

The Station: A Model for Content Co-Design with Rural Youth Susannah Gordon-Messer¹, PhD, Kate Kastelein¹, MFA, Brittney Nickerson¹, and Scott Byrd^{1,2*}, PhD

Susalillali Gordon-Messer, Fild, Kale Kastelenii, MFA, Dilliney Nickerson, and Scoll Dy

¹Maine Mathematics and Science Alliance, Augusta, ME and ²Mindbridge Center, Portland, ME

*Denotes current affiliation

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ABSTRACT: We describe the design, modification, implementation, and preliminary research of a place-based serious AR (augmented reality) application in a rural school setting. *The Station* is a collaboratively designed iPhone app that allows players to explore the world around them through educational quests. It links the virtual gameplay to real-world locations and discovery via GPS. The quest content is user generated through a companion editor, a web-based platform that allows anyone to design and author their own quest. When used in a student context, the editor allows student users to move from passive consumers of game content to active creators. We follow a group of ninth-grade students from rural western Maine who worked to create content for *The Station* in collaboration with Maine Mathematics and Science Alliance, who facilitated and researched the project. Youth participants were able to create game content for a real-world location that combined historical, geographical, and scientific knowledge while also learning the importance of storytelling. During our observations of the pilot deployment of this program, key elements emerged that should be incorporated as part of the co-design process for users to successfully create content for *The Station*. Our model can be useful in engaging youth as place-based content creators in both informal and formal education settings.

INTRODUCTION

This paper describes the implementation of a place-based serious augmented reality (AR) game in a rural school setting. In 2018, Maine Math and Science Alliance (MMSA) was awarded a Smart and Connected Communities Grant from the National Science Foundation (Grant #1831427). The initial proposal outlined an ambitious project in which game designers, youth, and community partners would work together to co-design an augmented reality game focused on sparking interest in and educating youth about careers in their communities. Agriculture, aquaculture, forestry, and energy were selected as target areas, with an eye toward sustainability.

Maine, classified by the U.S. census as the most rural state in the United States (US Census Bureau, 2010), was the testing ground for *The Station*. Rural students in states like Maine often do not have the same opportunities as their urban counterparts when it comes to STEM (Marietta and

Marietta, 2021) for a host of reasons including lack of access to STEM-rich places such as universities, industry, and research centers, as well as lack of access to technology including devices and internet connectivity. Additionally, youth who live in rural areas are often less likely to pursue degrees in STEM than their urban counterparts (NSC, 2021). This can be due to several factors including, but not limited to, lack of access to STEM opportunities, stigma surrounding STEM education, lack of support for teachers, and difficulty filling teaching vacancies (Kastelein et al., 2018; Lavalley, 2018) and youth may not have been presented with examples of how STEM is relevant in their own lives (Jaqueze et al., 2020). Meanwhile, rural industries such as those focused on by The Station-agriculture, aquaculture, forestry, and energy-are both STEM-rich and growing sectors in Maine (Maine Department of Economic Development, 2019). The Station aimed to address those needs by integrating informa-

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tion about those sectors and game design.

STEM is often broken into its component subjects, Science, Math, Engineering, and Technology, with each presented or taught in isolation from the other, which may make it difficult for youth to understand the interconnected nature of the subjects (Slykhuis et al., 2015). Serious games, with a purpose beyond entertainment, as a method for educating youth in the areas of computer science and technology, shows great potential (Michael and Chen, 2005; Romero et al., 2015). Additionally, potential uses for augmented reality, games, and applications which overlay digital elements onto existing places, in the educational, non-profit, and private sectors is an emerging field of study.

Initially, The Station had an ambitious goal and hoped to connect youth to the STEM "hiding in plain sight" in their communities while at the same time engaging them in all aspects of designing an AR application. Place-based education, which exposes youth to the relevance of various subjects, particularly STEM within the community they reside, may help youth increase their confidence in pursuing areas of studies in fields that had not previously been considered when they observe the impact that they can have in their own communities (Sobel, 2005; Chawla and Cushing, 2007; Gruenewald and Smith, 2008; Smith and Sobel, 2010). By including youth in the co-design of an application, The Station hoped to increase access to STEM-based learning opportunities, particularly in the field of computer science, as well as help participants understand the relevance of such studies in their own lives. Getting youth involved with the design process of the game offered the opportunity for youth to identify what they thought was important to highlight in their community and work collaboratively with game designers and content experts. Prior to COVID-19, we planned to arrange for youth to meet with MMSA staff and various community leaders and business owners via regular in-person workshops throughout the school year as well as at summer intensives. Due to COVID-19 restrictions, guests were not allowed on campus, and students were not able to travel off-campus for workshops. We modified the program to fit the needs of the students and COVID-19 protocols, and scaled back the game design and focused more heavily on co-designing content rather than career opportunities.

In the following, we describe the pivots necessary to adjust the program to a virtual platform, as well as the transition from a career-centric content model to a more general place-based model in a school setting. We were able to conduct a preliminary analysis based on partner interviews, observations, and artifacts from both workshops and game design sessions. Finally, we discuss the interdisciplinary, and replicable nature of the final product. While the app was envisioned for STEM learning, students using the editor to create game content engage with ELA, Geography, and the logic and planning associated with the game can be implemented in and out of school as a cross-disciplinary experiential learning tool.

THE STATION

Creating The App. The Station is a serious, place-based, augmented reality game that allows users to work through quests via an iPhone app. Funded by the National Science Foundation grant #183427, The Station was co-created by MMSA, a Maine-based non-profit which focuses on STEM education, and Field Day Lab (FDL), a game design and research lab at the University of Wisconsin Center for Education Research. FDL led the development process with their team responsible for design, art, and coding. MMSA staff provided feedback on concept art, design wireframes and prototype builds. Throughout development, the application was accessed through Apple's TestFlight application. New builds of The Station were tested first by FDL and MMSA staff. Once a beta prototype was reached, MMSA led playtesting involving partner organizations and associated students. Between 2018 and 2022, over 159 iterations of the app were created, tested, and updated. The



Figure 1. The Station welcome screen.

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Figure 2. Screenshots of the gameplay loop show examples of field notes and how one might progress through a quest.

Station is currently available as a free download in the Apple App store. Figure 1 shows the application welcome screen.

Game Play. When players first log in to *The Station*, they are guided through a short cartoon-based tutorial before beginning gameplay. This tutorial sets the game's backstory, inviting the players to join *The Station*, grab a virtual field notebook, and begin quests to explore the spaces around them. After viewing the tutorial, players view a screen that shows the avatar on a digital map of where they are standing and can select a starting point research station near them. Research stations serve as a jumping-off point for quests in a geographic area and can be located at places like schools, visitor centers, or museums. From there, players select a quest and begin their explorations. As the player moves through real space, they can interact with the digital Tour Stops and Field Notes as they get closer to them on the digital map.

To help in playtesting during COVID-19, FDL created an option for a player to use "warp mode." This allows players to access game content and go through a quest even if they are not on location. While warping is now a standard feature in the app, we found that playing the game on site was much more effective.

To complete a quest, players engage with three elements: tour stops, field notes, and observations.

- *Tour Stops*: Tour stops, which are another major component of the game, are represented by digital signposts in fixed locations. Most often, tour stops are located in areas where the quest authors would like players to pause and notice something about their surroundings. For example, for a quest focused on renewable energy in a town, a tour stop may be in front of a building that hosts a solar panel array. The player stops, clicks the signpost, and information about the solar array pops up on their screen.
- *Field Notes*: Field Notes –which are contained in digital treasure chests called caches throughout the game, are snippets of information that content creators would like the players to know more about.

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After field notes are collected, they are then sorted into various categories in a digital notebook. Field note treasure boxes are usually generated randomly along the quest route. In a Forestry themed quest, field notes might show a player examples of different products that can come from the forest.

• *Observations*: Observations are the final step in completing a quest. Once a player has visited tour stops and sorted field notes, they are asked questions that help them more deeply engage with the space



Figure 3. Screenshot of a quest in progress, showing the location of the avatar as well as caches that the player may collect.

they just explored. In an agriculture quest focused on apple orchards, players are asked to photograph a tree, identify the type of tree and answer questions about possible pest damage.

In the current, pilot version of *The Station*, player input including observations are not available for analysis on the backend, however, plans for upcoming iterations include this feature.

The Editor. A vital component of The Station is the editor which allows participants the opportunity to create content for others. The editor is an online platform where content designers input all of the information necessary to create a quest, including text, photos, and GPS coordinates. The editor allows students to create content in plain text, with no coding experience required. Creating a text-based editor levels the playing field for students and allows for content creation to begin quickly, without barriers. Content creators are led through a series of screens with fields for inputting all the components of a quest - tour stops, field notes, and observations. Content creators are encouraged to think strategically about adapting the physical place to digital space and merging what the players will experience while they engage in a quest in the real world while interacting with the digital components of the application on their device. Since the editor is such a crucial component of The Station, MMSA developed a series of video tutorials as well as a manual to aid users. Once users create or edit content in the editor and save it, the app automatically updates with new information. This allows creators to test their quests, identify problems, and make changes immediately.

PROGRAM DESCRIPTION

When we began work with students to create content, we envisioned workshops in which community partners, youth, and game designers all came together with equal input to create a final product. Our first school partner was Telstar Freshman Academy (TFA) located in Bethel, Maine. TFA is not located in a traditional school setting, but instead, students are transported from the local high school and take their classes on the vast and picturesque campus of Bryant Pond, a summer camp location owned by Maine 4H (Telstar, n.d.). TFA utilizes a project-based learning approach that combines experiential learning with outdoor education. Telstar's campus, which includes access to a lake, nature trails, and gardens, provides a wide variety of hands-on opportunities for students, which are composed solely of local ninth-graders who spend the year at the freshman academy before moving on to Telstar Academy. MMSA joined into a partnership with Telstar Freshman Academy with the hope that students would be able to integrate the application as a

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Figure 4. The editor provides users the opportunity to create their own quests, including tour stops, an important component where users can input exact GPS locations where they would like players to be directed.

meaningful part of their project-based learning curriculum.

Our initial collaborative meetings with Telstar took a broad approach to co-design where youth were asked for input on all aspects of the game, from avatar design to overall theme. Receiving this much feedback proved to be difficult, as there were often wide ranges of ideas and suggestions, as well as barriers with time and capacity for game design staff to prototype student suggestions. With the focus on the design of the app, it also didn't allow students time to focus on quest content as much. We shifted to a model of co-designing content, which still provided an opportunity for youth to engage with the project creatively. Co-designing content allowed the youth to focus on game mechanics i.e., the logical flow of the game, where to place tour stops, and what aspects of their chosen location are the most relevant to potential players. Content design also allowed the students more time to consider the content more deeply and learn more about their chosen quest site and components, which in turn created opportunities for the intersection of STEM, Geography, ELA, and History. This change also allowed for the Telstar classroom teachers to interject themes that the class was currently working on into the project. For example, one week the students were focused on sustainability and so brainstormed ideas on how that could fit into a quest.

We planned to host workshops using this new model during the spring of 2020. Due to COVID-19 closures, we were unable to do any of the work, and MMSA staff redesigned the program for a Fall 2020 launch. When TFA reopened for students in the fall of 2020, teachers were eager for tools that would help get their students outside, but

protocols did not allow for guests on-campus - workshops would have to be conducted over Zoom. To accommodate this change, MMSA broke the full-day workshop materials into one-hour chunks that could be presented over several weeks. A typical weekly session was structured so that an MMSA staff member would meet with three classes of students (12-16 students per class) and their teachers. One class also had six students who chose not to return to in-person learning and would join the workshops via Zoom as well. The Zoom meeting was projected onto a large screen in the classroom so that students and staff could easily see what the MMSA staff member was presenting. Google Jamboards and docs helped to facilitate collaboration and the teachers sent photos of whiteboard notes that students had created in the classroom. To ensure that technology was not a barrier to creating and testing content, MMSA purchased and loaned iPhones that were mailed to Telstar. Students were encouraged to play multiple quests using the Warped Mode in addition to playing quest content available on location. The breakdown of goals and activities for each week of the workshop session can be found in Table 1.

The biggest adjustment that the MMSA team made in transitioning to multiple virtual sessions was the creation of a mini-quest template. These quests consisted of only two tour stops and four field notes comprising two categories. MMSA staff determined the theme of the quest (sustainability) and the categories of field notes (sustainable energy and sustainable food practices). The students then took photos and set locations for the tour stops and field notes. Since students had not been given opportunities to explore the cam-

Table 1. Goals and materials for each week during the five-week virtual workshop series presented at Telstar by Susannah Gordon-Messer.

Week	Theme	Activities	Teacher Facilitated HW
1	Intro	 Introduction to the project Virtual walkthrough of the app Play a quest in warped mode 	Students played a short quest that their teachers had created based on learning about their unique school campus
2	Building a Quest	 The elements of a quest What is a storyboard Template for a mini quest 	Students completed Mini Quest Templates in Google Docs and MMSA staff provided feedback before the next session
3	Incorporating Feedback	 Looking through MMSA staff feedback Small group peer feedback 	Students revised Mini Quest Templates. They spent time walking around the campus taking photos and noting GPS locations for tour stops and field notes
4	Game Design and the Editor	 Q&A with David Gagnon, FDL Director Introduction to the editor 	In small groups, students were encouraged to try to put content into the editor
5	Testing a Prototype	• Full Quest Feedback	Students play tested two final quests and provided feedback to MMSA staff through surveys

pus much, the teachers helped to guide students to locations and provide context and history to make the quests more engaging. We found this mini-quest to be a very effective way of helping students create authentic, quality content in a condensed period. These small quests could then be combined into larger quests adding an element of whole-class collaboration to the final product.

At the end of the fall semester, students were asked if they would like to continue with *The Station* to create a special quest for incoming students and three signed up as part of the school's Pay it Forward program, where Telstar students design and implement a service-learning project. This group



Figure 5. A young player tests out a quest.

met with MMSA staff virtually five times over the course of three months and was able to have one, in-person socially distanced, and masked workshop with an MMSA staff member. During this workshop, students were allowed to explore the campus, some for the first time, and identify areas of interest for incoming students and families. Throughout the process, TFA teachers again helped to provide context and history behind specific features of the campus, something that the MMSA staff could not help with. The final quest highlighted the unique sustainability efforts and recreation opportunities of the school campus. In June 2022, 33 students played the quest as part of TFA's Step Up Day where incoming freshmen are invited to tour the campus.

Though the unexpected pivot to virtual was difficult to navigate at first, ultimately it gave us the opportunity to refocus the project and identify key components of co-design with youth. Namely, that quests are the most successful, i.e., follow a logical progression of tasks and are entertaining when created by a team of individuals that includes a location/content expert (in our case the TFA teachers) and an instructional designer (MMSA staff) working with youth. The content expert has knowledge or expertise about the information included in the quest. The instructional designer helps guide youth creators in storyboarding and putting content into the editor.

RESULTS

From September 2020 through December 2020, MMSA met with 40 Telstar 9th grade students during school time, virtually. Of the 40 original students that worked with us during the fall, three students continued on with The Station as part of a Pay it Forward project from January 2021 through June 2021. Two Telstar teachers worked with us throughout the duration project. Telstar was able to hold an end-of-theyear, in-person event to share their work with others. Students were guided by both MMSA staff and teacher mentors from the participating school. We gathered data to learn how The Station could be used as an effective and engaging way to get youth involved in exploring the outdoors and practicing elements of game design. As this was a pilot program and hindered greatly by COVID-19, we were able to identify, through emergent themes, areas to delve more deeply into in the next iteration of this project, including STEM-identity, community connection, and cross-disciplanry uses of the application.

We used three methods to gather data:

• Interviews were conducted in December 2020 via Zoom with both Telstar teacher mentors as well as with MMSA staff who interacted with youth over the course of the project.

- Observations of gameplay and partners were conducted live, in-person during the Pay it Forward event, by MMSA research team members in June 2021.
- Artifacts, including Zoom recordings and planning worksheets, were gathered and analyzed for emergent themes by members of the MMSA research team.

MMSA and teacher mentor interviews were analyzed for emergent themes using NVivo and Dedoose software. Artifacts including workshop planning materials and field notes, as well as transcripts and videos from in-person playtesting, were analyzed by the MMSA research team. Artifacts and interviews were reviewed and coded by MMSA research team members based on emergent themes. Due to IRB constraints, we were only able to focus on adult participants and gameplay artifacts. Below we present preliminary findings from both in-person and recorded workshops and events, interviews, and artifacts.

We found that place-based co-design was achievable with students during COVID-19 closures. However, due to the interactive, quest-based nature of The Station, which depended heavily on a physical location, major components were found lacking, and the program was much more effective when youth participants were able to visit the physical space in which the quest was situated. Furthermore, through our discussions with Telstar teacher mentors, three components emerged as critical components to co-designing content, particularly under the limited time available in terms of both meeting with MMSA program staff and building out quests on their own or in class. At various points during the project, one or more of the components were lacking, during which time MMSA staff observed stagnation in the project and a lack of enthusiasm by the students. Preliminary analysis suggests that three components, site, content expert, and instructional designer, are necessary to create content that connects with both the designers and the end-user.

Quest Content Components.

Site. Essential to a successful quest is a good site, a physical place that quest designers have access to. Though there is a warp option on the app, this was built mainly for testing and use during COVID-19. We found that while this is marginally useful, in order to build a good quest, one needs to be "on the ground" and immersed in the space. It is difficult to achieve the connection between virtual space and physical place with AR if one is not in the physical location where the game will ultimately be played. Access to the site also allows for rapid prototyping. Furthermore, solely virtual engagement does not allow for the player or the designers to make observations that are unique to the physical location. For example, a tour stop may ask players to stop in a specific

ic location and listen for the sounds of native birds. Virtual only creation and play severely hindered the players and creators from experiencing the full potential of the application.

STEMPort teacher mentors observed an increase in enthusiasm during workshop meetings after students were able to take their work outside in a group. The rainwater runoff activities created as a solution for at-home quest building and demonstration after COVID-19 never really resonated with the students: "We tried again to have them build water runoff so that they would have something to test in person, but it never stuck." Teacher mentors also expressed the importance of outdoor activities to increase student engagement saying, "We're always looking for hands-on, active, out-of-your seat, highly engaging ways to teach and to convey information and learn and teach skills and knowledge. And I think *The Station* is a great way to do that because it's very self-motivated."

Content Expert. Based on our work with Telstar students, we determined that a content expert greatly enhances the experience for both youth creators and end-users. A content expert is an individual who is either an expert in the subject matter or physical space the quest focuses on. The content expert can have existing knowledge or be willing to research and fact-check the information presented in the quest. It could be someone interested in learning more about a specific site and sharing that knowledge with others. In the case of Telstar, the content expert roles were filled by classroom teachers.

As described earlier, the Telstar Freshman Academy campus provides myriad opportunities for students to engage in the outside world. However, due to COVID-19 protocols access to many areas of the campus were inaccessible to students for a large portion of the school year. When restrictions eased and MMSA staff were able to meet with students in person as they planned their Pay It Forward quest, many were completely unfamiliar with the campus. Staff observed that students were able to find interesting and meaningful aspects of campus that they wanted to share with incoming students but were unable to provide vital information and context. In one instance, a student noticed that a bridge on campus looked like a good site to feature on the tour but was unsure about its use. The teacher, filling the role of content expert in this example, was able to give the student information about the bridge including that it had been built by former students.

Instructional Designer. Through additional observations of planning artifacts and student interaction with the application, we saw clear indications that creating a quest that made logistical sense, contained useful information, and was engaging for both students and players, was often a difficult concept for youth to grasp. Coupled with prototyping the editor numerous times over the course of the year, a frus-

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trating experience was had by some participants. Through interviews with staff, we learned that often students would be excited about a concept they wished to turn into a quest, but the complexities of finding relevant media and text as well as how to edit it down into simple components that would fit into the constraints of the game were also difficult to navigate.

The instructional designer understands the subtleties of what makes content engaging to the end-user and often is tasked with inputting information into the editor. This may include editing information provided by the content expert from multiple paragraphs into smaller excerpts focusing on the most essential information. The instructional designer may also aid in determining how many tour stops and field notes may best suit the quest and the amount of information being relayed. Finally, the instructional designer assists in creating a quest where information flows in an interesting but logical manner.

During our time at Telstar, MMSA staff member Susannah Gordon-Messer took the role of instructional designer after we observed the need for this role. While preparing for the Pay It Forward quest, Susannah, as instructional designer, was able to combine smaller quests, created by youth, into a larger cohesive quest for incoming freshmen that would be touring the campus. She then inputted the information into the editor.

The unique structure and time restrictions on offering *The Station* as an in-school project contributed to the emergence of these well-defined themes; it is possible that in a less structured setting the roles could be performed by one person or assigned to many. Plans for future iterations of *The Station* include virtual and in-person professional development opportunities, as well as updates to our website such as forums for partners and participants, and robust tutorials highlighting the various roles, so that educators may use the app without the direct, on-site support of MMSA staff.

FUTURE POTENTIAL/DISCUSSION

The Station provides near limitless opportunities for youth to create quests relating not only to STEM but other areas of interest, in their communities and beyond. Additionally, *The Station* provides for STEM learning to be present in nearly all aspects of quest design as participants think deeply not only about content, but how it is presented and then iterating on their design after testing it in real-time. Prior to COVID-19, MMSA and FDL had plans for numerous workshops with youth at summer camps, community fairs, and other out-of-school venues, in addition to the work planned at Telstar. Focusing intensely on using the application in an in-school setting helped unearth components necessary for a successful quest that we may not have been able to identify otherwise. Furthermore, adjusting for shorter, weekly virtual workshops forced us to rethink how the co-design process would work and how we presented materials and interacted with students. While these pivots were frustrating and difficult at the time, we managed to adapt the program successfully, and lay the groundwork for future collaborations.

In the future, we are hopeful that we may be able to bring *The Station* to youth via workshops in out-of-school settings, as we previously planned. We have seen how meaningful the in-person, on-site engagement with content was to student designers and players and the opportunity to have a fully immersive, all-day event on-site at a summer camp, for example. Now, however, we have much deeper knowledge about what resonates with the youth, what parameters need to be in place, and how to communicate the structure in a way that is easy for youth to understand. That said, we look forward to future opportunities to further improve on the application based on creator and user feedback.

The pilot of *The Station* at Telstar was certainly enlightening in terms of the adaptability of the application, and our program in general. And though the pivots and lessons learned were often challenging, in the end, we were able to create an application that is adaptable for in and out of school programs, multitudes of subject matter, and provides an opportunity for youth to explore the outdoors while gaining knowledge about mobile application development. After the release of the application into the app store in the spring of 2022, and as more opportunities arise for people to gather together indoors and out, we hope to broaden the reach and impact of *The Station* in the future.

AUTHOR INFORMATION

Corresponding Author

Kate Kastelein. kkastelein@mmsa.org

Author Contributions

The manuscript was written through contributions of all authors. All authors have given approval to the final version of the manuscript.

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ABBREVIATIONS

AR: Augmented Reality; FDL: Field Day Lab; MMSA: Maine Math and Science Alliance; TFA: Telstar Freshman Academy

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