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HOW AN AUTHENTIC SCIENCE COURSE BECAME DIGITAL AND ONLINE DURING THE COVID-19 PANDEMIC

CÓMO UN CURSO DE CIENCIAS AUTÉNTICO SE VOLVIÓ DIGITAL Y EN LÍNEA DURANTE LA PANDEMIA COVID-19

COMO UM CURSO DE CIÊNCIA AUTÊNTICO SE TORNOU DIGITAL E ONLINE DURANTE A PANDEMIA COVID-19

Maritza Bentham Macdonald[1]
Adriana Aquino-Gerard[2]

Abstract
This paper describes the conditions for teaching students and teacher-residents in the autumn of 2020 when professors in many countries needed to implement remote teaching. Also, the teaching and cultural institutions were closed and only functioning online. The context is a science and culture museum in NYC with a graduate college (Richard Gilder Graduate School). The program offers a Master Level Residency Program for secondary science teachers. All courses are co-taught by teams of a teacher educator and a museum scientist. In this case, the teaching team (authors) included a teacher educator specialized in curriculum design and pedagogy for informal and multilingual settings; the scientist is an evolutionary biologist specializing in Ichthyology at the museum.
Keywords: teacher education; teacher residency; remote teaching.

Resumen
Este documento describe las condiciones para enseñar a los estudiantes y a los maestros-residentes en el otoño de 2020 cuando los profesores de muchos países necesitaban implementar una enseñanza remota. Además, las instituciones de enseñanza y culturales estaban cerradas y solo funcionaban en línea. El contexto es un museo de ciencias y cultura en Nueva York con una universidad de posgrado (Richard Gilder Graduate School). El programa ofrece un programa de residencia de nivel maestro para profesores de ciencias secundarias. Todos los cursos son conjuntos por equipos de un educador de docentes y un científico del museo. En este caso, el equipo de enseñanza (autores) incluyó a un educador docente especializado en diseño curricular y pedagogía para entornos informales y multilingües; El científico es un biólogo evolutivo especializado en ictiología en el museo.
Palabras clave: Formación docente; Residencia de enseñanza; Enseñanza remota.

Resumo
Este artigo descreve as condições para ensinar aos alunos e professores residentes no outono de 2020, quando professores de muitos países precisavam implementar o ensino remoto. Além disso, as instituições de ensino e cultura estavam fechadas e funcionando apenas online. O contexto é um museu de ciência e

[1]PhD in Education with Specialization in Teacher Education and Curriculum Design in Columbia University, Teachers College, EUA. Orcid: https://orcid.org/0009-0000-6255-025X. E-mail: mmacdonald@amnh.org
[2]PhD in Natural Sciences in National University of La Plata. Senior Science Content Specialist in the Department of Education of the American Museum of Natural History (AMNH), EUA. Orcid: https://orcid.org/0000-0002-2668-6851. E-mail: aaquino@amnh.org

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cultura em Nova York com uma faculdade de pós-graduação (Richard Gilder Graduate School). O programa oferece um programa de residência à nível de mestrado para professores de ciências secundárias. Todos os cursos são co-ensinados por equipes de um educador de professores e um cientista do museu. Nesse caso, a equipe de ensino (autores) incluiu um educador de professores especializado em design e pedagogia do currículo para configurações informais e multilíngues; O cientista é um biólogo evolutivo especializado em ictiologia no museu.
Palavras-chave: formação docente; residência docente; ensino remoto.

Introduction – Context

> This is my first semester as a science teacher-resident, and it feels surrealistic. I have not personally met my mentors, students, or college professors. I am also new to this urban setting (Teacher residente, 2020).

The initial quote by a teacher resident describes the conditions for teaching students and teacher-residents in the autumn of 2020 when professors in many countries needed to implement remote teaching. Also, the teaching and cultural institutions were closed and only functioning online. The context is a science and culture museum in NYC with a graduate college (Richard Gilder Graduate School). The program offers a Master Level Residency Program for secondary science teachers. All courses are co-taught by teams of a teacher educator and a museum scientist. In this case, the teaching team (authors) included a teacher educator specialized in curriculum design and pedagogy for informal and multilingual settings; the scientist is an evolutionary biologist specializing in Ichthyology at the museum (https://www.amnh.org/learn-teach/master-arts-teaching).

This participatory self-study describes three adaptations the co-teaching team designed, tested, revised, and implemented in a required Master level science and pedagogy course. The purpose of the course was to prepare science teacher-residents to use informal institutions to teach and learn science. Scientific and cultural institutions, such as museums, parks, rivers, planetariums, and gardens, are supported by multiple research areas. Place-based Education (Semken *et al.*, 2017) and the strands of earning in informal settings (Fenichel & Schweingruber, 2010) were critical. During two years of remote teaching due to Covid-19 (2020-1021). In 2022 classes were taught in person and original scientific conditions, such as laboratories, scientific collections, interactions with scientists, exhibitions, models, and visits to multiple informal institutions. Some of

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the adaptations remained as additional online resources and, in some cases, for hybrid courses.

The critical assignment to redesign and adapt

Course participants needed to learn how to develop and implement a Museum Investigation that complements the school curriculum with a group of students. The professors selected this assignment because of its theoretical and scientific-pedagogical rigor outlined in the following rubrics for the course different aspects of the course assignments:

(1) Showed how teachers used their knowledge of "Sense of Place" (Semken *et al.*, 2017) to use the informal science and cultural settings in NYC;

(2) Demonstrated that teachers used the research strands for learning in informal settings; such as intrinsic and extrinsic motivation, scientific thinking, language, and tools of science (Fenichel, M. and Schweingruber, H. A. (2010);

(3) Participated in a choice of Citizen Science programs (Follet, R., and Strezov; V., 2018) for observation, recording, and collecting data for scientific purposes;

In the following sections, we describe the three components of the curse that were adapted from authentic hands-on instruction to various online and digital strategies.

Scientist describes the stages and adaptations of an authentic investigation

During the course's first session, students are introduced to a learning experience that follows the three-part model for curriculum-based teaching using informal environments.

The science content goal of the lesson is the evolutionary concept of common ancestry as the best explanation to make sense of the patterns similarly observed among species. This concept is introduced in the post-visit activity. The context of the activity is the study of the diversity of fishes, which is the specialty of one of the authors (A.A.), Ichthyology.

1) Pre-visit activity: (AA) introduces her scientific specialty, biological systematics, which studies biodiversity. She explains they will go on an expedition (to

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the Hall of Ocean Life). To discover new species of fish, we first need to develop our specialty, which will be the fins of fishes—using a wet collection of fishes (specimens preserved in an ethanol solution). Next, students examine a variety of fish species and count the number of types of fins for each species, which, no matter the species, are five types of fins. Following that, learn the names of the fins. The facilitator explains that they will go on an expedition to the Hall of Ocean Life, where they will choose a species of fish represented in one of the eight featured marine ecosystems on display. They need to sketch the fish and identify the fins based on what they have just learned (now, their background knowledge).

2) Visit/expedition activity: Students spend about 30 minutes in the hall and select, sketch, and label the fins of their fish.

3) Post-visit activity: Back in the classroom, students share their "discoveries," which capture the vast diversity of fish species (35,000 spp.). The professor questions students to help them understand how the fin pattern is maintained, even in the extreme differences in the shape of the fishes and their habitats. How can we explain this observed pattern or phenomenon? The conversation leads students to infer common ancestry as the best explanation.

Throughout the years that the class had been offered at the museum, the fish investigation had been an effective way to let students experience the 3-part teaching model of informal learning embedded into the curriculum-based lesson. The specimens examined during the pre-visit activity and those selected to sketch during the expedition to the Hall of Ocean Life were replaced with digital 3-D models which, if used online, can be examined and manipulated at no cost (www.Sketchfab.com).

1) Students working in a breakout group were assigned a 3D model of a fish species. The task was the same as the one in the face-to-face version: to count the types of fins they observed. As a large group, the facilitator shared the names, made them notice a similar pattern, and introduced the virtual expedition to the Hall of Ocean Life, during which they could "discover" their fish species.

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2) Professor introduced the Hall of Ocean Life and the featured ecosystems with a guided tour using the platform Google Arts and Culture (https://artsandculture.google.com/)

For the "discovery" experience of the online version, each ecosystem was represented by a high-resolution image inserted in a Google slide, which also presented images with hyperlinks to the 3D models already identified. The authors selected 3D species models from the same taxonomic groups as the specimens on display in the hall ecosystems. After examining the slide deck, each student selected one species, opened the hyperlink, examined the fish by manipulating the model, sketched, and identified the fins. Finally, the sketch was uploaded to a shared slide deck to create a digital exhibition of their observed fish and its ecosystem.

3) Similarly, in the third part of the lesson, students shared their "discoveries" and explained the fish pattern. The professor posed questions that helped students (teacher-residents) notice the pattern of similarities to develop a scientific explanation of the evolutionary concept of "common ancestry" as the most likely explanation of the pattern of fin similarities. This process prepared the teacher residents to be able to participate in Citizen Science Projects several weeks later.

Adapted Assignment to strengthen theoretical foundations

The professors and teacher residents connected via zoom from their homes or apartments. The topic of a zoom session was to discuss and share examples of the differences between an investigation, like the Fish class, and an expedition, like the ones they would be researching and doing online. The professors created a Reading Response assignment with readings and responses on Place-Based Education (Semken, 2018), with a free-choice podcast component to solidify theory and practice.

Place-based Reading Response: Please read *Semken et al. (2017). Place-Based Education in Geoscience: Theory, Research, Practice, and Assessment. J Geo. Edu. 65, 542–562 (2017) and respond in a 2-3pg document that: a) Defines what place-based learning is; b) Describes a personal experience with a place of learning that influenced

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your interests in science; and c) Explains any ideas you are gained for planning a place-based expedition.

Practice: Freely select one of the following "The Bowery Boys: New York City History" podcasts that interest you. The podcasts provide the history of various informal settings in NYC. Write a paragraph explaining why you selected this podcast and the most important thing you learned or surprised you about the particular place. (Half page maximum).

1. #360 The Botanical Gardens of New York City https://podcasts.apple.com/us/podcast/353-harlem-before-the-renaissance/id258530615?i=1000510710799

2. Rewind: The American Museum of Natural History https://omny.fm/shows/the-bowery-boys-new-york-city-history/dinosaurs-and-diamonds-the-american-museum-of-natu

3. #341 The Metropolitan Museum of Art https://omny.fm/shows/the-bowery-boys-new-york-city-history/the-metropolitan-museum-of-art

4. #54 The Creation of Central Park https://omny.fm/shows/the-bowery-boys-new-york-city-history/land-of-the-lenape-a-violent-tale-of-uneasy-allian

5. #297 Dr. Hosack's Enchanted Garden: Botany, Medicine, and Discovery in Old New York https://omny.fm/shows/the-bowery-boys-new-york-city-history/dr-hosacks-enchanted-garden-botany-medicine-and-di

6. #293 Secret Places of Upper Manhattan https://www.boweryboyshistory.com/2019/06/secret-places-of-upper-manhattan.html

7. #381 The Wonderful Home of Louis Armstrong https://is.scribd.com/podcast/418271507/281-The-Treasures-of-Downtown-Brooklyn

8. #162 George Washington Bridge https://boweryboys.libsyn.com/162-george-washington-bridge

The work of Museum Scientists to Introduce Citizen Science

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One of the most important tasks by museums during the pandemic was to develop online resources, such as guided online expeditions, podcasts, online lab demonstrations, or presentations by scientists using open platforms such as Facebook and YouTube.

Teachers and students rarely meet scientists who share their work with educators. Professors selected a series of online presentations by museum scientists to teach about the different scientific research areas at the museum and introduce the final assignment in a Citizen Science Program. This strategy was complemented by creating "Small discussion groups" discussed and modeled during the ZOOM-based class periods to learn more about the work of the AMNH museum scientists and how to use these digital presentations as part of their teaching strategies.

- Hall of Planet Earth (https://www.facebook.com/watch/?v=351719368728775) , Hall of the Universe (https://www.facebook.com/watch/?v=372769376868282) , Hall of North American Mammals (https://www.facebook.com/watch/?v=2002676050041320)
- Astronomy online: Space Junk: Jackie Faherty and Deion Desir, NYC Teacher (https://youtu.be/dMbm7hccp1o)
- What Color is a Blue Whale? Dr. Melanie Steassny (https://youtu.be/2F6r-GplE9s)
- Preserving Lonesome George: Exhibitions and Conservation Department and Scientists (https://www.youtube.com/watch?v=AZKbO2B7po0)
- Meet the Titanosaur: Dr. Mark Norell (https://youtu.be/nTIJc4j5F9c)
- The Milky Way as You have never seen it: Dr. Jackie Faherty.

Becoming a community science researcher or Citizen Scientist:

The strategy of requiring course participants to join a community research project was new to this course. In retrospect, it allowed participants to develop their identity as scientists. During COVID-19 and remote teaching, there needed to be access to the museum laboratories. Fortunately, there are many opportunities to collect data for

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scientific research in the USA and other European and South American countries. In community science, called participatory science, non-professionals contribute their time, energy, or expertise to research. Whatever name is used, the approach is more popular than ever and even has journals dedicated to it. The number of annual publications mentioning 'citizen science' went from 151 in 2015 to more than 640 in 2021, according to the Web of Science database.

We selected and introduced the following USA Citizen Science Projects. Class participants were required to choose two projects, join them as researchers for a week, and complete a 5-10 side PowerPoint to present to the class.

- NYBG. Citizen Science (https://www.nybg.org/plant-research-and-conservation/center-for-conservation-strategy/citizen-science/)
- EPA. How to Find Citizen Science Projects (https://www.epa.gov/citizen-science/how-find-citizen-science-projects)
- California Academy of Sciences. Choose Your Own Citizen Science Project (https://www.calacademy.org/educators/lesson-plans/choose-your-own-citizen-science-project)
- National Geographic. Citizen Science Project. Learn about how you can participate in citizen science projects. (http://www.nationalgeographic.org/idea/citizen-science-projects/)
- INaturalist.org
- Explore.org Education
- Journey North - Tracking Migrations and Seasons (https://journeynorth.org/)
- Cornell University. Celebrate Urban Birds (https://celebrateurbanbirds.org/)

PowerPoint Response to Citizen Science Programs: Select two projects listed here and develop a 5-10 slide that responds to the following questions.

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Conclusions

In 2022, the authors began to teach in groups at the museum and, over two semesters, analyzed how the authentic science strategies they had developed during the pandemic could be integrated into the on-site course structure. These are their main findings.

1. Most resident teachers selected to do a guided expedition.

2. Research on Place-Based Education became as crucial as Research on Learning in Informal Settings. The reading response assignment was continued. The professors learned more about their student's interest in science.

3. The residents used the 3-D Digitalized collection resources to teach and demonstrate to their students in schools, with or without labs, how to study "Biodiversity of Fishes."

4. Professors included a half hour of observing different species and places with the Cameras used by Citizen Science programs in each session. Usually, discussions included comparisons of species or geographical and geological locations affected by the pandemic, climate change, recurring national disasters, or the beauty of rain forests, spring season, or butterfly migrations.

5. Strategy 3 (Identifying resources and scientists) was not used in the on-site course because studying the exhibitions and interacting with scientists were part of the on-site experiences. However, residents in 2022 will use those resources in their schools, where no scientists exist.

In conclusion, the authors hope that these adaptations and instructional practices contribute to the ongoing work of University professors who educate teachers in the following areas: Self-Study research, Informal Science Research, Partnerships between formal and informal education departments, and co-teaching models.

The authors have been co-teaching in various programs for about 15 years and make a habit of examining changes they must make for multiple reasons. Changes meet the content or pedagogy needs of teacher-residents and new teachers taking their courses. However, during the pandemic, the adaptations required much talking, reading, reviewing

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resources, doing additional research, and developing teaching strategies and assignments using digital processes and resources that could eventually be used in schools.

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As autoras foram responsáveis pela concepção do artigo, pela análise e interpretação dos dados, pela redação e revisão crítica do conteúdo do manuscrito e, ainda, pela aprovação da versão final publicada.

[3] CitizenScience.gov is an official government website designed to accelerate the use of crowdsourcing and citizen science across the U.S. government. In citizen science, the public participates voluntarily in the scientific process, addressing real-world problems.