STUDENT PROJECT VIRTUAL WORLDS AS WINDOWS ON SCIENTIFIC CULTURES IN CTC SCIFAIR

Margaret Corbit, Richard Bernstein, Suzanne Kolodziej, Cathy McIntyre
Cornell Theory Center, Research Outreach, Cornell University

Abstract

The SciFair program is an Internet-based science communication fair. This supplemental education program has engaged seven to ten primarily underserved, rural or minority communities around the US annually since 2003. In 2005, a pilot site in Singapore was added. The SciFair program leverages the appeal of an online multi-user virtual environment to engage teens in exploring and communicating about science, in the hope of increasing scientific literacy. The virtual worlds created through each program reflect personal or group contexts for various science topics. A review of five sites offers a kaleidoscopic view of SciFair's contexts within learning communities, and the apparent roles of scientific culture in these community projects. Programs are described and assessed based on educational context, cultural relevance of the selected topic, integration of content with other forms of expression, and the elements of scientific culture represented. This approach adds a new dimension to evaluation of SciFair programs.

Keywords: multi-user virtual environment, knowledge space, scientific culture, virtual world

1. Introduction

The SciFair outreach program at the Cornell Theory Center, Cornell University, is an Internet-based science communication fair used as a supplemental or informal learning program. It has run at seven to ten sites per year around the United States since 2003. SciFair participants are primarily from underserved, rural, or minority communities. In 2005, the program expanded to add a pilot site in Singapore. This program is intended to help middle and high schools build science literacy through student-centered team experiences of creative expression about science.

The SciFair program leverages the appeal of an online multi-user virtual environment to engage teens in creating their own knowledge spaces, centered on a scientific area of their choice. A *knowledge space* is comprised of an organized 3D presentation of textual and visual information, its environmental design and user interactivity within a virtual world. It often includes gaming elements and original web content. The program appears to have the greatest impact on students who begin with neutral or negative attitudes toward science, as discussed elsewhere. We believe these students are attracted by the technology and then drawn into building their science literacy through the team based projects. Anecdotal evidence suggests that social interaction across scientific cultures with college student mentors, program staff, scientists, and peer SciFair teams all lead to increased motivation and performance [1].

The knowledge spaces reflect personal or group contexts for various science topics. They include worlds created by Northwest American Indian teams, a primarily African American urban middle school team in Virginia, a working class suburban school in New York, and a primary school science class in Singapore. We present a review of these worlds: a kaleidoscopic view of SciFair's contexts within learning communities, and the apparent roles of scientific culture in these community projects.

1.1. The SciFair Process and Model

To begin a SciFair program at a school or educational site we establish a relationship with the administration through a personal visit, presentations, and staff development workshops. We work with the administration and community liaisons to identify and train one or more coaches for the team. The *coach* is an educator on-site with an interest in science, computer technology, or both, who is responsible for recruiting and supervising the team of participants, and coordinating with our program staff. Our technical coordinator simultaneously clears the way for software installation and network access. Once any obvious social or technical barriers have been removed, we assign a pair of *mentors*, Cornell undergraduate students who are the team's guides and role models. The coach and mentors coordinate to lead the team through a sequence of interactions *inworld*, meaning within the social, online virtual environment. The virtual environment combines a navigable 3D virtual world, a web browser and text-based chat. Teams work together to create, or *build*, shared 3D content directly within the environment. Each user is represented by an animated visual representation called an *avatar*. Sessions usually occur twice a week for 1-2 hours, as a club or after-school activity. The progression of interactions is based on the three natural stages of the SciFair Model [1].

The first stage of this model focuses on team formation and mastery of the virtual world technology through the *homesteading* process, in which participants construct a personal 3D space that reflect their personalities. The second stage of this model focuses on science and technology topics. Students select and research a particular science-related issue, technology, phenomenon or topic area, then design and construct an interactive exhibit. Students are encouraged to create their own contexts for the topic they select and express their newfound knowledge creatively. They begin by discussing what kind of space they want to build, for example a gallery, a maze, a landscape, or a temple. Finally, the team shares its exhibit with peers from other teams and educational professionals online. They also demonstrate their work in person for members of the local community including peers, parents, or school administrators. This final, third stage is called the *showcase*.

Whenever possible, we connect the project teams with Cornell researchers, who might communicate via e-mail, visit the student projects, make an inworld presentation, or attend the final showcase. The entire process is flexible and accommodates the priorities and circumstances at each site. In some cases programs occur during class rather than after school; sometimes the project is directly integrated with curriculum. Or the coach or mentors might construct the knowledge space rather than the students, engaging the team in the design process and discussion.

1.2. Scientific Culture

According to Durant *et al*, Scientific culture encompasses widespread "understanding of the process of scientific inquiry" and "knowledge of the elementary findings of science," or scientific process and scientific knowledge in short. The model for assessing scientific culture presented by Godin and Gringas asserts that "science and technology, together being a social phenomenon based on collective effort, must necessarily be included as forms of the social organization of culture." According to this model, scientific culture has both individual and social or collective dimensions. Society uses three "modes of appropriation" for scientific culture: learning mode, meaning education and training; implication mode, meaning the two-way interactions between scientists and other members of society; and socio-organization mode, meaning formal and informal institutions. The level of a society's scientific culture and literacy can be assessed based on an input-output feedback model of its science-related practices, and indicators can be selected for these inputs, practices and outputs to reflect each mode of appropriation. Each indicator can be either individual or social in nature, and qualitative or quantitative [2], [3].

2. Methods for Comparison

We will compare some of the worlds created through the SciFair Model with the aim of learning about the scientific cultures of the learning communities who created them. We provide a qualitative assessment of the level of scientific culture, and the unique ways in which it appears to be integrated into the overall culture, at each site. Our assessment only reflects the SciFair community for each site, not entire school communities, but it does provide useful insight into the variety of expressions of scientific culture.

Our assessments are built on personal observations and social interactions, public documentation related to the sites, input from liaisons acting as support agents, survey data and reports, text chat logs from online sessions, and exploration of the worlds themselves. As outside visitors to each virtual world, we have only a narrow window into each project's content, as well as the community experience it represents.

Each SciFair program is unique. This is partially a reflection of the different cultures at the sites and their attitudes toward science and its primacy in education—the apparent scientific culture within which the teams functions. It is also a reflection of the background and priorities of the coach and mentors, the level of interaction with school curriculum and circumstances such as technical infrastructure and school scheduling. With this in mind, we provide some background on the socio-economic status of the communities and the local educational context of the SciFair program.

The outcomes of SciFair projects are graphically demonstrated in the spaces themselves, which are the principal artifacts of the process. Although it is difficult to gain a holistic impression of these knowledge spaces without in-depth interviews, we can compare their style and content to deepen our impression of the scientific culture of the teams. We observe the synergy between scientific culture and other forms of cultural expression in these projects, alongside evidence of scientific literacy and interest. Because our main sources of information are the teams' final products and survey information, our assessment is primarily focused on the output indicators for scientific culture.

3. Attitudes toward Science

Entry surveys for the program indicate the students' initial attitudes toward science. Students rated the following six statements on a scale from 1 (strongly disagree) to 4 (strongly agree): I like Science; I am good in Science; Science is important in everyone's life; I would like a job using Science; Scientists are doing a good job; I trust what scientists say. The ratings were totaled to form an overall Science Attitude Score. The range of possible scores is 6 to 24, with a midpoint of 15. Scores that fall below 15 indicate a negative Science Attitude while scores above 15 indicate a positive Science Attitude.

For the 2004-5 academic year, survey data was collected from SciFair students at American Indian School #1, Urban Virginia Middle School, and Long Island Middle School. 50% of the students at American Indian School #1 expressed a negative attitude toward science; the mean score for the team was 15.75 ($n = 8$, $s.d. = 2.87$). Only 22% of the students at the Long Island Middle School showed a negative attitude toward science; the mean score for the team was 18.13 ($n = 23$, $s.d. = 3.24$). In contrast, 100% of the students at the Urban Virginia Middle School expressed a positive attitude toward science; the mean score for the team was 20.5 ($n = 8$, $s.d. = 2.93$). These results are shown in Table 1. There was a significant difference among the means, $F(2, 36) = 4.67$, $p < .05$. Post hoc analysis using the Least Significant Difference test indicated the mean difference (4.75) between American School #1[a] and Urban Virginia Middle School[b] scores was significant, $p < .01$.

Table 1: Science Attitude Mean Scores

School	N	Mean	Standard Deviation	Standard Error
American Indian School #1	8	15.75[a]	2.87	1.01
Long Island Middle School	23	18.13	3.24	0.68
Urban Virginia Middle School	8	20.5[b]	2.93	1.04

4. SciFair Case Studies

We compare four schools in the United States: two are American Indian Schools in the Pacific Northwest; one is an urban, primarily African American middle school in Virginia; and the fourth school is a working-class suburban school on Long Island, New York. Each of these ran an academic year-long program. We add to this a description of a small scale project with a primary school in Singapore, which ran a six-week program. In each case, we present contextual information, a description of the team's topic and knowledge space, and a qualitative assessment of the scientific culture we observe. The assessment is based on the initial circumstances of the program including curriculum integration, coach's teaching subject, student attitudes toward science if available, and the program's role at the school; cultural relevance of the selected topic; integration of content with other forms of expression; and the elements of scientific culture represented [4].

In particular, we looked at the online mission statements of all schools. Both American Indian Schools and Urban Virginia Middle School identify student safety as a priority. The American Indian Schools and Long Island Middle School emphasize cultural tolerance and citizenship.

4.1. American Indian School #1

American Indian School #1 is a K-12 (kindergarten through grade twelve) school with approximately 300 students in a large reservation on the Pacific Ocean coast of Washington State. The native culture is prominently featured at the school through art displays, architecture, and programming. The school mission is to provide all students the opportunity to reach their full potential. According to the state report card, more than 65% of the student body comes from low-income families and approximately 50% graduate from high school on time. In the face of this challenge, this school was recognized as the most improved school in Washington State in 2002. This can be seen in the students' performance on standardized reading and writing tests. Scores still lag in science and math. The coach at American Indian School #1 sets the team priorities as "behavior, technology, and internet research skills." While he is a math and computer arts teacher, he works with SciFair to provide the students a choice of science topics that relate to their landscape. The themes have been tsunamis and volcanoes. The program takes place during elective course time. Students spend between 1.5 and 3 hours each week in their world or working on content for it. SciFair is embraced at American Indian School #1 for the opportunities it provides students to create, to communicate with peer role models, and to present their work to others.

4.1.1. World Description

In 2003-4 the American Indian School #1 team studied tsunamis. The world is an aesthetically pleasing virtual community space. One student incorporated scanned images of her artwork as pictures on the wall of her home. Most of the team's science research and communication activity focused on creating PowerPoint slide presentations about tsunamis, which they linked into the world. The world also features a multimedia gallery used by a Cornell undergraduate researcher to explain his tsunami-related research involving a laboratory wave tank. Three students incorporated what they had learned about tsunamis into the world, and another demonstrated his knowledge by dominating chat discussion after the undergraduate research presentation.

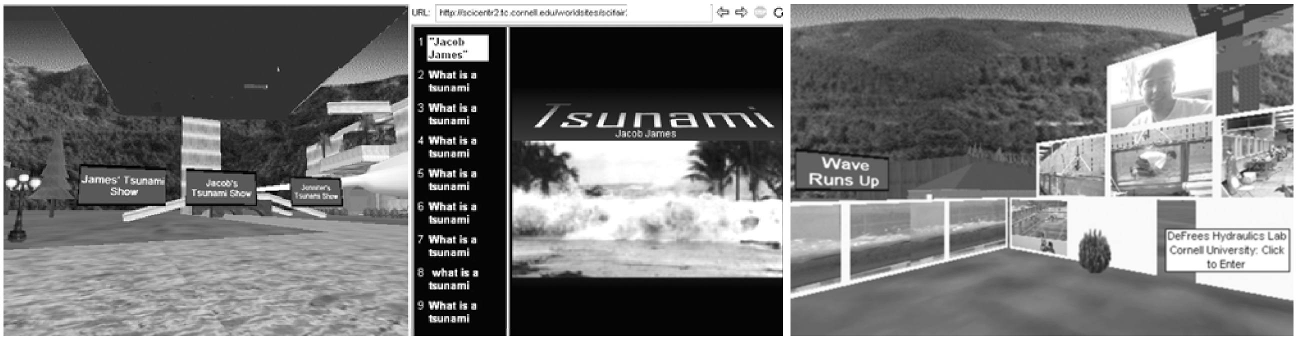

Figure 1. American Indian School #1 combined building inworld (left) with research and preparation of slide presentations on tsunamis (center). At the end of the program, Cornell undergraduate researchers visited the students' world and shared images and slides from their research in civil engineering (right).

4.1.2. Assessment

At American Indian School #1, top priority is placed on engaging the students to keep them coming to school and learning useful workplace skills. Cultural heritage is a central theme. This team's entry survey data reflect the challenge faced by the school to motivate the students about science. The coach's academic teaching focus is computer arts and math, not science, and the program is not integrated with the science curriculum. Thus, the team had relatively little inherent connection to either the individual or social dimension of scientific culture at the start.

This site's selected topics have been concrete examples of scientific knowledge relevant to local geography with recent historic importance. The information contained in the exhibit is characterized primarily as scientific knowledge, rather than scientific process. The virtual world presents both a community social space and an expression of knowledge. However, these components are substantially separate from each other, and mentors reported difficulty motivating the teens to incorporate their science content into the virtual space. This suggests that in this community, scientific culture is relatively isolated from the overall culture. The coach views the program as high successful. Showcase opportunities for this program focus on student presentations of the overall project at inter-tribal meetings and educational technology conferences.

4.2. American Indian School #2

American Indian School #2 is a charter K-8 school with approximately 100 students each year. It is situated beside a river that feeds into Puget Sound. Like American Indian School #1, the school culture is permeated with the art and traditions of the northwest American Indian Tribes. It is a charter school requiring parental commitment, and many students travel great distances each day. The expectations for student achievement are higher than those at American Indian School #1. Although the mission of this school is also to prepare its students to meet life's challenges, there is a special emphasis on culturally relevant education. The school faces a challenge supporting youth from as many as 30 tribes each year. A media arts teacher and a science teacher coach the team together. Their shared interests drive the project, which is an exhibit about watershed ecology to be used in upper level elementary science classes. While student interest has grown to include 12 students, the school's computer resources have diminished, forcing students to take turns on computers. At American Indian School #2, SciFair is valued for the appeal of the technology and its capacity to enhance classroom learning, including lab activities. The students spent up to 2 hours per week in their world.

4.2.1. World Description

The world created by American Indian School #2 is a two-year and ongoing project. It is a bold, literal landscape, incorporating many scientifically relevant features of a watershed. Upon entering the world, the Web browser provides the following introduction:

> *[Our School] is one of the schools who participate in Project Green to test water quality in our local rivers and streams and report the data to gain an overall picture of water quality for our particular watershed. We do dissolved oxygen, turbidity, fecal coliform, total solids, pH, nitrates, and temperature tests. We also do a macro-invertebrate survey that also indicates the general health of the river. We plan on incorporating all this data, plus the steps involved in the process, water cycle, salmon information, and general watershed knowledge in our virtual world.*
>
> *Our world models the landscape of the areas of watershed near the school site. When you visit, you are welcome to start in the glacier and walk through areas of watershed while learning about water quality testing!*
>
> --*[The] Team*

The team features school sports and cultural activities among the science content. Students have posted an introduction to the world and suggestions for a self-guided tour, including a treasure hunt that can only be solved by exploring each area of the watershed. The students have also begun to homestead within the landscape, building personal houses.

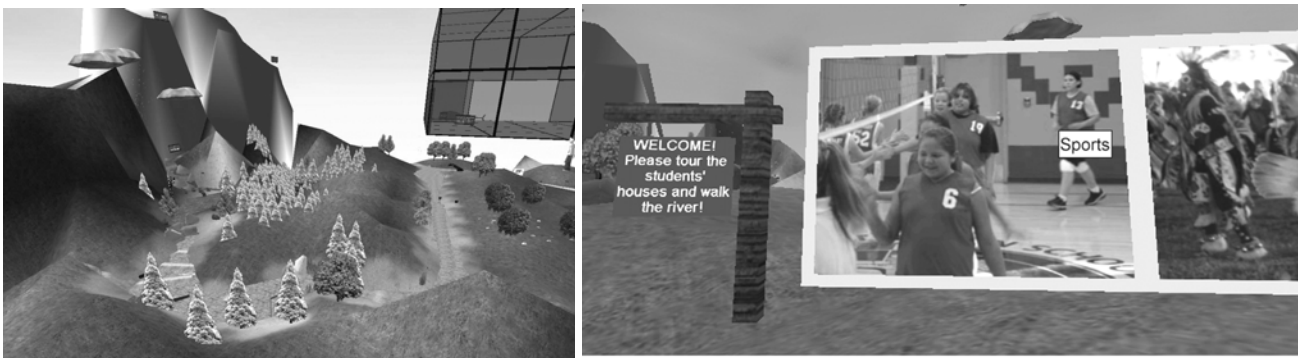

Figure 2. The virtual watershed built by American Indian School #2 reflects the snow-capped mountains and evergreen forests of the region (left). Student activities, including traditional dances, are featured in the world with picture objects (right).

4.2.2. Assessment

As a charter school with high expectations for their students, American Indian School #2 works to place science within the context of culture in the classroom as well as in SciFair. The program is directly integrated with the school's science curriculum. We do not currently have data on the school's overall science performance, nor an assessment of the students' attitudes toward science. Still, the community creating this project begins with a science focus, at least from a social perspective.

The sustained focus on watershed studies relates directly to their riverside setting and cultural history. The school is built on the site where a tribal leader committed repeated acts of civil disobedience in the effort to regain tribal fishing rights. The scientific content is situated within a realistic rendering of the local watershed, and social expression and interactive activities are integrated. The information presented includes both scientific process regarding water quality drawn from the Project Green curriculum, and scientific knowledge about watershed ecology. While the presentation quality and comprehensive integration of scientific culture and other cultural values was certainly driven by the teaching interests of the coaches, we still observe a synergy of scientific culture within the overall culture with this community. Like American Indian School #1, this team was compelled by science situated within the students' immediate experience. With limited student engagement in the first year, the showcase activity focused on students introducing the environment to visitors at a family open house.

4.3. Urban Virginia Middle School

The Urban Virginia Middle School is a mostly African American middle school with more than 500 students. The mission is to ensure that students have the opportunity to dream, learn, and live in a non-threatening environment. The school culture is focused primarily on basic safety for its students, mutual respect, and core skills. One third of the population of the city live below the poverty level and this school is located in a depressed area. SciFair takes place in an after school program coached by a science teacher. When we launched SciFair, this school was incorporating a specific note-taking system into the core curriculum. The team mentors supported the teens in using it for their online research. At this school, SciFair is an opportunity for good students to build their computer skills and explore science in a social setting. Students spend three to four hours per week on their projects. However, the program experiences frequent challenges such as technical problems and scheduling disruptions.

4.3.1. World Description

The Urban Virginia Middle School students chose to feature the Human Genome Project. The world prominently features a massive model of the comic character Dilbert, which houses information gathered primarily by the coach and mentors. The students' own galleries are in a neighborhood at Dilbert's feet. The exhibits feature muscular dystrophy, sickle cell anemia, and other inherited diseases. A quiz game serves as a review of the information presented in the space. The team's accompanying Web site also welcomes visitors with its plans for developing their virtual world.

4.3.2. Assessment

The school's long-term goal is to become a magnet school for science and math. It also holds its students to high standards. The team's coach is a science teacher, but the program is purely extra-curricular. This group had the most positive initial attitude toward science on average, out of the three teams we sampled. The team began with a relatively strong connection to the scientific culture inherent in SciFair, in both individual and social terms.

The science topic, the Human Genome Project, was connected to the students' lives through the study of heritable diseases that affect the larger communities with which they identify. These include Sickle Cell Anemia, common among African Americans, and two forms of muscular dystrophy that affect children. It also incorporated subjects that captured the team's imagination, including the Proteus Syndrome, or Elephant Man Disease. The exhibit features a combination of different presentation formats. The topic relevance and combination of factual and creative expression are suggestive of integration of scientific culture within the community. The information presented is primarily scientific knowledge related to genetics, rather than scientific processes of the Human Genome Project. Finally, this team chose a topic with a strong social relevance for the larger communities they represent, with a hint of interest in exploratory science. They presented their project at a family dinner showcase event at the school also attended by school administrators.

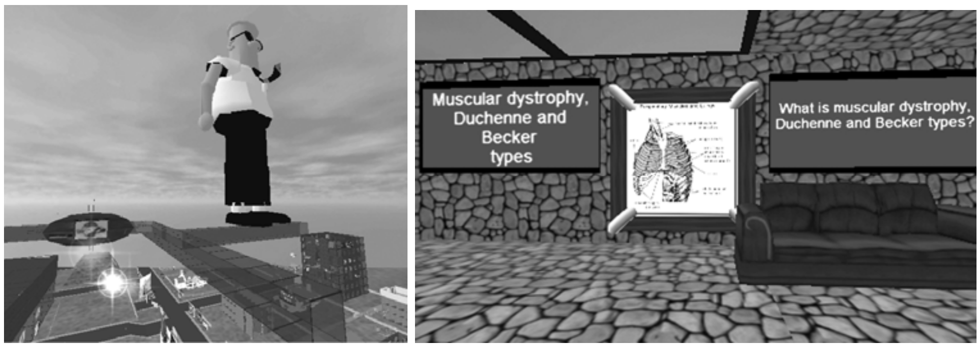

Figure 3. The cartoon character of monumental scale stands above the rest of the structures in the Urban Virginia Middle School world (left). Student exhibits are displayed in a gallery format (right).

4.4. Long Island Middle School

Long Island Middle School serves a small, diverse working class school district, primarily Caucasian with a significant Hispanic population. It has less than 400 students in the fifth through eighth grade. The team's coaches are a seventh grade science teacher and a computer teacher. The coaches' goals are to increase computer technology skills, to deepen understanding of Mars from the perspectives of earth science and biology, and to enhance behavioral skills such as teamwork. The team included a 20-member after-school computer club and a seventh grade science class. The computer club led exhibit design and building one afternoon each week for two hours, while the science class explored, contributed ideas and conducted research during class. In the 2005-6 academic year, the program has expanded to include the entire seventh grade's contributions to a new project during science class.

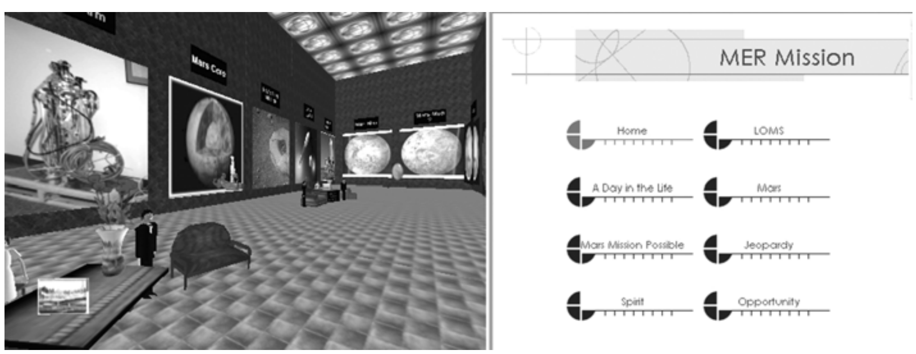

Figure 4. The first gallery in the Long Island Middle School's world features a rich exhibit covering many aspects of Mars exploration (left). The world is populated with virtual characters that link to the students' recorded speeches. The Web content (right) serves as a navigation tool for visitors.

4.4.1. World Description

The Long Island Middle School team created a world featuring the possibility of life on Mars, and Mars exploration in general. Created by an especially large group of students, the world is full of images and voiceovers recorded by the students. The knowledge space guides visitors through a narrative highlighting a manned mission to Mars. It begins with a gallery full of pictures, sounds and movies covering many aspects of the subject. Then visitors board a rocket and fly to Mars. On the Martian surface, they encounter the rovers Spirit and Opportunity, information about the planet, and quiz challenges. The students created and incorporated a web site with slideshows and another quiz game.

4.4.2. Assessment

This world reflects the educational priorities of the coaches. The science teacher focused student activities on the concept of life on Mars. Her first semester earth science curriculum provided the students a framework for studying the planet. In the second semester, the life science curriculum examined the basic requirements for supporting “life as we know it.” Students in the computer club became very excited as they explored and learned more about the multimedia capabilities of the software. In addition to the virtual world project, the coaches arranged a field trip to a nearby company that creates hardware for NASA Mars exploration. The students attracted to the computer club portion of the program had mixed, but predominantly positive, initial attitudes toward science. This community incorporated scientific culture from the start socially, but only partly so individually.

The Mars topic suggests an interest in exploratory science, with much less direct relevance to the students’ immediate and community surroundings than the other topics described so far. The integration of content with multimedia presentations, environmental design, story, interactivity and cooperation shown in this project are evidence for both the energy of the coaches and the role of scientific culture for this community. The space expresses knowledge about Mars exploration and scientific processes, while also incorporating a wealth of historical and cultural perspectives. This group has showcased their project for online visitors from Cornell, the chairman of their school board, and a variety of online visitors.

4.5. Singapore Primary School

The head of the Singapore Primary School science department describes the school as middle-class. His goal in running a SciFair program was to explore the features of the virtual learning environment and to consider alternatives in teaching science. He selected students who would benefit from extra help studying the solar system and gave them the opportunity to work after school, two hours weekly for six weeks, to build a museum about the solar system. Because we did not follow the full engagement process of the SciFair model in this case, we have very little information about the school and the students involved.

4.5.1. World Description

Visitors enter a lunar landscape with a night sky full of stars. To one side they see a blue glass structure containing three exhibits. The first is a solar system gallery with images from the Web and descriptions written by students. On the second level is a hall of fame featuring Taylor Wang and Yang Liwei, the first Chinese men in space and the Chinese spacecraft Shenzhou 5. This floor also features the history of astronomy from the Greek philosopher Thales to Yuri Gagarin and Neil Armstrong’s walk on the moon. The top floor features a model of the solar system including moving planetary orbits. The space is well organized and interesting to explore, including the gallery of Chinese astronauts. Their explanatory signs contain no spelling errors. The students who created this world are in the fifth grade and English is not their primary language. It was extraordinary to learn that students were selected for the team with the intent of improving their science grades, given the depth of the information presented. Almost everything in this world was built by the students.

Figure 5. Yang Liwei, Chinese astronaut, and Aristotle are featured in the Singapore Primary School history of astronomy gallery (left). The students also created the site of an alien invasion outside their museum (right).

4.5.2. Assessment

This project stands out in terms of the quantity of scientific content incorporated into the exhibit and the depth of design, especially considering the time allotted. As a supplemental exercise for a science class, coached by a science teacher, this project began connected to scientific culture in the social dimension.

While the topic was a result of class curriculum, it still shows an interest in exploratory science. The knowledge space, though simple in its artistic expression, incorporates both scientific knowledge and cultural history. The team demonstrated a basic understanding of the mathematical relationships of the planetary orbits by working with the coach and mentor to create a moving model. The showcase for Singapore Primary School was a student-guided tour for their mentor and the SciFair staff. The students and coach logged in from their homes on Friday night for a Saturday morning presentation to their visitors from Ithaca, NY, USA.

5. Discussion

We have explored a variety of applications of the SciFair model, situated in different school environments. Each had a distinctive role for the program within the learning community, coach motivation, and a science topic with relevance to the team. As a science communication program, SciFair gives students a unique forum for expressing scientific information they have researched as well as their own creative contexts for the information.

The program's focus on science discovery and access to Cornell research provides a connection to scientific culture. But the initial scientific context varies greatly between communities. American Indian School #2, Long Island Middle School, and Singapore Primary School integrated the program within science curriculum, while the others did not. All of the programs except American Indian School #1 had a science teacher as a coach. Both American Indian Schools and the Long Island Middle School had a technology or media arts teacher as a coach. Both American Indian School teams met during class time, while the Urban Virginia Middle School and Singapore Primary School teams met after school; Long Island Middle School combined both formats. These differences suggest similar variation in the social dimension of scientific culture inherent in the communities represented by each program.

The Science Attitude score analysis of our entry survey is an output indicator for the individual dimension of scientific culture in each of the communities. It shows that attitudes about science among SciFair participants can vary significantly by school. The Urban Virginia Middle School students expressed a unanimously positive attitude toward science. The students at Long Island Middle School expressed feeling less positive about science and the American Indian School #1 students were significantly more negative. This trend was consistent across each survey question. While our data is limited to only those students participating in the SciFair program, this finding suggests that the integration of scientific culture can vary widely for individuals between our program schools.

The teams at American Indian School #2, Long Island Middle School, and to some degree Singapore Primary School, incorporated scientific process into the content of their knowledge spaces, while the others focused on scientific knowledge. This represents a broader incorporation of scientific culture into their projects. At American Indian School #1, scientific process was infused by SciFair staff through the integration of a Cornell research presentation.

The American Indian School #2 and the Long Island Middle School teams incorporated detailed surroundings and narrative into their presentations in order to situate the science content. The Urban Virginia Middle School and Singapore Primary School teams both organized their information in a structured way, using images and interactive elements. The science content in the American Indian School #1 project was largely isolated from the other elements of individual and community expression. This hints at a range of the level to which scientific culture was integrated into the overall culture of the learning community. While it is interesting that the students at both American Indian Schools asserted their individual and group identities alongside their science content, the other teams did complete the homesteading phase, and expressed themselves creatively in separate virtual worlds.

The teams or their coaches chose research topics with different relationships to the learning communities. Both American Indian School teams featured subjects with concrete relevance to local geography and cultural history: tsunamis and watershed ecology. The Urban Virginia Middle School team studied the Human Genome Project, and featured inherited diseases socially relevant to the students' representative communities. And the Long Island Middle School and Singapore Primary School teams researched topics in astronomy, a more exploratory subject in terms of its relevance to the students' immediate experience. At American Indian School #2 and Singapore Primary School, the topics were a direct result of the science curriculum, and the Life on Mars subject at Long Island Middle school represents an application of the curriculum to a novel issue.

For two of the three programs that were integrated into the science curriculum, the showcase event was a forum for students to present new scientific knowledge. The showcase at American Indian School #1 demonstrated the students' mastery of new technologies and communication skills. At the Urban Virginia Middle School, the showcase combined opportunities for demonstration both of new learning in science and new skills for computer-based communication.

In this supplemental education program, most of the work of researching, designing, building, and presenting these SciFair projects fits in the learning mode of appropriation of science as described by Godin and Gingras. In some cases, the programs involved the implication mode as well. A Cornell undergraduate wave science researcher led an online presentation and discussion with the American Indian School #1 team. The Long Island Middle School team communicated electronically with the a Mars exploration research group at Cornell, visited a local company that manufactured hardware for a Mars mission, and hosted an online visit by a worker at that company.

6. Conclusion

Our exploration of five SciFair programs, their educational contexts, and the characteristics of their final projects has provided valuable insight into the variety of scientific culture they represent. A leader in multicultural educational reform, Dr. Geneva Gay at the University of Washington recommends that teachers and school leaders become experts in "culturally responsive teaching," a method that uses students' "cultural knowledge, prior experiences, and learning styles" in daily lessons. The SciFair Model is designed to be flexible and to be adapted to a wide variety of settings, especially in terms of cultural diversity. Our intent is that through encouraging the teams to find and build their own contexts for their scientific explorations, we encourage cultural relevance and accommodate the educational priorities of the communities. We see here a balance between adoption of the program for both technology and science education, at least in part reflecting the priorities of the communities. Even within the limitations and constraints of the evaluation of a supplemental learning program, this examination from the perspective of scientific culture has deepened our understanding of the learning communities at our sites. This perspective will also inform development of new metrics for program evaluation and research [5].

7. References

[1] Corbit, M., S. Kolodziej, and R. Bernstein. "SciFair: A Multi-User Virtual Environment For Building Science Literacy," Proceedings of the Beijing PCST Working Symposium, China, 2005.

[2] Durant, J. R., G. A. Evans, and G. P. Thomas. "The public understanding of science," *Nature* 340 (1989): 11–14.

[3] Godin, B. and Y. Gingras. "What is scientific and technological culture and how is it measured?" *Public Understanding of Science* 9 (2000) 43-58.

[4] Information pertaining to individual schools and their communities is confidential and available upon request.

[5] Gay, G. "Diverse Learners Blossom in Culturally Responsive Classrooms," Report to the National Science Teachers Association Minority Caucus 2006 at the George Washington Carver Breakfast, http://caucus.edhost.org/view_entry.phtml?entry=20060119-3