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Introduction

This report provides a brief summary of a research meeting on making and makerspaces organized by Children’s Museum of Pittsburgh and the University of Pittsburgh’s Learning Research and Development Center. The meeting took place July 21<sup>st</sup> and 22<sup>nd</sup>, 2014 at The Children’s Museum.

Motivated by a resurgence of interest in DIY (do-it-yourself) culture and prompted by the introduction of new technologies, physical computing and fabrication, the Maker Movement offers new opportunities for learning experiences that develop creativity and innovation. Making and makerspaces represent an emerging movement in education that integrates hands-on learning experiences with physical and digital tools. Classroom teachers, school administrators, and designers of informal learning environments are seeking funding, building facilities, and sharing strategies for integrating making into formal and informal learning contexts.

While the educational movement has surged ahead and already has many great stories and maker projects to share, the learning research on making and makerspaces is just getting started. Many in the research community are now asking what, exactly, it means to learn through making? What does evidence of learning look like in the context of making activities? What is needed to leverage what are typically hobbyist practices of adults and transform them into designed learning experiences for children, youth and families? How might we support formal and informal educators in their pursuit to integrate making into learning experiences? What further research is needed to broaden participation in making?

We invited leading researchers who are actively pursing questions as these to share their work and discuss the future of the field. To complement the researchers’ perspectives and to ground the conversations in current practice and policy, we also invited some key practitioners, funders, and network leaders who are leading figures in the educational making world.
Meeting Goals
The three primary goals of the meeting for researchers, practitioners and funders were to:

• Share emerging research efforts on making as a learning endeavor

• Identify points of synergy, collaboration, and gaps in the making research network

• Discuss how to strengthen the field of making research by setting an emergent research road map for the field.

In what follows, we will highlight some of the important themes and shared resources that emerged from our discussions.

Day One Agenda
July 21, 2014

9:00am    Breakfast & Networking
9:30am    Welcome to Museum
9:35am    Framing the Meeting
9:45am    Snapshot of the Field
10:00am   Small Group Discussion: Topics
          Where are we now? Where are we going?
          What are the core questions for the field?
          What are the research-practice gaps?
          What is the low hanging fruit?
11:00am   Share Out of Small Group Discussion
12:00pm   Lunch and Exploration of Museum
1:30pm  Small Group Discussion: Problems of Practice by Setting
   • Affordances of Context
   • What’s most important to understand about how this context is changed, influenced and distinguished by making?
   • How can the research field productively connect with this setting?

2:15pm  Share Out of Small Group Discussion

3:00pm  Break

3:30pm  Small Group Discussion: Investment: Systems, Scaling & Assessment
   • What’s the broader policy context?
   • What do stakeholders expect from making

4:15pm  Share Out of Small Group Discussion

4:45pm  Reflection & Closure

5:00pm  Happy Hour in MAKESHOP

6:00pm  Dinner in Studio
Day Two Agenda
July 21, 2014

9:00am  Breakfast & Reflections
10:00am  What is making?
12:00pm  Lunch
1:00pm  Shared Vision of the Road Ahead
2:30pm  Reflections

The Landscape of Learning Research on Making

Leading up to the meeting, we surveyed meeting participants to get a sense of their current research on making. In particular, we were curious to map the age-groups and making contexts (e.g., schools, museums, libraries, etc.) that are currently being studied. We also were interested in charting the range of theoretical perspectives that currently serve as lenses in the ongoing research.
Figure 1: Word cloud based on participants’ answers to the question about the theoretical perspectives represented by the research. A wide range of approaches was represented at the meeting, with various forms of constructionism, design-based research, and a concern for social and cultural context being a common unifying thread.
Figure 2: We surveyed the meeting participants about the age groups that they were investigating or that were engaged in making at their research and design sites. Participants were able to mark as many age groups in the survey as were appropriate. Middle and high-school aged children was the most common target of research, although both younger children and adults were also represented in participant responses.
Figure 3: We asked the meeting participants about the settings in which they were designing and investigating making. Participants were able to mark as many settings as were appropriate to their research and programs. We made the intentional distinction of afterschool programs separated from the other settings since we knew that many of the studies were happening in places like Boys and Girls Clubs. Note that the settings were more or less equally represented, which is was one of the goals of the meeting.
Emerging Learning Research Areas in Making

Based on discussions, reflection, and consensus process at the meeting, we identified six general categories of research questions that characterize the current state of the field. The questions reflect the ongoing research of meeting participants, but also are based on critical gaps we identified that will need to be addressed in order to further the development of maker programs and makerspaces for learning.

1. What are the characteristics of powerful making spaces and do those characteristics depend on the specific physical setting of the maker space (museums, libraries, schools, etc.)?

The design of the space in which the maker program takes place as well as how the making activity is arrayed and supported through design can play a substantial role in participants' learning. This is significant both for formal learning environments as well as informal environments, although the designs and activity may be different in important ways based on institutional priorities as well as the goals the maker program is attempting to address.

2. What’s the connection between becoming a maker and being engaged in STEM pathways? What other educational outcomes are potentially impacted by making?

This is a significant question considering the current educational policy environment that often seeks to link maker experiences with STEM content and skills. Therefore, these outcomes may address a specific disciplinary connection that may exist exists making and STEM, as well as be associated with specific STEM pathways that might lead a young learner towards a STEM career. However, there are non-content-related skills that may also be cultivated through participation in making. These include the development of an interest related to making, building an identity around some aspect of making, the growth of self-efficacy tied to maker-related tasks, as well as increased motivation and engagement linked to maker-related and program-related tasks. Finally, important outcomes may also be developed around creativity and innovation, among other 21st century skills; important areas policymakers point to as catalysts for career readiness and entrepreneurial ventures.

3. What are the core practices of making? How can we assess the practices and impact of making experiences?

A focus on learning practices as an area of research can serve at least three goals. First, some researchers noted that engagement in learning practices of making could be a means for defining what constitutes an ambitious making experience. Second, practices can serve as analytic tools for observing making as a learning process.
Taking seriously the cliché that we know making when we see it, practices can serve as guideposts for assessing maker experiences and noticing shifts in behavior over time. Third, similar to the educational outcomes, identifying the disciplinary practices embedded in maker activities can both offer opportunities to document learning related to content areas such as science and engineering and provides a stronger empirical argument for the value of making as strongly tied, potentially, to content area practices identified by formal educational objectives and standards. However, the equity conversation needs to address more than just availability. It will also be important to design for the ways in which making and makerspaces are sensitive to different cultural practices related to making, or perhaps presently unrecognized by making and maker culture as it is currently understood. In addition, it is important that making, as an educational innovation, will not just reproduce some of the values and practices that have marginalized certain populations in the past.

4. What are the ways that making experiences fit into broader learning ecologies and pathways? How can we do research that traces longitudinal pathways for learning as making?

A current notion in learning research is to view learning as taking place within a network or ecology of experiences and places. As these spaces and experiences become linked, they can potentially create more in-depth learning experiences through making. What are the ways that making fits within a learning ecology? What does it mean to have maker experiences that provide greater and greater depth and breadth for the learner and learning community?

5. How do we create a professional development community to engage and develop educators who facilitate making?

A consensus among the participants of the meeting was that productive making experiences include human facilitation. Making is certainly a material-based activity, but the human-infrastructure that supports making is crucial. What does it mean to effectively facilitate making experiences? Are there important differences among the roles of different kinds of

6. How do we create accessible and equitable maker experiences for all children?

As the maker movement builds and educators seek to create powerful learning experiences for children, a challenge will be to ensure that these experiences are available to all. However, the equity conversation needs to address more than just availability. It will also be important to design for the ways in which making and makerspaces are sensitive to different cultural
facilitators (teachers, informal educators, mentors, e.g.)? How does the physical context influence facilitation? What knowledge and skills should facilitators have to be effective? And what experiences should be created to prepare facilitators of making?
We surveyed the participants ahead of time and asked them to provide citations for writings they have engaged in that is relevant to research on making and makerspaces. We list citations here, but the most updated list will always be available at http://makingandlearning.org.


*Making Thinking Happen* blog: http://makingthinkinghappen.wordpress.com/


Roque, R., Rusk, N., Blanton, A. (2013) Youth roles and development of leadership in an online creative community. Computer Supported Collaborative Learning (CSCL). Madison, WI.


Inspiring References for Maker Researcher

We also asked the research participants to provide citations for writings outside of maker research that have been helpful to their work or that have inspired them in their work. The following citations were provided.


YALSA (2014) The Future of Library Services for and With Teens: A Call to Action
Additional Suggested Resources

Generated and shared through discussion:

The work of the Maker Effect Foundation --
http://www.themakereffect.org/maker-mindset

The Connected Learning Group –
http://connectedlearning.tv/what-is-connected-learning

Maker Effect Foundation –
http://www.themakereffect.org/maker-mindset/

DML Connected Learning Group –
http://connectedlearning.tv/what-is-connected-learning

Tinkering Studio Framework—
http://www.tinkering.exploratorium.edu/learning-and-facilitation-framework

Fundamentals of Tinkering Coursera Class—
https://class.coursera.org/tinkering-001

ASTC’s Community of Practice - Making and Tinkering in Museums—http://tinyurl.com/kyyj7z8

Kids DIY Media project— http://Kidsdiymedia.com

Maker Education Initiative, Resource Library
http://makered.org/resources

Maker Ed, Teacher Discussion Group—
http://makered.org/Community

Build in Progress, from Lifelong Kindergarten Group—
http://buildinprogress.media.mit.edu/

Informal Science.org Wiki—
http://informalscience.org/research/wiki/Making-and-Tinkering-Programs, search with "Maker" and "Tinker"


Learning Activation Lab: http://www.activationlab.org/

MIT Media Press, Books from the John D. and Catherine T. MacArthur Foundation Series on Digital Media and
http://mitpress.mit.edu/books/short-circuits - E-Puppetree
http://mitpress.mit.edu/books/soft-circuits - E-Textiles
http://mitpress.mit.edu/books/script-changers - Digital Storytelling with Scratch
http://mitpress.mit.edu/books/gaming-system - Game Design with Gamestar Mechanic

The Framework Institute—
http://frameworksinstitute.org/toolkits/dml
# Meeting Participants

We sought to invite a diverse group of people involved in a program of research on making or makerspaces. The following is a list of the people who participated in the meeting:

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<th>Name</th>
<th>Organization/University</th>
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<tr>
<td>Ugochi Acholonu</td>
<td>DePaul University</td>
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<tr>
<td>Tom Akiva</td>
<td>Learning Research and Development Center / University of Pittsburgh</td>
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<tr>
<td>Gregg Behr</td>
<td>Grable Foundation</td>
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<tr>
<td>Jamie Bell</td>
<td>CAISE</td>
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<tr>
<td>Marjorie Bequette</td>
<td>Science Museum of Minnesota</td>
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<tr>
<td>LeAnn Bowler</td>
<td>University of Pittsburgh</td>
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<tr>
<td>Lisa Brahms</td>
<td>Children’s Museum of Pittsburgh</td>
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<tr>
<td>Mac Cannady</td>
<td>Lawrence Hall of Science</td>
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<tr>
<td>Edward Clapp</td>
<td>Project Zero/Harvard University</td>
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<tr>
<td>Kevin Crowley</td>
<td>University of Pittsburgh</td>
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<tr>
<td>Drew Davidson</td>
<td>Entertainment Technology Center/Carnegie Mellon University</td>
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<tr>
<td>Jim Denova</td>
<td>Claude Worthington Benedum Foundation</td>
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<td>Rena Dorph</td>
<td>Lawrence Hall of Science</td>
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<td>Deborah Fields</td>
<td>Utah State University</td>
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<tr>
<td>Claudia French</td>
<td>Institute of Museum and Library Sciences</td>
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<tr>
<td>Brian Gravel</td>
<td>Tufts University</td>
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<td>Josh Gutwill</td>
<td>Exploratorium</td>
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<td>Yasmin Kafai</td>
<td>University of Pennsylvania</td>
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<td>Victor Lee</td>
<td>Utah State University</td>
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<tr>
<td>Breanne Litts</td>
<td>University of Wisconsin, Madison</td>
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<td>Aaminah Norris</td>
<td>The Representation Project</td>
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<td>Kylie Peppler</td>
<td>Indiana University</td>
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<td>Mike Petrich</td>
<td>Exploratorium</td>
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<td>Lisa Regalla</td>
<td>Maker Education Initiative</td>
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<td>Adam Rogers</td>
<td>North Carolina State University Library</td>
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<td>Ricarose Roque</td>
<td>MIT</td>
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<td>Andrea Saenz</td>
<td>Chicago Public Library</td>
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<td>Rafi Santo</td>
<td>Indiana University</td>
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<tr>
<td>Name</td>
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<tr>
<td>Janet Sarbaugh</td>
<td>Heinz Endowments</td>
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<td>Chris Schunn</td>
<td>Learning Research and Development Center / University of Pittsburgh</td>
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<td>Kim Sheridan</td>
<td>George Mason University</td>
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<td>Eric Siegel</td>
<td>New York Hall of Science</td>
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<td>Ana Tilton</td>
<td>Grant Makers for Education</td>
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<td>Shirin Voussoughi</td>
<td>Exploratorium/Northwestern University</td>
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<td>Peter Wardrip</td>
<td>Children’s Museum of Pittsburgh / University of Pittsburgh</td>
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<td>Janella Watson</td>
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<td>Jane Werner</td>
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<td>Karen Wilkinson</td>
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<tr>
<td>Corey Wittig</td>
<td>Carnegie Library of Pittsburgh</td>
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<td>Jen Wyld</td>
<td>Oregon State University</td>
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Special thanks to

Continue the Conversation:

www.makingandlearning.org

www.informalscience.org

All photographs by Renee Rosensteel