been addressing this need by creating and running a series of workshops for faculty that focus on invitational rhetoric in inclusive STEM teaching. Participating faculty engage with readings and videos, do gamified activities to make their own classes more inclusive, and meet weekly (over 5 weeks) for discussion. To drive home the need for inclusion and collaboration, participants also play a collaborative online game that the iSTEAM team developed to emphasize the importance of including people with diverse skill sets and perspectives. With a Creative Commons license, participants in the workshops are also encouraged to consider how they might use the game in their own classrooms.

This paper describes the game, its premise, and its underlying themes. It further explains how the game can be used in workshops and other educational settings. Results of pilot tests further demonstrate the benefits of using this game in an educational context.

Introduction

Engineering, like many other STEM fields, requires a firm understanding and rigorous application of numerous foundational principles, theories, and practices. Yet because engineering courses tend to focus on these technical aspects, engineering students could not be faulted for believing that every engineering problem has a "best" technical solution. This view is further reinforced by the competitive nature of shows like Shark Tank and events such as Hack-a-Thons.

In reality, today's engineering problems exist within a socio-technical framework where people are affected by the technical solutions that engineers devise. In courses that focus solely on technical issues, not enough attention is paid to the pitfalls that arise from not considering diverse perspectives, needs, and values. It is well known that designing air bags for the average man made the air bags more dangerous for women and teens (Gupta, 2021). There are many other examples of technologies that, without considering a diverse set of users, can be unhelpful in some cases and downright damaging in others (Wachter-Boettcher, 2017). Spiekermann argues that the values of all potential stakeholders need to be considered in a value-based engineering approach to creating socio-technical systems (Spiekermann & Watkins, 2020).

This dilemma begs the question: How can we get STEM students to truly understand the value of multi-disciplinary collaboration, and encourage them to seek insights from diverse perspectives? We hypothesized that a collaborative game, played in a classroom setting and followed up with a reflective discussion, could help.

Background

In 2023 we initiated the i-STEAM Project, a gamified faculty development learning workshop for enhancing inclusive teaching in STEM using transcultural rhetorical practices drawn from the arts and humanities (Foss & Griffin, 1995). The purpose of this project has been to help STEM instructors to make their classes more inviting and inclusive by changing how they engage and talk to and with their students. The project, and the outcomes from delivery over two years, is described in other ASEE publications (Halada et. al, 2024; Halada et. al, 2025).

As we helped instructors update their course to be more welcoming, we wanted them to learn from different rhetorical framings – drawn from different cultures and found in humanities scholarship – how to make assignments and projects, class activities and discussions more collaborative. We decided to do this with a collaborative game to practically reinforce the value of collaborative (rather than agonistic or confrontational) learning.

Using game elements in non-game contexts has been proven to effectively increase motivation, engagement, and performance among learners (Hallifax et al, 2019). Beyond the traditional points/badges/leaderboards, gamified learning activities can encourage community, collaboration, and constructivist learning rather than conflict and competition (Karakop, 2017). Games that are collaborative have been shown to be effective for helping students to develop habits and attitudes enabling them to work together to solve common problems (Sung & Hwang, 2013; Zeng, Parks & Shang, 2020).

The resulting collaborative game, "It Takes a Village", was designed to underscore the importance of collective effort, resource management, and sustainability within a simulated community context. In competitive settings, students may become more focused on personal achievement, sometimes at the expense of peer relationships or collective success. By contrast, a collaborative framework fosters the development of skills such as communication, negotiation, and collective decision-making, which are critical both in academic settings and in broader societal contexts. Through this game, teachers can highlight how cooperation contributes to effective problem-solving and sustainability, both in the game world and in real-life contexts. This approach aligns with pedagogical principles that emphasize cooperative learning, shared responsibility, and mutual problem-solving—values that have been shown to enhance deeper understanding, critical thinking, and empathy among students. In the workshop, we paired the game play with reading and video discussions about inclusive, collaborative, and solution-seeking modes of learning.

It Takes a Village: A Collaborative Online Game

Peace has returned after a long and brutal war, and the government is re-building. You and your team have been selected to help bring one of the villages back to order. However, you have a limited budget, and only one year, and the weather can be unpredictable. And although you have the assistance of a group of villagers, you have to collaboratively do your part to keep them well fed and happy, so they too can collaborate in the project ... or else they will leave in frustration. Can you bring the facilities back to sustainable levels before you run out of time, and before too many villagers leave?

Gameplay

The game is played in a standard HTML5 web browser, with each player using their own computer. A new game is initiated by a "host" who then shares the randomly generated game code with up to five other players. Players are then asked to choose a role in the game: no role can be assumed by more than one player, and one player must play the Chief. Table 1 shows the various roles, their special abilities, and "skills" that they can apply when it is their turn. Figure 1 shows the selection screen.

Table 1. Player roles

Role	Ability	Skill	Skill Cost
Chief	Assign villagers to work roles	Increase village's reputation by 1; at 3, get a new villager	6
Doctor	Heal sick villagers	Vaccinate villager, making them immune to illness until next mutation	3
Scientist	Reveal location of apple trees	Predict next event	4
Sociologist	See how happy the villagers are	Remove effects of least effective & least favorite tasks until next mutation	3
Farmer	Seeds planted mature 1 day earlier	Permanently fertilize 1 plot of land	4
Engineer	Upgrade materials to boost progress	Convert bricks to steel	6

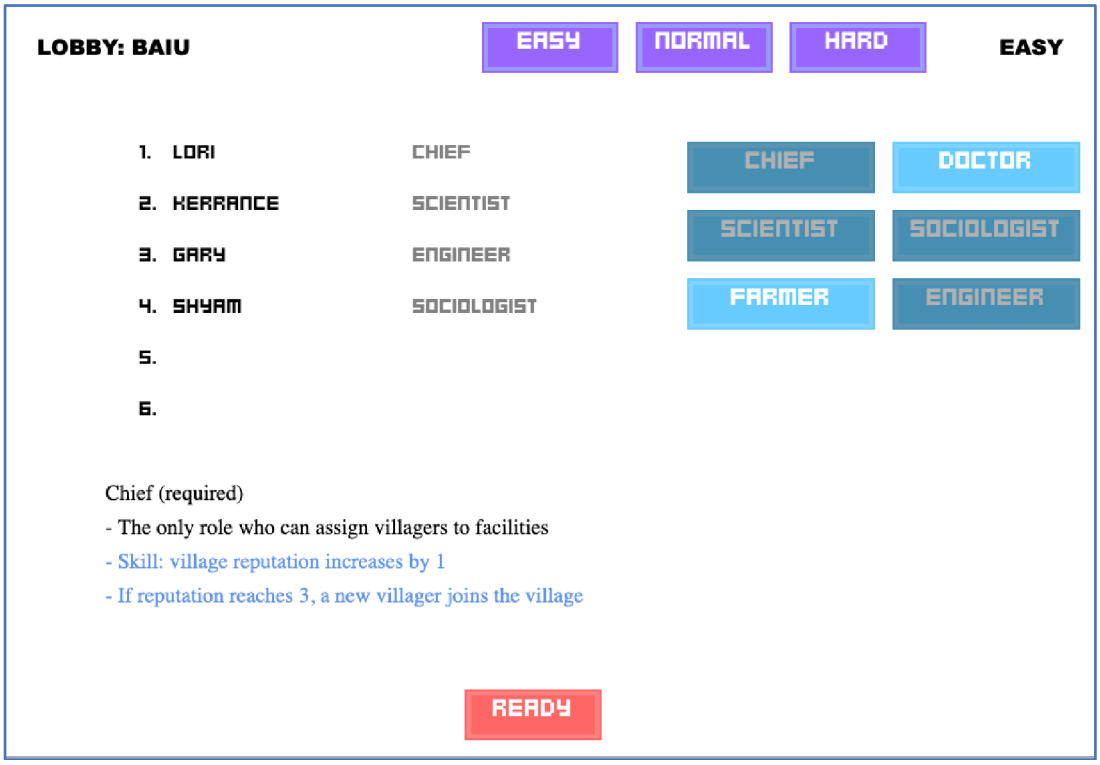

Figure 1. Selecting player roles at the beginning of the game

The game begins with a neutral event (cloudy day) in the springtime. Once the game starts, players take turns using up to eight actions per turn to help the project to progress. Actions include assigning jobs to the villagers, planting and harvesting crops, upgrading facilities, and using special skills as allowed by the player role. Players can also feed villagers without using

any action points. Each turn represents one "day" in a year that cycles through four seasons with ten days in each season. Every three days a new event is triggered; events become increasingly catastrophic with each new season.

Villagers are non-player characters who are assigned (by the Chief) to work at various facilities, all of which need to be upgraded. When a player clicks on a villager, their current status appears on the left side of the screen as shown in figure 2. Each villager has a favorite and least favorite facility to work in, which can affect their happiness levels. Villagers also have skills and abilities (reflected as most and least effective) that will affect the progress of the facilities that they work in. Additionally, they have favorite foods; feeding them something other than their favorite will decrease their hunger but won't completely satiate them. Reflecting complexities of human behavior, these diverse preferences, being randomly assigned, can sometimes appear contradictory, such as when a villager's favorite job is the one they are least effective at. Of course, all of these preferences can change periodically. Players need to carefully monitor these villagers and their preferences because unhappy villagers are likely to leave the village, making it more difficult to achieve the goals of the game before the end of the timeframe.

Figure 2. Villager status shows hunger levels and where the villager is working. It also shows the villager's work and food preferences. Only the Sociologist can see how happy the villager is.

Clicking on a facility shows that facility's status, as shown in figure 3. Progress is achieved by having villagers working there, and by using materials to improve the facility. When a facility achieves the desired progress, it can be upgraded; players must make twelve upgrades before the year ends to win the game.

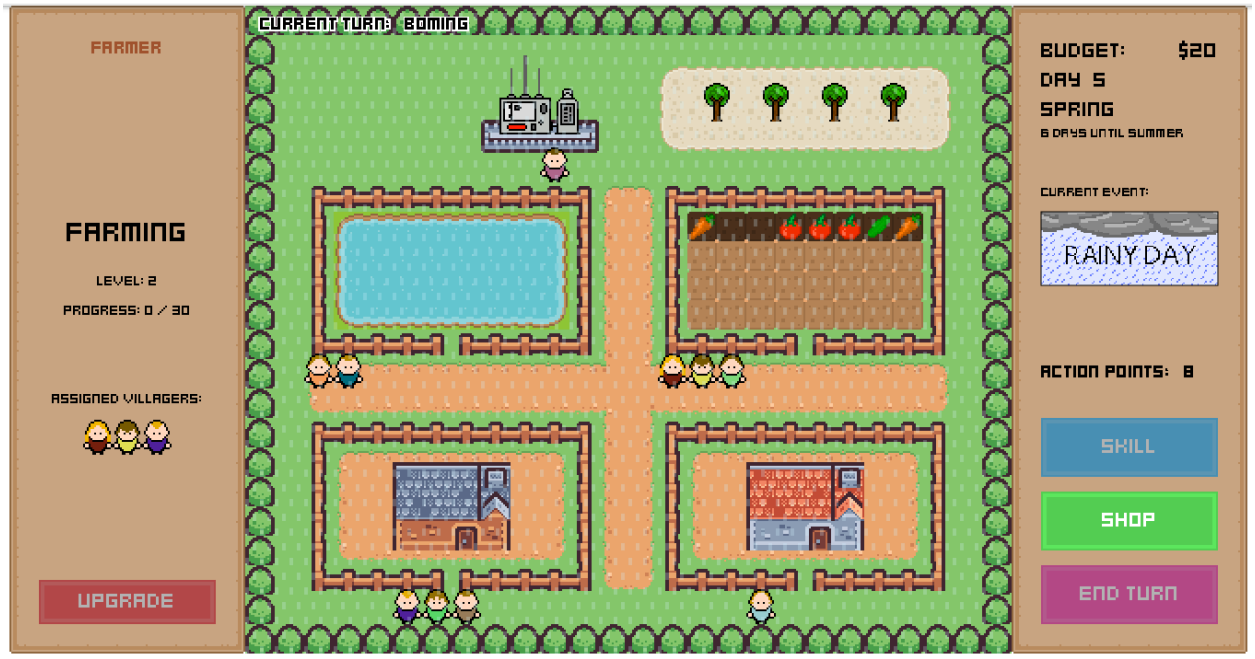

Figure 3. Status of the Farming facility

Playing a game to a successful conclusion takes approximately one hour. A heavily edited 3-minute video of a game being played can be seen here: https://youtu.be/tyKpIWnxAGU?si=u8EiFI8Xsj1XGRJD.

Implementation

The game was developed in JavaScript and runs on a Node.js server, using the Socket.IO library for communicating between the server and connected user clients. The server is capable of managing the game states of multiple concurrent games and is responsible for propagating modified game states as a result of player actions to all other users. Game assets including images, audio, and utilized fonts are purely client-side and will be downloaded by the web browser.

When a player chooses to start a new game, the server randomly generates a unique 4-letter lobby code that other players can then use to join that same lobby. Communicating between players in the same game is done using this lobby code, and this code will be freed up when either the game ends or all players have disconnected.

The visual layout of the game is composed of 2D tiles, each tile being 16x16 pixels with larger images being a multiple of these dimensions. Tilemap artwork is created by kenney.nl and is licensed under CC0 1.0 Universal. Maps for the game were created using the Tiled Map Editor software. All other artwork including game-specific images and character designs were created from scratch by Kerrance Dai and Paul Zou.

Rendering images and user input handling is done client-side using HTML5 Canvas. Upon a user action in an active game, a socket message will be sent to the server, and the server will update the internal state of the game. Then, the server will send a message to all other users echoing

these changes, and the canvas will re-render accordingly. As such, most handled messages on the server side have equivalent handlers on the client side.

Collecting game statistics was initially done by logging the game state changes on the server side and printing them as pure text to the console. This method was later changed to utilizing MongoDB via the Mongoose package for Node.js, where game state changes were stored as entries in a database. Upon completion of data collection, this mechanism was removed from the game, and thus the current build of the game does not collect any data.

Methods

The game was play tested four different times over two years: twice with students in a course on game design, and twice with participants in the iSTEAM workshops. At the conclusion of each play test we asked the participants to fill out a quick survey. Table 2 shows the questions and format for the answers.

Table 2. Post-game questionnaire

Question	Answer Format
What will players learn from playing this game?	Long answer
How fun was it to play the game?	Likert scale
How effective is this game for team building?	Likert scale
How could this game be further improved?	Long answer
How could you see yourself using this game in your teaching?	Long answer

In the game design classes, which were all face-to-face and held in a computer lab, the students were first given a brief overview of the game by the instructor. They were then divided into groups of 3-5, based on their seating proximity, and instructed to play the game with one student in each group serving as host (and Chief). Students then played the game for a fixed period of time (not enough time to finish a game successfully). Near the end of the class they were asked to fill out the questionnaire. Students were already familiar with this idea of play testing games, as it was an activity repeated throughout the semester to provide constructive feedback and thereby help their classmates to make their game designs better.

In the iSTEAM workshops, the game was played by STEM faculty who were learning to make their classes more inclusive (Halada et. al, 2024). Each week these faculty participants would meet as a group with the facilitators on Zoom. After discussing the week's assigned readings and activities on inclusive STEM education, participants were given an overview of the game and then put into breakout rooms with 3-5 participants in each and the instructions to play the game with one participant in the room serving as host (and Chief). Even though participants did not have enough time to finish a game, due to time constraints within the faculty development workshop meetings, each workshop cohort had several opportunities to play the game. They were able to observe or experience the game well enough to complete the survey. Participants were asked to fill out the survey at the end of the workshop.

Results

Due to the differing demographics, and motivations, we examine the results with students and faculty participants separately.

Game Design Students

The first playtest was conducted with 34 game design students. At this point the only people who had played the game previously were the developers, and so we did not realize how difficult it was to grasp the complexities of the gameplay. Responses to the questionnaire were used to improve the game and our presentation of it to the workshop participants.

In the following year, the game was play tested with another class of 41 game design students. These students were given a more detailed introduction and were given more time to play the game. They also provided feedback, much of which has been incorporated into the latest version of the game. Figure 4 shows how better understanding the game, and having more time to play it, increased students' perceived level of fun. Figure 5 shows that it also impacted their perceptions of how effective the game would be as a team-building activity.

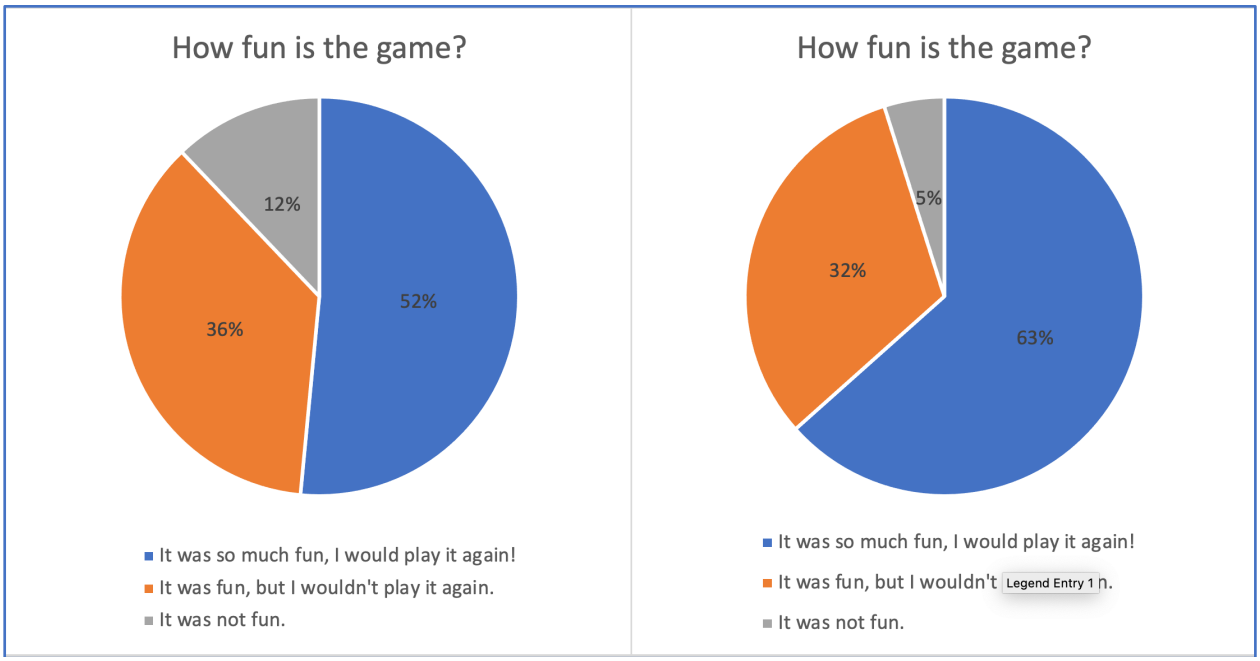

Figure 4. Game design student responses to the question "How fun was it to play the game?" collected in the first playtest (left) and the playtest one year later (right).

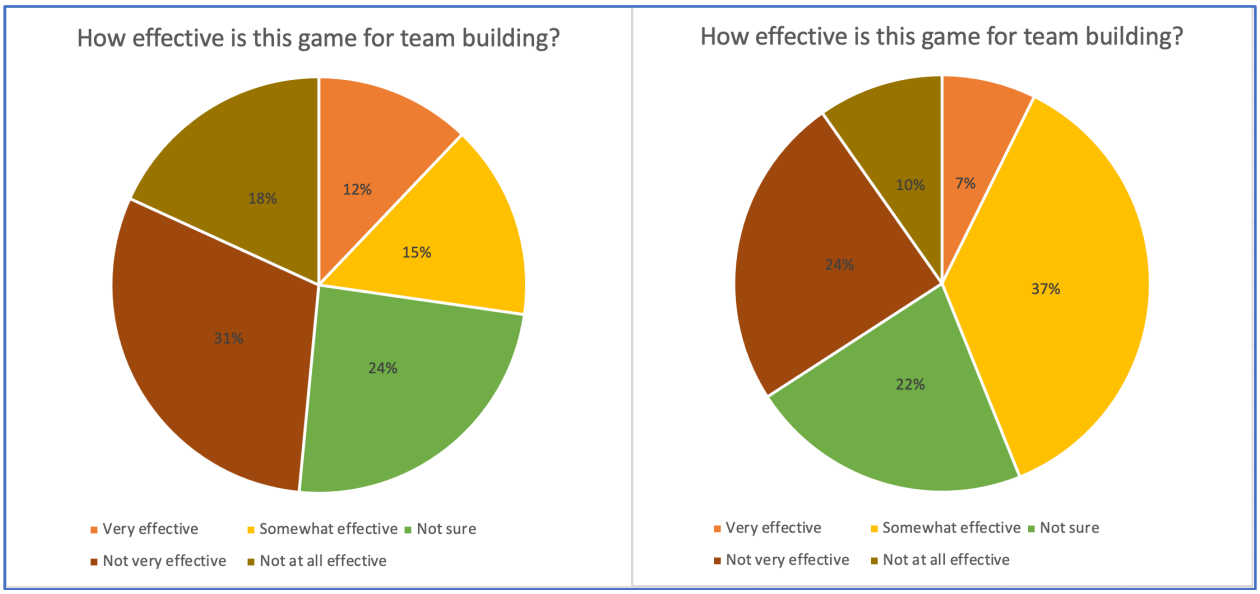

Figure 5. Game design student responses to the question "How effective is this game for team building?" collected in the first playtest (left) and the playtest one year later (right).

STEM Faculty Participants

Although 14 faculty participated in the iSTEAM workshops in the first year, and 40 participated in the second year, only 12 in total filled out the game questionnaire (6 from each year). We therefore consider these as a group.

Figure 6 shows respondents' perceptions of how fun the game is, and how useful it is for team building in the class. Because these participants are not necessarily people who like to play games (unlike the students), their perception of fun is less than that of the students. However many of them did see the value of using the game as a team building activity.

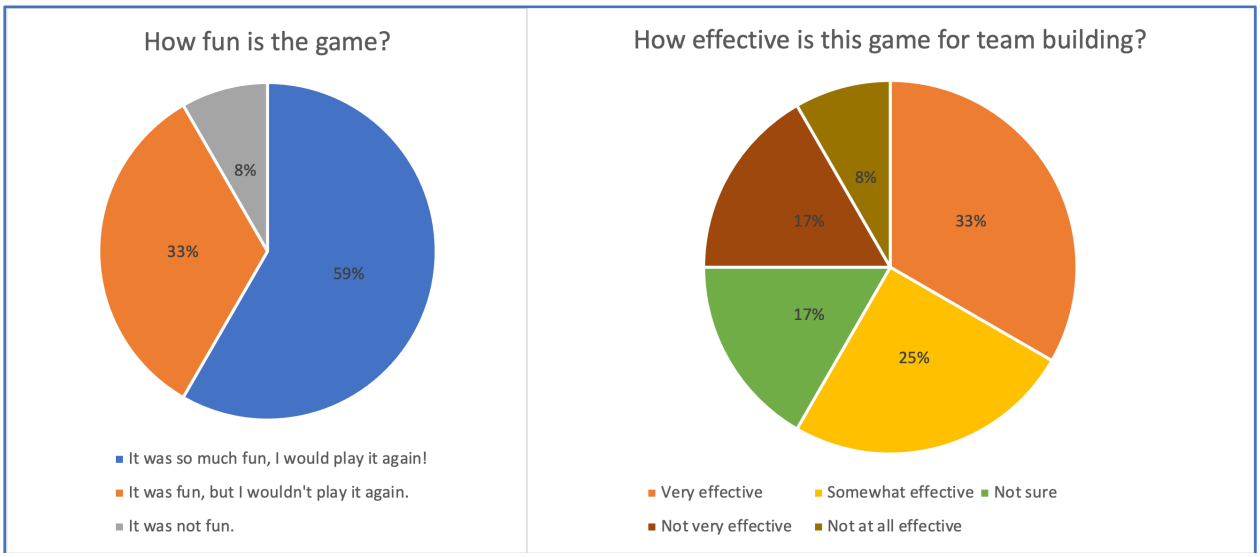

Figure 5. STEM faculty responses to the questions "How fun was it to play the game?" (left) and "How effective is this game for team building?" (right).

Table 3 shows the STEM faculty participants' responses regarding what students could learn from playing this game. Table 4 shows their responses regarding how they would use the game in their classroom.

Table 3. STEM faculty responses to the question "What will players learn from playing this game?"

Players learn teamwork and collaboration. Members provide assistance as needed to others to help the game progress. Everyone was supportive and tolerant of those who struggled more. This showed inclusivity. I think it would have helped if we had explicitely been instructed to read the manual before playing the game. I found it a bit stressful as I didn't have a great understanding of how the game progressed.
We need to communicate clearly with those around us. In a team setting, we all have unique talents (doctor, engineer, scientist, sociologist...) and can contribute in different ways.
Players will learn that it is possible to play and have fun without competing with, destroying, ... others.
This game is great because of the cooperative environment it promotes. It promotes communication and understanding different communication styles. It also helps allow everyone in a group to be a vocal or a silent leader. It appreciates people's different strengths because you need to work together to win the game. It is also great for team building because your win or lose together. I think this type of game is also much more current.
Build the communication skill and learn how to achieve the goal as a group
players will learn to manage resources such each day to assign people jobs
Collaboration, scarcity of resources, the need for planning
They will learn to work cooperatively for the good of all villagers.
collaboration
I think that it teaches the importance of different roles and collaboration of learning everyone else's roles to help. So that one person may be the doctor - but other people in the game can help the doctor in choosing the right choice.
Players learn how important some things are in real life and how to collaborate with other people for achieving a specific outcome.
system view of the problem (not possible to solve one problem without considering implications), planning (need to think couple days ahead), teamwork (need to work together)

Table 4. STEM faculty responses to the question "How could you see yourself using this game in your teaching?"

I liked that I could play this game with anyone.
I could draw a LOT of analogies for more collaborative, inclusive classroom and teaching strategies.
Great for team building, great for learning each others and your own strengths or areas of improvement. It is very student-centric and invites discussion and collaboration. All applicable.
develop the communication skills and get to know each other so that students can identify who they are. It makes the class more vivid, active and productive
it could parallel the way in which a professor needs to manage students within the classroom
Collaboration, resource limitations, and the need for thoughtful planning are skills some students lack. Making analogies between the game and real-life constraints would help many students.
It shows that students can learn from each other and from their experiences without the instructor lecturing.
Building of team spirit between students. Also, learning to take initiatives.
Interaction between different team members in course project can be demonstrated through this game. I will think about that.

Conclusions

It Takes a Village: A Collaborative Online Game can be used to show students the importance of considering the needs of diverse stakeholders, listening to different perspectives, and respecting the differing skills and abilities within teams. And many players think that it is fun to play. It must be noted that, to achieve the full benefits of the game, players need some guidance as well as sufficient time to successfully complete a game. We also recommend following a game session with a discussion reviewing what the players learned, and how that might apply to real life situations. With some scaffolding, collaborative games like this can be used to greatly foster teamwork.

In addition to serving as an engaging classroom activity, "It Takes a Village" could also be used as a foundation for pedagogical discussions, assignments, and reflections in any STEM class. For example, after playing the game, students could reflect on the collaborative strategies they employed as they plan a group project in any discipline, or discuss the challenges they faced in balancing resources and ensuring the well-being of all villagers in courses related to socio-technical problem domains. This reflection could be structured as a written assignment or a group discussion, where students examine the dynamics of cooperation, the role of leadership, and the tension between individual and collective needs. Such reflections and discussions could provide opportunities for students to connect the game's concepts to real-world scenarios, such as community development, environmental sustainability, and collective governance.

In short, "It Takes a Village" can be more than just a game — it can serve as a tool for learning important life skills as well as for promoting a pedagogical approach that fosters collaboration over competition.

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