Makerspace in the Primary Grades: Best Fieldtrip Ever!

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Abstract

The makerspace movement has emerged in schools in recent years, alongside STEM and STEAM approaches to education. Makerspace activities are lauded for their ability to engage students in active learning, problem-solving, and design-based thinking. However, many teachers struggle with how to implement this approach in their own classrooms. Based on a collaborative teacher inquiry involving teachers and university researchers in Southern Ontario, Canada, this article describes a day-long makerspace fieldtrip offered by the university for students in grades 2 and 3. The authors report on what the teachers learned from the experience and how they transferred these principles to their classrooms, and became leaders in makerspace education for colleagues.

Introduction

There was a quiet hum of voices in the gymnasium. Children and adults huddled over tables at various stations (i.e., centres), sometimes working individually but often in pairs or small clusters. The 84 students from grades 1 to 3 barely noticed the parent volunteers, teachers, and support staff circulating among them. They were engrossed in various forms of construction, using items that included LEGO bricks, cardboard, beads, fabric, duct tape, egg cartons, and wood. Some donned virtual reality headsets (VRH), or created scenes using Green Screen. Still others worked quietly on coding activities, robotics, and electronic circuit boards. No one wandered around the large gym or ran between stations; everyone was fully engaged.
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The scene described above took place at the Hamilton campus of Brock University’s Faculty of Education in October 2017, the result of a school–university partnership exploring the innovative potential of makerspaces. Brock researchers and teachers from a school board in the catchment area have been engaged in a multi-year collaborative inquiry project investigating the use of digital technology in primary classrooms. Our current focus on makerspaces resulted in a day-long field trip for students from four classrooms in two Oakville/Burlington schools. This event was a follow-up to a highly successful initial field trip the previous February involving the same teachers but different students.

This paper outlines the questions that participating teachers sought to explore about makerspace as a pedagogy and how the school–university partnership provided students with a rich learning experience. The teachers reflect on their learning and how they subsequently have incorporated makerspace activities into their respective classrooms. An important outcome of the project was the modeling and leadership the teachers then provided in their own school board.

**What is Makerspace?**

The impetus for exploring makerspace came from the participating teachers. One commented that it was the new teaching buzzword that kept appearing when she accessed educational sites for other information. She had heard about STEM (Science, Technology, Engineering, and Mathematics) and STEAM (Science, Technology, Engineering, Arts, and Mathematics) challenges but was attracted to the orientation of makerspace, which she sensed was “more open-ended, informal, and authentic.” A second teacher had done some preliminary work with STEM and from her online searches about makerspace believed it was worth exploring further, as “it supported inquiry, collaboration, media integration and STEM.” An initial question for the collaborative inquiry, then, was “What is makerspace?”

Roffey, Sverko, and Therien (2016) maintain that although the term “makerspace” is popular in educational circles, teachers have to search widely to find coherent information about what this innovation actually means and how to make it work in classroom settings. Roffey et al. explain that makerspace is related to the DIY (Do It Yourself) movement in the public forum and only recently has moved into educational settings. The so-called makerspace movement, as summarized by Roffey et al., includes the following features:

1. It fosters creativity, innovation, independence, and technological literacy
2. Learners create their own knowledge by creating and interacting with physical objects
3. A focus is placed on hands-on materials and real-world problems
4. Students construct things that they share with others
5. It is closely related to media literacy, design thinking, problem-solving, and self-directed learning

Tishman and Clapp (2017) emphasize the importance of a sense of agency in makerspace activities, “a sense that it’s possible to reshape the way things are by directing one’s actions purposefully” (p. 58). This results in an “I-can-do-that” spirit in learners and fosters “maker empowerment,” which Tishman and Clapp define as “the inclination and capacity to shape one’s world through building, tinkering, redesigning, and hacking” (p. 59). Students are supported in developing sensitivity to the designed dimensions of the world, rather than just observing objects casually. Tishman and Clapp encourage students to look closely and to address three questions: “What are its parts? What are its purposes? What are its complexities?” (p. 59). This orientation helps students of all ages to solve problems in a wide range of real-world contexts.

What Do Maker Activities Look Like?

Although understanding the basic principles of the maker movement was an important starting point, our Collaborative Inquiry group still asked what this approach looks like in real terms, especially in primary classrooms. Coincidentally, the Brock researchers were aware that the Faculty of Education’s Instructional Resource Centre (IRC) was also exploring makerspaces and had already experimented with some hands-on activities. At the request of the teachers in the study, the researchers approached the IRC management in the fall of 2016 and asked whether they would develop a full-day workshop for the classes in the study. The IRC responded enthusiastically, and in February 2017 two busloads of primary children arrived on campus, accompanied by three classroom teachers, a teacher librarian, and several parent volunteers.

The students were welcomed by several IRC staff members and were told they could select any activity among over a dozen offered. Six more centres were added to the choices by the time a second field trip occurred in the following school year. Table 1 shows the range of activities provided. Some are arts-based while others focus more closely on technology.
Throughout the morning, students were encouraged (but not required) to switch centres every 30 minutes, which meant they experienced at least three choices in the circuit; after lunch they were allowed to return to an activity or have free range in selecting others. In most cases a station had a selection of materials with minimal instructions. This was not simply to accommodate the early reading skills of the primary students, but also to encourage them to use their imagination and creativity rather than produce a prescribed product. At times, however, sample products were present, and students showed their creativity by embellishing their own with personal touches. In some centres (such as robotics and coding), specific challenges and instructions were given, with an adult present to provide support.

Table 1 outlines the nature of each centre in the circuit and materials provided at the tables. Students were free to take with them at the end of the day any of the arts-based products they created.

<table>
<thead>
<tr>
<th>Centre</th>
<th>Task/Products</th>
<th>Materials</th>
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<tbody>
<tr>
<td>Sewing and Textiles</td>
<td>Student choice; several students made headbands, pot holders (with adult assistance), purses, pillows, hair bows</td>
<td>Sewing machine and supplies; fabric; yarn; weaving looms; buttons; patterns; cutting mats; scissors (etc.)</td>
</tr>
<tr>
<td>Cardboard Construction</td>
<td>Student choice (e.g., shapes and towers; garage; fantasy creatures; ramps; houses/forts)</td>
<td>Styrofoam balls; cut-down boxes and pieces; shoeboxes; paper towel tubes; stretch bands; glue guns; markers; masking tape; egg cartons; elastics; scissors; string; twine; straws; cardboard screws (3D printed connectors for straws); X-acto knives; box cutters; Klever Kutters</td>
</tr>
<tr>
<td>Duct Tape</td>
<td>Many students created purses, wallets, hair bows (often based on samples at station)</td>
<td>Various colours and patterns of duct tape; Ziploc bags; scissors; ribbon; elastics; rainbow looms</td>
</tr>
<tr>
<td>Paper Crafting</td>
<td>Cards; buttons; pictures; 3D structures</td>
<td>Varied types and colours of paper; construction paper; card stock; button-maker machine and buttons; scissors</td>
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<tr>
<td>Makerspace in the Primary Grades</td>
<td>(regular and edging); dye cuts; glue; glitter; rubber ink stamps; felt; tape; markers; pencil crayons; stickers; origami books</td>
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<tr>
<td><strong>Beading</strong></td>
<td>Key chains; necklaces; bracelets; rings</td>
<td>Wide selection of beads; key rings; pipe cleaners; beading cord; wire; string; hemp, leather, and stretchy cord; thread; scissors; jewellery pliers; jewellery mats; Ziploc bags</td>
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<tr>
<td><strong>Woodworking</strong></td>
<td>Student choice (e.g., birdhouse; garage; boxes [provided]; storage containers; jewellery boxes)</td>
<td>Popsicle sticks; dowels; wood blocks; scraps of wood; glue gun and glue; hammers; nails; string; wood-burning iron; shapes and designs; paintbrushes; paint (etc.)</td>
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<tr>
<td><strong>LEGO</strong></td>
<td>Students often added to structures begun by others</td>
<td>Large selection of LEGO bricks in various sizes, colours, and shapes</td>
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</table>
| **Electronics Kits/Circuits** | Kits and projects based on kits:  
- Snap: assemble kits to make circuits, based on lessons provided  
- littleBits kits (e.g., making fans and buzzers work  
- Paper: create a circuit with copper foil to make lights work | Troubleshooting guides; fans; buzzers; copper foil; 3V batteries; LED lights; circuit templates and examples; markers; pencils; crayons; Snap circuits; littleBits; paper circuit cards |
<p>| <strong>Hands-on Coding</strong> | Some students created games (e.g., colour blocks on a grid to create a landscape for a video game; create a picture and drop a monster character [Monster] into the picture—monster interacts with the world they had created) | Bloxels; Bloxels Apps; Osmo Creative Set; Osmo Tangram &amp; Words Set; Osmo Coding Jam; iPads; Osmo Apps (Monster, Newton, Masterpiece, Tangram, Numbers, Words, Coding Jam) |
| <strong>Scratch Coding</strong> | For programming interactive stories, games, and animations | Laptops; basic instructions; URL for Scratch; Scratch Coding cards and books |
| <strong>Microcontrollers</strong> | For example: Students attached Makey Makey to | Makey Makey; Microbit; Raspberry Pi; Hummingbird; |</p>
<table>
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<th>Makerspace in the Primary Grades</th>
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<tr>
<td>banana and used as a keyboard</td>
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<td>Green Screen</td>
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<td>Virtual and Augmented Reality</td>
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<td>Design Challenge</td>
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<td>3D Printing</td>
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<tr>
<td>Robots</td>
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Reflections on the Field Trip

The students spontaneously expressed their delight with the makerspace activities throughout the day, and one boy was heard to say, “If school was always like this I wouldn’t mind going!” When the students returned to their schools, their teachers asked for written reflections on the experience and what they had learned. Typical responses mentioned an appreciation for being able to make their own choices in activities and the unique nature of many of the stations. The following quotes are representative of student comments:

- I liked that WE got to do whatever WE wanted and my favourite station was the duct tape and I also liked all the centres. I learned how to use a hammer.
- I learned that you can have fun with anything.
- I like the VRH [virtual reality headset]. I learned you can make things out of your imagination.

The teachers echoed the students’ enthusiasm for the day. One wrote,

I have never been on a field trip that was so engaging for the students—not one student was even remotely idle at any point in the day. Allowing them to choose what they
wanted to do and giving them time to really work through their activity is what made this experience so great for them. Support was there if they needed it, but otherwise they were allowed the time to create, struggle, persevere, and celebrate their accomplishments.

By working alongside their students during the day, the teachers made a number of observations that would guide them in implementing makerspaces in their own classrooms:

1. Students enjoyed being given freedom to choose activities, pace themselves, and interact with materials. As one teacher commented, “They could touch EVERYTHING, which is unheard of at most field trips. They didn’t have to listen to anyone, except for general instructions, and could just ‘have at it.’ They could pick what they were interested in and continue with that activity until they felt they were done.”

2. Although students enjoyed using the robots and VR activities, when given a choice to return to any station after lunch most chose more hands-on “craft” options rather than technology. One teacher observed, “The cardboard and wood building were amazing—kids couldn’t believe they could use real nails and hammers and did such a great job and were very serious about using them properly.”

3. The novelty of technology wears off quickly if the purpose of an activity is not visible to students. One of the researchers noted, “It was very obvious that the role of the teacher is still key. They often help students identify a purpose. I can draw lines for a bot to travel along, but when the purpose is to design the best racecourse the thought put into creating the best path forward is greater.”

4. Students enjoyed making items that had real-world connections. A boy at the bead centre remarked that he liked making something real people could use and therefore he made a key chain. The researcher noted that product samples at stations should be gender-neutral or have features that appeal to all students.

5. Learning skills are an integral part of the makerspace experience. It is easy for students to abandon an activity if they face a roadblock or fail to plan strategically. The teachers realized the importance of making goals such as perseverance, collaboration, planning, and problem-solving explicit and having students reflect on these skills.

**Back in the Classroom**

The challenge facing teachers upon returning to their schools was knowing how to transfer what they had learned about makerspaces into their day-to-day instruction. It is one thing to set up multiple stations in a gymnasium with many adult helpers and ample supplies but quite another to adapt this innovation to the realities of individual classrooms.
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Resources

How can the classroom teacher acquire the resources needed for makerspace activities? One of the teachers divided the resources needed into three categories:

1. Cheap and consumable, but need to be replaced once materials are used up (e.g., duct tape, beads)
2. Expensive overhead but no upkeep costs (e.g., circuitry kits, robots)
3. Free (e.g., online coding sites, Tinkercad for 3D printing without the actual 3D printing)

In one school, the principal provided money to purchase some items from categories 1 and 2 as well as a storage shelf on wheels to house all the items from category 1. In another school, a parent volunteer on the field trip was a member of the school’s Parent Council. Her proposal to this body resulted in funds being allocated for a makerspace in the school accessible to all classes. The teachers also borrowed robotics kits (such as Ozobots) from their school board resource centre. They noted the importance of communicating with parents at curriculum nights and through other channels to request items from category 1.

Students can also be involved in decisions around supplies. In one instance a class of grade 3 students expressed an interest in learning about looms. A group went online to watch a tutorial and determined needed items for their teacher. They advised her on where to shop and gave her a detailed shopping list.

Timetabling and Connections to Curriculum

Where should makerspace time be positioned in the daily timetables and to what degree should it link with other curriculum areas? These issues are vital to address considering the multiple demands already made on classroom time. How can makerspace activities, as engaging as they are, be justified within the complex framework of student learning?

Most of the teachers embedded their makerspace work within routines already established for literacy centres. In some cases, makerspace stations were an option within other more traditional centres. One teacher made an explicit effort to link makerspace with STEM challenges and to reflect on the similarities and differences. For example, her students planned a cardboard structure, estimated its dimensions, constructed it, and reflected on the process and product. They also created a video of their work and shared it with their classmates. Throughout
the challenge, connections were made to math, science, literacy, and learning skills. At the present time most of the makerspace activities occur within the classrooms, although one of the schools is considering expanding the role of the school library to include a common area for makerspace.

**Applying the Principles of Makerspace to a Classroom Challenge**

The following describes a challenge posed to a grade 3 class in the study, with students working in small teams of two or three to create their solutions. Their teacher, Jodie (pseudonym), directs their attention to the front table where there is a collection of small Disney characters. As Jodie begins to introduce the figures, the children spontaneously move to the carpet, very excited to see what will unfold.

She says the characters were with her on the drive to school; they were talking about how hard they had worked at school that year and wondered if they could go to Canada’s Wonderland as a reward. Jodie reminded the dolls that they were much too small for Wonderland, but she thought she knew some people who could help. She then tells the class that today they are going to make the characters an amusement park sized to the needs of the Disney figures. Jodie reminds the students to begin with a plan (Figure 2). She brings out a box of building supplies that include egg cartons, sticks, clay, paper towel rolls, straws, pipe cleaners, berry boxes, and yogurt tops. The students are excited and ask for hot glue guns, which Jodie says they won’t be using due to safety concerns. They begin to plan by making a list of rides at Wonderland. The children are very excited and plenty of on-topic conversation fills the room. They brainstorm possible rides or structures including a bench to sit on, roller coaster, Ferris wheel, playground, bouncy castle, climbing wall, water slide/splash pool, and Drop Zone.
When one child indicates she has never been to Wonderland, Jodie says she thinks they need some inspiration. She has a YouTube video queued up that shows a variety of rides. When the video concludes, Jodie makes the connection to previously taught concepts that were provided by the science teacher in the structures unit. She encourages the class to consider principles such as a wide base, triangulation, force, and friction when drawing their plans.

The students prepare for the challenge by discussing the following:

- Things that rides have in common
- What materials might work
- Who is going to work on what to ensure variety
- Who we work best with (students wanted to choose their own teams)
- Plans should be completed quickly on graph paper

The teams showed creativity and ingenuity in creating the rides. One built a Drop Zone using a paper towel roll as the tower, a berry box with a hole cut in the bottom to slide up and down, and
some clay to anchor it to the desk (Figure 3). Another group built a climbing wall using yogurt tops and cardboard. The students constructing the Ferris wheel used egg carton sections for seats.

Figure 3. Drop Zone using paper towel roll and berry box.

The activity, while totally engaging and fun for the students, also incorporated the key principles the teachers had discerned from the makerspace field trip. The students formed their own groups and had free choice in the rides they created and the materials used. The design challenge had a real-world connection. Although Jodie’s “conversation” with the Disney characters was made up, the children used their real-life experiences with Canada’s Wonderland
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to tackle the challenge, and knew that in the actual world engineers do design rides for theme parks.

Even though the challenge was open-ended, the teacher still played an important role. She required students to make a plan, provided support for background knowledge, made connections to concepts previously covered in science, and helped students reflect on their learning skills and work habits. Throughout the challenge she was encouraging students to cultivate sensitivity to design (Tishman & Clapp, 2017).

Each teacher commented on the value of makerspaces in developing and reinforcing learning skills and work habits. One indicated that perseverance through a difficult task was a goal for their school improvement plan. After the field trip in Year 1, a teacher decided she would introduce makerspaces the first week of school next fall, since “its greatest effect is on how a student collaborates, perseveres, self-regulates, cooperates, responds to challenges—basically all the things we comment on for the learning skills portion of the report card.”

Teachers as Leaders

The teachers did not confine their learning to their own classrooms but instead actively shared it in their schools and beyond. One participant furthered her knowledge of coding and robotics by returning to Brock for an additional weekend workshop and continued to follow makerspace-related sites on social media. She later created a presentation that she shared during a half-day session at her school as well as an in-service session for school board itinerant teachers and consultants.

The teachers in the second school joined a board-wide Library Commons project exploring the creation of a makerspace area for all classes to utilize. They also demonstrated makerspace activities for their staff during a professional development day and invited a third teacher and his class to join them on the second field trip.

The IRC at Brock also benefited from interacting with the schools. IRC staff members were able to test their makerspace activities with actual students and make any needed adjustments. As a result of students’ and teachers’ enthusiastic response, the IRC offered the field trips to schools across their catchment area the following year. Over 300 students from grades 1 through 6 attended the sessions, while three other workshops were provided for teacher candidates at Brock University.
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While a great deal of planning went into makerspace experiences both at Brock and in the schools involved in the collaborative inquiry, in the end two statements summarize the spirit that characterizes makerspace. One of the teachers said, “Talk very little, have lots of materials available, and let them go.” This was echoed by a member of the IRC who stated, “We are learning; schools are learning; kids benefit.”

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References
