

# Virtual Gallery Walk, an Innovative Outlet for Sharing Student Research Work in K-12 Classrooms

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**Abstract** - This paper discusses a case study which aims to make research projects more engaging for middle school students by incorporating a variation to the traditional gallery walk workflow. The process begins by having the students conduct individual research on one of a finite list of topics and produce a poster that details what they have learned. We collect the research posters and transfer the media into the shared virtual world of Second Life, where a developer organizes the posters into a “virtual museum” of full-color high-quality panels displaying the students’ creations. Students return to the computer lab, log in to the virtual world, and explore the virtual gallery. This gives students the opportunity to learn more about the other topics from their peers in an engaging, interactive, and fun way. We evaluate the effectiveness of this workflow by injecting quizzes on the topic material before the research phase, after the research phase, and after using the virtual gallery walk. As virtual worlds are rarely utilized in K-12 classrooms, the virtual gallery walk is innovative as a vehicle for student learning and as a possible outlet for sharing the work with community of other students active within Second Life.

*Index Terms* – Gallery Walk, Virtual Environments, Second Life, K-12 Education

## BACKGROUND

The gallery walk is a popular exercise in science classrooms that is designed to build students’ proficiency in researching materials, processing and organizing the data they uncover, and presenting their findings in an attractive and understandable format that is ultimately presented to their classmates. While such an activity is invaluable in furthering students’ understanding of the designated material and in learning how to find information and cite sources, it also promotes key elements of peer collaboration. “Showing off what [the students] have done puts them into the spotlight and gives them an opportunity to get help from the rest of the class. At its best, the gallery walk is not only a source of ideas but also provides a venue for talking science, using evidence in support of claims, and providing explanations that others can understand” [1].

Gallery walks have been put to use regularly in several schools participating in Ohio University’s “Science and Technology Enrichment for Appalachian Middle-Schoolers”

(STEAM) program. STEAM is a GK-12 program funded by the National Science Foundation that pairs graduate students in computer science and related disciplines with local area science teachers to develop engaging educational games and simulations targeted at improving student learning and bolstering interest in science and technology related disciplines. These researchers hypothesized that by incorporating a gallery walk into a shared virtual environment the students would have more fun, be more engaged, and have access to more student research materials than by using more traditional means.

## RELATED WORK

The notion of using three-dimensional, immersive virtual environments in education is not new, and has shown promise as an effective vehicle for fostering active learning. The World Wide Web Instructional Committee (WWWIC) has been developing curriculum aids for a variety of different disciplines that utilize such environments. Several qualities of the virtual gallery walk, such as being immersive, spatially-oriented, exploratory, and multiplayer, are listed as key principals that the WWWIC developers strive for in creating their simulations [2]. In particular, this multiplayer component has been shown to have a profound effect in engaging the students, particularly when the virtual environments offer a means in allowing participants to communicate and collaborate within a virtual world [3].

While the application of virtual environments to the traditional gallery walk workflow as a mechanism for disseminating student research work in K-12 schools is a relatively new concept, developers have been building custom galleries within virtual environments for some time. The “interactive virtual gallery” is one such example that provides a suite of editors that enable users to construct rich, 3-dimensional galleries that can be viewed locally or shared with other prospective visitors via the internet [4].

## TEST SETUP

In this case study we describe two full deployments of the virtual gallery walk process flow. The first instance, the “Biome Gallery Walk”, was deployed to a 7<sup>th</sup> grade science classroom in April of 2007. The second instance, the “Diversity Gallery Walk”, was deployed in December of 2007 by the same teacher and fellow pair at the same school but with new set of 7<sup>th</sup> grade science students. Each

deployment is described in detail in the major sections that follow.

### Lab Environment

Both deployments of the virtual gallery walk utilized the same computer lab, and this lab was used for both the research and dissemination pieces of the gallery walk process workflow. In this subsection we describe the equipment that was used in this study.

The computer lab contained roughly twenty Dell-brand computers, though at any given time anywhere from three to seven computers were rendered unusable by the students due to either hardware or software problems. All computers were of an identical model and so had identical initial specifications. These specifications were as follows:

- Pentium 4 3.0 Gigahertz CPU
- 1 gigabyte of RAM
- An onboard Intel Express Chipset video card with 8-224 MB shared VRAM
- An 80 GB hard drive

Additional equipment in the form of GeForce 6200LE video cards were purchased for this lab to improve the lab computers' capabilities in displaying dynamically-changing three-dimensional graphics in real time. This is crucial for the test computers to be capable of rendering the virtual environments used in the project at acceptable frame rates, which in turn creates a more natural, immersive experience for the students.

The lab computers shared a T1 connection that had been benchmarked to be capable of downloading at roughly 1.3MB/sec. Since the virtual environments used in the Biome Gallery Walk connected to a remote server across the internet to acquire information regarding the status of the shared virtual environment (such as graphics and player locations), the link to the internet was identified as a possible bottleneck, particularly if all computers utilized the link for this activity simultaneously.

### Software Environment

Second Life was used as the vehicle for both developing the virtual gallery and deploying it to the students. Second Life is software that provides for a virtual world. To use this software, clients first register for a free account with Linden Labs, the creators of the Second Life client software and the caretakers for the official Second Life servers. Once this is complete, each user is provided with their own avatar, a virtual person that uniquely represents them within the virtual environment. These avatars can be extensively customized by the user. The freedom to create an avatar that is unique and highly-personalized is one means by which the virtual environment can be made more immersive to the user. An example of an avatar is shown in Figure I.



FIGURE I  
CUSTOMIZED AVATAR IN SECOND LIFE.

By using the username and password combination that the user specified during the account creation process, users can login as the corresponding avatar to explore the three-dimensional virtual world of Second Life. In most cases, this involves first exploring an “Orientation Island” that is designed to help familiarize the users with Second Life’s controls. These controls allow the user to walk, fly, interact with objects, communicate with other avatars, and manipulate the camera.

When they feel ready, the user can “teleport” away from this island to explore other locations of interest. What is compelling about these other locations is that the content that populates nearly all of the locations was created by other avatars. This content can be anything from clothing to houses, and is built by using an intuitive in-game modeling editor. Furthermore, the models that are created can be scripted through a flexible in-game scripting editor that uses a C-like programming language and an extensive list of well-documented APIs. Finally, Second Life’s EULA allows—and in fact encourages—these creations to be distributed to other avatars while the original creator retains the intellectual property rights to the creation.

Second Life was chosen as the platform for the virtual gallery walk and several other educational software games and simulations because of the relative ease in developing the relevant content and deploying it within a shared virtual world. However, safely and securely deploying Second Life within K-12 schools required a fair amount of forethought, planning, and configuration. Second Life offers two worlds (known as “grids”) that correspond to specific age groups. Since we would be using Second Life in a 7<sup>th</sup> grade classroom, that was needed to utilize the “Teen Grid”, which accommodates users that fall between ages 13 to 17, rather than the “Main Grid”, which is for users who are older than 17. This required the graduate fellow, the teacher, and other adults who would need accounts on the Teen Grid to undergo a background check before their accounts would be released.

In order to build the virtual gallery as well as other educational software projects within Second Life, we communicated with Linden Labs to purchase an “island”, or a plot of virtual land under the owner’s administration where the projects could be developed. We formed an agreement with Linden Labs that the island would be created with the special property that only the set of user accounts that would be provided with the island would have access to the island, and these accounts would be incapable of teleporting or otherwise transporting to other locations within the Teen Grid. In addition, standard accounts on the Teen Grid would similarly be incapable of entering this island. This effectively created an island in complete isolation, which enabled a level of privacy and security for our target classrooms that is crucial to this type of educational project in K-12 education.

The Second Life client viewer was the only application that needed to be installed on the lab computers for students to perform the virtual gallery. After we conducted a series of discussions with administrative and IT staff and received their approval to proceed with the project, a graduate fellow was permitted to install the software on each lab computer. The graduate fellow then tested the software and observed no problems connecting to the servers that hosted the virtual island from the lab.

### STANDARDS

The virtual gallery walk activity described in this paper was designed to accommodate a wide range of 7<sup>th</sup> grade benchmarks that are mandated by the Ohio Department of Education. Relevant benchmarks in language arts include:

- **Publishing, No. 17:** *Prepare for publication (e.g., for display or for sharing with others) writing that follows a format appropriate to the purpose, using such techniques as electronic resources, principles of design (e.g., margins, tabs, spacing and columns) and graphics (e.g., drawings, charts and graphs) to enhance the final product.*
- **Research, No. 1:** *Generate a topic, assigned or personal interest, and open-ended questions for research and develop a plan for gathering information.*
- **Research, No. 2:** *Identify appropriate sources and gather relevant information from multiple sources (e.g., school library catalogs, online databases, electronic resources and Internet-based resources).*
- **Research, No. 3:** *Identify and explain the importance of validity in sources, including publication date, coverage, language, points of view, and describe primary and secondary sources.*
- **Research, No. 5:** *Analyze and organize important information, and select appropriate sources to support central ideas, concepts and themes.*
- **Research, No. 7:** *Use an appropriate form of documentation, with teacher assistance, to acknowledge sources (e.g., bibliography, works cited).*

- **Research, No. 8:** *Use a variety of communication techniques, including oral, visual, written or multimedia reports, to present information that supports a clear position with organized and relevant evidence about the topic or research question.*

The science benchmarks that are met in the virtual gallery walk activity are dependent on the topic that is to be researched by the students in the activity. Each activity described below will discuss the specific science benchmarks that were met by its corresponding research topic.

### BIOME GALLERY WALK

The biome gallery walk was the first of two deployments of the virtual gallery walk and was conducted in April of 2007. Under standard 45 minute periods this activity took roughly one school week to complete. It was divided into a three-day research period and a two-day gallery walk period.

#### Research Period

The central topic of this activity revolved around exploring the major land biomes that are supported by the earth. This topic is covered under Grade 7 Earth Science Standard Number 8 in the Ohio Department of Education Standards: *Describe how temperature and precipitation determine climatic zones (biomes) (e.g., desert, grasslands, forests, tundra and alpine)*

The research period began on a Wednesday and ended on a Friday to allow ample time for the developer to prepare the virtual gallery over the weekend. To begin the research period, each student selected the biome they were most interested in researching. The list of possible biomes for this activity consisted of:

- Tundra
- Taiga
- Tropical Rainforest
- Deciduous Rainforest
- Grasslands
- Desert

After selecting their biomes, students began their research. Several pre-selected resources and web sites were provided as a starting point, but students were free to conduct further research on their own. During this period the students worked to develop a poster using Microsoft Word that would encapsulate the results of the research on their biome. A rubric was provided to the students that specified several major elements that the instructor would be looking for in the finished posters. The rubric called for posters to contain pictures and information regarding plant and animal life found in the biome. It also instructed the students to include weather and temperature information about the biome and to cite all sources used in the construction of the poster.

**Biome Gallery**

After the research phase of the gallery walk was finished and the Microsoft Word biome poster files were collected, the graduate fellow worked on incorporating the posters into a virtual gallery. Figure II shows a screenshot of the finished gallery.

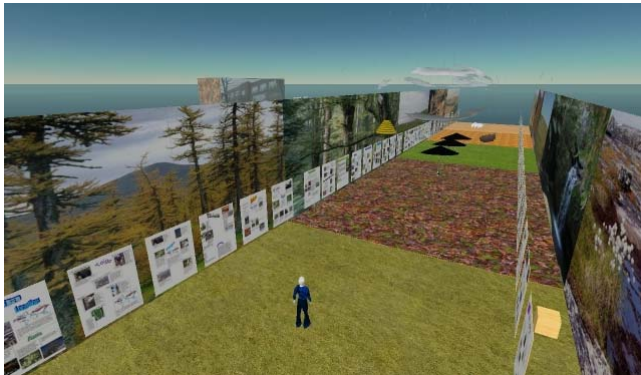


FIGURE II  
VIRTUAL BIOME GALLERY WITHIN SECOND LIFE

By converting the posters into images and uploading them into Second Life, the developer was able to organize the materials into a detailed, vibrant virtual gallery of student research work. Relevant posters for each of the six major biomes covered in this activity were organized and placed within that biome’s section in the virtual gallery. To further enhance the immersive nature of the gallery, the developer utilized Second Life’s scripting capabilities to produce weather effects that accentuated the various aspects of relevant biomes. For example, scripted special effects gave the impression that snow was falling over the tundra section of the virtual gallery, while clouds that produced virtual rain loomed over the tropical rainforest section.

**Research Methodology**

The initial deployment of the virtual gallery walk served largely to gauge the students’ reactions to conducting the activity within a virtual world and to evaluate their ability to learn how to control their avatars and manipulate the camera to get the best views of the student posters. Most students exhibited very few difficulties adapting to Second Life’s control scheme, which helped to ensure they were able to complete the worksheet that accompanied the activity within the time that was allotted for exploring the virtual gallery. After completing the activity, each student was provided with a simple evaluation form where they stated the aspects they enjoyed about the activity, suggestions for improvement, and space for their general comments.

**Deployment Period**

The deployment period consisted of two days during which the students were allowed to login to Second Life using accounts tied to the isolated private island to explore the virtual gallery and learn about other biomes than the one

they selected to research from the posters that were created by their classmates. An example of such a poster is shown in Figure III.

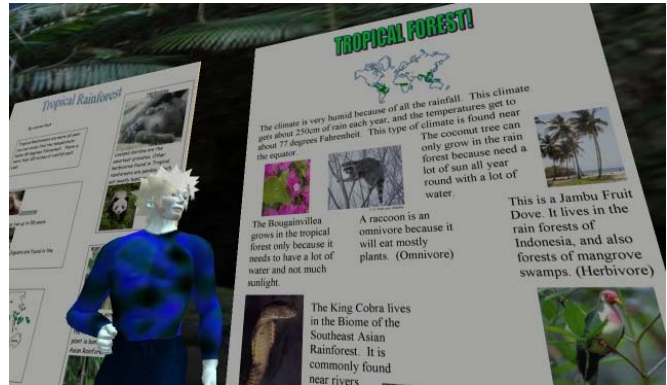


FIGURE III  
EXAMPLE POSTER WITHIN THE VIRTUAL BIOME GALLERY

Students were provided with a worksheet where they would fill in information about each biome. This information ranged from the location of each biome to the plant and animal life that is found there. More open-ended questions required students to compare and contrast two biomes, as well as to select a biome and describe why they would like to live there.

**Results**

Several positive outcomes were observed. The majority of both female and male students reported that they had greatly enjoyed the activity and wished to repeat the virtual gallery walk in the future. Students were particularly excited at the chance to view their own work “digitized within a video game”. Students also reported great satisfaction with several other capabilities of the software, including being able to customize their avatar, see each other’s avatars in the world, and communicate using Second Life’s built-in chat capabilities.

We also took note of some problems that we experienced with this initial deployment so that we could improve upon the experience in subsequent deployments of the activity. First, the island was populated with content intended for use with other activities. While we encourage exploration of the environment to an extent, the presence of this content served as a distraction for some students. In addition, we observed some choppy movement or slow loading on the gallery on certain machines, particularly in larger classes when nearly all of the roughly twenty machines were in use simultaneously.

**DIVERSITY GALLERY WALK**

The diversity gallery walk was the second of two deployments of the virtual gallery walk and was conducted in December of 2007. Once again the activity took roughly one school week to complete under 45 minute periods and

was divided into a three-day research period and a two-day gallery walk period.

### Research Period

This time the topic for the virtual gallery walk centered on major classifications of organisms. This topic is covered under Grade 7 Life Science Standard Number 8 in the Ohio Department of Education Standards: *Investigate the great diversity among organisms.*

Once again the research period began on a Wednesday and ended on a Friday to allow ample time for the developer to prepare the virtual gallery over the weekend. To begin the research period, each student selected a major classification of organisms and conducted in-depth research on one organism within that classification. The major classifications for this activity consisted of:

- Fish
- Cnidarians
- Mollusks
- Echinoderms
- Crustaceans
- Reptiles
- Birds
- Mammals

Once again students were asked to prepare a poster using Microsoft Word that reflects the results of their research. Students were again provided with guidelines as to the content that was expected to appear on the posters. These expectations included pictures of the organism, predators, prey, and notable adaptations. Students were also expected to cite any sources they used in preparing the poster.

### OpenSim and the Diversity Gallery

After observing some performance issues due to limited bandwidth and some issues with certain students remaining on-task due to the large number of distractions present on the private island, we decided to make use of OpenSim for constructing the diversity gallery. OpenSim is an open source alternative server framework for Second Life, albeit still very early in development as of 2007. By installing OpenSim on a laptop computer and using it as a server, lab computers were able to connect to the server computer through its internal network, which in turn allowed for fewer issues with bandwidth and better performance. In addition, privacy and security issues were mitigated since the server computer was only accessible from within the school's internal network. Finally, students were less likely to become distracted by other projects since the island supported by the OpenSim server could be devoted entirely to hosting the virtual gallery. Figure IV shows the diversity gallery running within an island hosted by the OpenSim server.

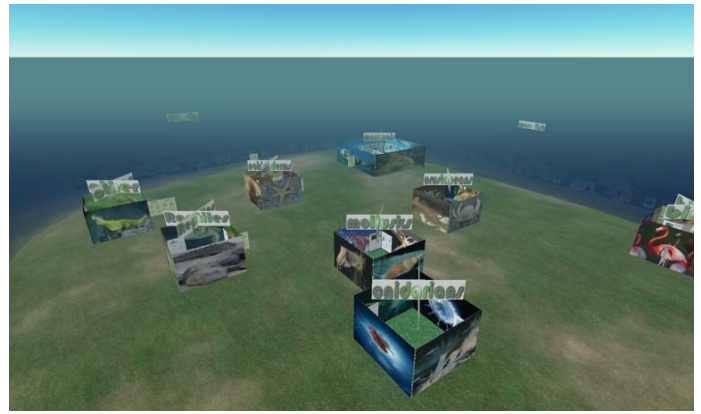


FIGURE IV  
DIVERSITY GALLERY RUNNING ON OPENSIM

The diversity gallery was organized into “exhibits” for each major organism type. Since the majority of the students chose to research fish, the fish exhibit was moved into the underwater sections at the shore of the island. This helped to save space and to encourage exploration of the island.

### Research Methodology

The diversity gallery walk utilized a series of quizzes to gauge the degree of learning throughout the gallery walk process workflow. The first quiz was dubbed the “pre-research test” and was taken by all students before beginning the research phase. The second quiz was dubbed the “post-research test” and was taken by all students after conducting the research phase but before experiencing the virtual gallery walk. The third and final quiz was dubbed the “post-game test” and was taken by after conducting the virtual gallery walk.

Each quiz consisted of ten questions. Nine of the questions were multiple choice, and the tenth was a short answer question. To help ensure the questions asked on each quiz carried no bias, a pool of twenty-two multiple choice questions and three short answer questions was created. Nine multiple choice questions and one short answer question were randomly selected from the pool by using a random number generator. These questions were used for the pre-research test. This process was repeated to form the post-research test. The post-game test utilized the remaining four multiple choice questions and short answer question. It also made use of five multiple choice questions created from information observed from the student research posters.

As we are always interested in feedback from the students regarding the activity, we once again issued a simple three question survey to them after completing the virtual gallery walk activity. The focus of the survey was to help ascertain what the students enjoyed most about the virtual gallery, what could be improved, and any other comments they wanted to offer.

**Deployment Period**

The deployment period consisted of two days during which the students were allowed to login to the OpenSim Second Life server running on a laptop machine connected to the lab network and learn about other organisms than the one they selected to research from the posters that were created by their classmates. An example of a poster from the Diversity Gallery Walk is shown in Figure V.

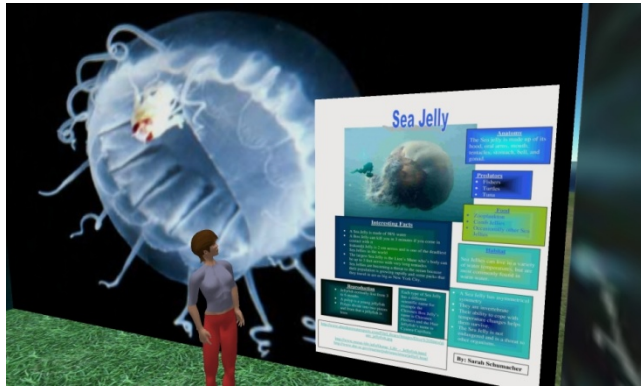


FIGURE V  
EXAMPLE POSTER WITHIN THE VIRTUAL DIVERSITY GALLERY

As with the biome gallery walk, a worksheet accompanied the diversity gallery walk. While the worksheet for the biome gallery walk asked for very general information, the diversity gallery walk worksheet asked very specific questions that could only be answered by drawing information from very specific posters. This turned the activity into a kind of “scavenger hunt” for information, which helped the students to look more closely at the posters for information that would help them complete the worksheet.

**Results**

The results of the pre-research, post-research, and post-game tests are shown in Table I.

TABLE I  
DIVERSITY GALLERY WALK TEST RESULTS

Test	N	Mean Score	Standard Deviation
Pre-Research	86	3.01	1.712
Post-Research	86	5.26	1.730
Post-Game	88	4.977	1.6950

The post-research tests showed significantly higher scores than the pre-research tests despite the fact that students only researched one of several topics by the test during this period. The post-game test, however, showed slightly lower scores than the post-research test. Item analysis tells us that this was due in large part to a perceived higher difficulty being given to the five questions specific to this quiz that were taken directly from individual student posters. We hypothesize that, with over eighty posters to study, the possible range of material for these more specific questions increased the overall difficulty of the quiz.

**CONCLUSION / FUTURE WORK**

The virtual gallery was deployed to a 7<sup>th</sup> grade science classroom on two separate occasions. Feedback regarding the activity was collected from the students. One student described the activity as “3d-ish and more fun than just looking other people’s poster in real life”. Other students felt that “it was awesome to be in a virtual world and chatting with schoolmates” as well as that “it was cool that we could learn and have fun at the same time”. The schoolteacher and over 95% of the test sample of eighty-eight students wished to repeat the activity.

We continue to improve the activity to be even more immersive and educational. We are developing virtual galleries using alternative software development platforms, including a custom game engine developed using C++ and OpenGL. For these future gallery walks we intend to integrate sound clips of each student reading the contents of their posters into the gallery walk to help tailor the activity to more auditory learners.

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