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Science 3D: Discovery, Design & Development through Makerspaces

What is this research about?

This research, which was a partnership between the University of Ontario Institute of Technology, the Ontario Ministry of Education and the Council of Ontario Directors of Education, investigated the impact of using "makerspace" pedagogies in the teaching and learning process to bridge the gap between our technology-infused world and Ontario's current curriculum. Maker pedagogies are founded on learning theories such as inquiry, play-based learning, constructionism, and, at the center of this approach is the emphasis on the development of students' 21st Century skills/competencies. In this study, elementary teachers used makerspace pedagogies to promote inquiry, innovation, design thinking, critical thinking, problem-solving and collaboration in their classrooms and schools.

What you need to know:

This research investigates the impact of "makerspace" pedagogies that facilitate the discovery, design and development (3Ds) of digital and tangible products for teachers and their students. The research questions focus on how educators can use makerspace pedagogies to promote inquiry, play, imagination, innovation, critical and creative thinking, problem solving and collaboration. With the provision of resources and customized professional development, teachers are introduced to innovative ideas and practices in "critical making" pedagogies. They are provided with the knowledge, skills and confidence to establish and implement a makerspace/maker culture in their schools, where learners can congregate to design, engineer, and fabricate digitally enhanced products of all kinds, both digital and tangible, and explore the uses of digital technologies in general.

What did the researchers do?

The research involved the establishment of makerspaces in 11 Ontario elementary schools. Three teachers per school worked in cross-curricular teams to promote, observe and evaluate the impact of this kind of critical making. Each school received support and professional development from the project team in order to develop an intensive school-based inquiry project. Qualitative,

ethnographic case study methods probed teacher participants' experiences and learning. This was supplemented with in-depth interviews, allowing participants to describe their experience in their own words, encouraging metacognition about their thought processes and affective states before, during and after instruction and work. Research documentation included digital video and audio recordings, on-the-ground field notes and observational notes, and pre- and post-interviews with participants.

What did the researchers find?

After analysis of the data, many sub-themes emerged that could be aligned under the five overarching research questions. However, the sub-themes and research questions could be further divided into four main themes. These include: 1) Challenges; 2) Supports; 3) Best Practices; and, 4) Benefits.

1) What challenges exist for teachers/schools in establishing a makerspace/using maker pedagogies with students?

i.) **Deciding on a focus**. Choosing a technological focus and determining the exact purpose of the space was a challenge for many of the schools, as was managing and storing the materials.

ii.) **Motivating frustrated students**. While all of the schools ultimately reported increased motivation for their students, some teachers reported difficulty motivating students who were easily frustrated by the constructionist and problem-solving-based model of learning.

iii.) **Initial distraction of new technology**. The initial distraction of the new technology was a challenge for many of the teachers at the beginning of the project; however, most came to recognize that this was a normal part of the technology integration and adoption process.

iv.) **Connecting to the curriculum**. Some teachers at the beginning of the project found making connections to the curriculum a seamless process; however, many found it a challenge and often cited time-constraints as their primary set back.

2) What supports are necessary for teachers shifting to an inquiry-based, maker pedagogy approach?

i.) **Professional development**. This was an important factor for the schools when it came to adopting the maker tools and pedagogy. Despite the initial training provided, several participants felt that additional professional development would have been helpful.

ii.) **Permission to make mistakes**. The teachers found that working in an environment with a failure-positive mindset encouraged them to experiment with the tools and activities, to learn alongside their students and to take risks with the technology.

iii.) **Collaborative planning time**. Many of participants talked about the value they found in having collaborative planning time to allow for rich discussion, technical support and idea sharing.

iv.) **Quality leadership**. Support from the administration, the technology lead teachers and other teachers who came forward in leadership roles had a positive impact on how successful the schools were in adopting the maker pedagogies and developing the skills of other educators.

3) What are some best practices associated with a maker pedagogy approach?

i.) **Inquiry-based, passion-based and personalized learning**. In adopting the maker approach to learning, many schools encouraged students to choose a topic to explore, research it in-depth and create something in response to the question driving their inquiry.

ii.) **Pedagogical documentation**. Reflection using maker journals or other reflective tools has been instrumental in making the learning process visible to both the students and teachers.

4a) Benefits: What impact, if any, does a maker pedagogy approach have on student achievement and well-being?

i.) **Engagement and motivation**. Every school in the study reported a significant increase in student engagement and motivation.

ii.) **Academic Achievement & Improvements in Behaviour**. Many schools also reported an increase in academic achievement — especially for students who previously had difficulties in the traditional classroom due to various exceptionalities.

4b) Benefits: How might educators use makerspace pedagogies to promote 21st Century skills such as inquiry, imagination, innovation and design thinking, critical thinking, problem solving and collaboration?

A variety of 21st Century skills and competencies were developed as a result of the makerspaces. Across the board, problem-solving, collaboration and the development of perseverance were consistently cited as major outcomes of involvement in the project.

How can you use this research?

The benefits of the research include: 1) enhanced understanding of how critical making may be integrated into school contexts; 2) enhanced understanding of the materialities and modalities afforded to learners through digital design and production; 3) development and communication of best practices for the use of critical making in educational contexts, including how these will inform teacher preparation programs; 4) development and communication of models for school-home and school-community connections where students engage in digital making for wider audiences, i.e. MakerFaires and exhibitions; 5) contribution to the development of school district policy at a time when digital making is in its infancy in education; 6) development of the research capacity of graduate students in this field, to encourage future research as digital making pedagogies and technologies continue to evolve; and, 7) increased student capacity in STEAM education, which may lead to increased future participation in the digital and knowledge economies. Although it can be a challenge to find a dedicated space to house a makerspace and to properly outfit that space, the benefits are certainly worth the effort and cost. A designated place, whether a room in the school learning commons or a station in the classroom that changes its focus regularly, allows students to reap the benefits from playing, tinkering, discovering, designing and developing.

About the Researchers:

Dr. Janette Hughes is Canada Research Chair in Technology and Pedagogy and Professor at the University of Ontario Institute of Technology. She is the creator of the STEAM 3D Maker Lab at UOIT and teaches courses in critical making and digital literacies. Her research interests include critical digital literacies, production pedagogies, teacher professional development and elementary and secondary literacy education.

Laura Morrison is a sessional instructor and research assistant in the Faculty of Education at the University of Ontario Institute of Technology. She teaches Learning in Digital Contexts to teacher candidates and assists on a variety of funded education-based research projects including the Makerspace project.

Stephanie Thompson is an academic and research associate in the Faculty of Education at the University of Ontario Institute of Technology. She teaches a number of courses in the Bachelor of Education program and is the project manager for the Makerspace project.

Original Article:

http://janettehughes.ca/lab/wp-content/uploads/2016/10/MOE-Report_Makerspaces_Hughes2017.pdf

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