

Project **MAPLE**

MAkerspaces **P**romoting **L**earning and **E**ngagement

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Study Overview

Focus on Metacognition: knowledge and self-regulation

- Metacognitive knowledge is what we know about our cognitive processes
- Metacognitive self-regulation refers to activities and strategies learners use to monitor and control their learning

Addressing the gap in the literature: rigorous research on the Makerspace movement and learning through making

- In conversation with literature: tinkering, digital literacies, collaborative intelligence, empathy, computational thinking and project-based learning
- Starter set of variables (**iteration, persistence, intentionality**)

End Goals: research, education and service

- Help to establish a foundational base for research that will inform our understanding of how to best meet the instructional needs of struggling learners with school-based Makerspaces
- Promote the University of Illinois Land Grant Mission of civic engagement: foster networks of knowledge-exchange and capacity building in both formal and informal education settings

Research Design

Research Questions

- How are struggling learners engaging in maker experiences? What barriers exist for struggling learners in middle schools during makerspace activities?
- How can metacognitive strategy instruction support students with disabilities and other struggling learners to meaningfully engage in the design/redesign process within makerspace experiences?

Sample

- Four Public Middle Schools in CU – STEM classes
- About 280 learners total but classes are around 25 kids each
- Focus on students with learning disabilities and/or at risk for academic failure
- About even split gender, ~65% students of color and/or low-income

Data-collection instruments

- Classroom and student observation
- Teacher and student interviews
- Artifact analysis interviews
- Collaborative Computing Observation Instrument (C-COI; screen/audio capture)

Capacity Building

Professional Development

- Teachers and Fab Lab staff work together to extend existing curricular goals and material
- Run-it-thrice model: teachers ultimately lead activities
- Work with existing school IT personnel and resources
- Teachers are paid a \$2k stipend, students take home creations like 3D prints, stickers and Arduinos

Makerspace Network

- Each school gets \$10k to establish makerspaces in classrooms
- This is in addition to existing equipment available at nearby libraries and after-school centers
- On-going partnership with Fab Lab after the grant

Pilot Study: Towards a Progressive Model for Metacognitive Strategies and Makerspace Learning



Jeff Ginger // Maya Israel // Rebecca Teasdale // Lisa Bievenue // Suzanne Linder // Johnell Bentz // 2015-2016

Many educational institutions, including schools, libraries and museums are investing in makerspaces and related programming. However, there is limited research on makerspace learning outcomes and appropriate strategies to support diverse learners in academic settings. Our study aims to address:

- 1 What learning barriers are present during the project-based iterative design processes common to makerspace experiences, especially for struggling learners and those from underserved backgrounds?
- 2 How can instruction that supports metacognitive strategies be integrated within K-12 classroom makerspace activities to address those barriers? Why might this matter? What are the pedagogical implications?

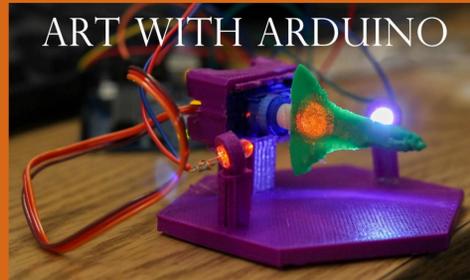
This summer we conducted observations and instructor interviews for several summer camps comprised of ~60 youth ages 9-14. Data collection focused primarily on investigating instructional design, artifact analysis and interpretation of process. The camps studied included several themes, including computational thinking, digital/media literacies and art education. Insights pulled from this data will be used in the process of writing a DRK-12 NSF grant aimed at fully testing a similar framework in local middle schools. We hope to release both portable curriculum as well as assessment models.



Videogame Design (D,E)



E-textiles Monster Maker (C)



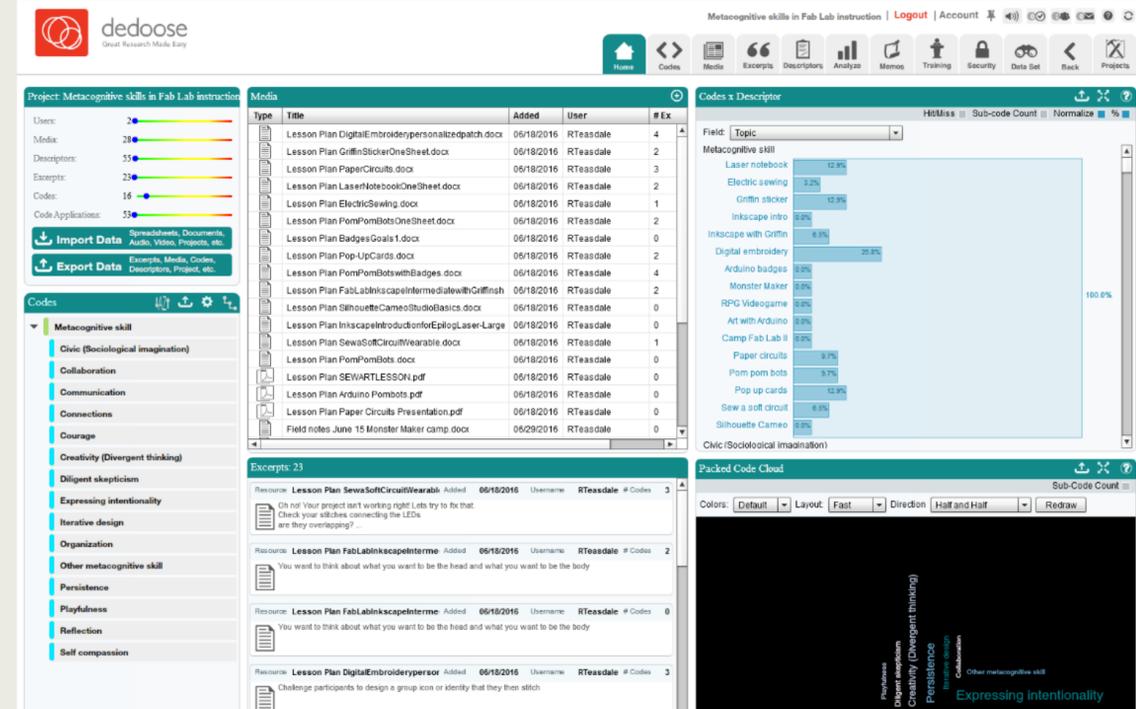
Arduino Artistic Automation (A)



Design Process Studio (B)

“A lot of it comes through questions – what can I ask so you can figure it out rather than me telling you how to do it. Being able to assess where the student is at and know what the end goal is. What do you think needs to happen here? What are you thinking about this issue? Or if they don’t have ideas - posing questions so they figure it out themselves, so take ownership of their thoughts and ideas.” – Instructor

“The entire idea of Camp Fab Lab II [Design Studio] is learning to learn. Thinking about a problem they would encounter in their life, learning how to solve that problem in groups and helping each other. Different people have different strengths and weakness, kids develop analysis skills, it happens naturally – I’m in charge of cutting, you’re in charge of gluing, based on their experience. This is how they learn to work together.” – Instructor



Metacognitive Strategies	Collaboration	Communication	Creativity	Intentionality	Iterative design	Organization	Persistence	Playfulness	Self-Compassion
Camp (# instructors)									
Art with Arduino (4)			XXX X	XXX X	XX	X			
Camp Fab Lab II Design Studio (3)	XX X	XXX	XXX	XXX	XXX				
Monster Maker (3)	X	XX	XX	XX		X	XX X	XX X	X
RPG Videogame Design (3)	X	X		XXX	XXX	X	XX X	X	
Special Needs RPG Videogame Design (2)	X		XX	XX	X	X			

Metacognitive Skill	This code is used when a lesson plan or instructor...	Self-assessment interview or journal prompts...
Persistence	Explains the process of learning through failure Models how to learn from failure through “think-aloud” strategies Discusses scenarios where final designs occurred after many iterations and failures Helps makers overcome frustration when designs do not work as intended	What do you do when you're frustrated? Do you independently pursue understanding?
Connections (networking)	Introduces people or resources that makers can use when they need help Suggests how makers can make connections with people who might help them in the future Encourages makers to make use of their connections and resource	Do you try to make connections with new people who might be able to help you in the future? Do you make use of your connections/resources when you need help?
Self-compassion	Encourages makers to treat themselves compassionately when they have difficulty Models how to make productive use of failure	When you're having difficulty with something, how do you feel about yourself? Do you make productive use of failure?
Courage	Encourages makers to take risks Supports makers when they encounter uncertainty	How do you react to uncertainty? What do you do when you feel overwhelmed? Do you take intellectual risks?
Creativity (divergent thinking)	Encourages makers to seek out new ideas Supports makers in taking intellectual risks Helps makers look for connections between ideas	Where do you turn for new ideas? Do you look for connections between ideas? Do you apply past experiences to new situations?
Playfulness	Invites makers to engage in tinkering, boundary pushing and simulation in the process Encourages makers to have fun Re-frames problems that arise during an activity as opportunities	Are you able to have fun and see problems as opportunities? Do you engage in tinkering, boundary-pushing and simulation in the process of projects?
Organization	Explains how or why to keep accurate, thorough, and consistent records of work Encourages makers to refer to past or existing projects and materials to assist them	Do you keep accurate, thorough, and consistent records of work? Do you refer to past/existing projects and materials to assist you in projects?
Communication	Helps makers clearly convey an idea to someone else using visuals, speech, demos Encourages makers to give examples that support their ideas Supports makers in relating ideas to one another	Can you clearly convey an idea to someone else using visuals, speech or demonstrations? Do you give examples that support your ideas? Do you seek to relate ideas to one another?
Iterative design	Helps makers plan incremental steps in their design Provides students with scaffolds for changing one variable at a time during iteration Supports makers in testing/retesting their design Provides opportunities for makers to provide feedback on the design of others	What steps did you go through to make your creation? Did one activity make it easier to do other activities? How did feedback from other learners or instructors help you to improve your design? Did you start over or change your design?
Diligent Skepticism	Models how to scrutinize sources of information and methods for production Encourages makers to test their ideas Invites makers to evaluate the quality or value of activities Helps makers identify problems with activities that lead to poor outcomes	How do you evaluate the quality/value of activities? Do you scrutinize sources of information and methods for production and test your ideas? Can you identify problems with activities that lead to poor outcomes?
Collaboration	Invites makers to share their ideas with others Encourages makers to consider strategies employed by their peers to adopt Emphasizes importance of being respectful, supportive, and constructively critical with peers	Are you respectful, supportive and constructively-critical of peers? Do you share your ideas with others? Do you consider strategies employed by your peers to use as your own?
Reflection	Invites makers to consider past experiences when making choices Models reflection that is thoughtful and substantive	Do you consider past experiences when making choices? Are your reflections thoughtful and substantive?
Civic (Sociological Imagination)	Encourages makers to seek out new ideas Supports makers in taking intellectual risks Helps makers look for connections between ideas	How might your own struggles with a project relate to those of others? Can you identify some of the possible second-order effects of projects that make impact culture, the environment or social inclusion?

Teacher Observation Rubric

Activity & Time	Teacher Concept Presentation	Teacher Strategies	Classroom Atmosphere
Note time start/end or activity transition	<input type="checkbox"/> Verbal (reads written instructions) <input type="checkbox"/> Verbal (paraphrases instructions) <input type="checkbox"/> Verbal (discusses purpose)	<u>Provides structure & consistency</u> <input type="checkbox"/> Sets expectations, e.g., advanced organizer, states learning/behavioral expectations (describe) <input type="checkbox"/> Activates Prior Knowledge, e.g., reviews previous lesson (describe) <input type="checkbox"/> Supports planning, e.g., written instructions, highlight key points (describe) <input type="checkbox"/> Task management prompts/reminders, e.g., states needed materials, explains resources; divides work into smaller units (describe)	<input type="checkbox"/> Students engaged <input type="checkbox"/> Students asking questions <input type="checkbox"/> Students excited <input type="checkbox"/> Students bored <input type="checkbox"/> Students confused <input type="checkbox"/> Students off-task <input type="checkbox"/> Other:
Configuration	<input type="checkbox"/> Visual (on screen)		
<input type="checkbox"/> Whole class <input type="checkbox"/> Small groups <input type="checkbox"/> Pairs <input type="checkbox"/> Individual <input type="checkbox"/> Other:	<input type="checkbox"/> Visual (tangible product) <input type="checkbox"/> Action/modeling <input type="checkbox"/> Non-verbal cueing <input type="checkbox"/> Other:		
Movement	Materials & Resources	<u>Supporting thinking and metacognition</u> <input type="checkbox"/> Encouraging students to find answers to their questions, e.g., think aloud, self-question, peer-question <input type="checkbox"/> Supports non-linear thinking (describe) <input type="checkbox"/> Positive statements (describe) <input type="checkbox"/> Prompt Student Collaboration, cooperative learning strategies (describe) <input type="checkbox"/> Challenge students with new materials or tools (describe)	Barriers
<input type="checkbox"/> Teacher walking room <input type="checkbox"/> Teacher stationary <input type="checkbox"/> Teacher moves to respond to questions <input type="checkbox"/> Students moving around room	<input type="checkbox"/> Student Computers <input type="checkbox"/> Chromebooks <input type="checkbox"/> Teacher Computer <input type="checkbox"/> No Computer <input type="checkbox"/> Maker resources <input type="checkbox"/> Other:		
<input type="checkbox"/> Students moving in area of room	Type of Product		
<input type="checkbox"/> Other:	<input type="checkbox"/> Tangible, physical <input type="checkbox"/> Computer-based <input type="checkbox"/> Other		
		<u>Accommodations</u> <input type="checkbox"/> Simplifies instructions, choices, scheduling (describe) <input type="checkbox"/> Discreet cues to stay on task; advanced warnings; reminders to focus; lowers noise level (describe) <input type="checkbox"/> Multiple ways of assessments, formative, low-stakes, mini-assessments, self-assessment, check for understanding, oral checks, timed tests (describe) <input type="checkbox"/> Other:	<input type="checkbox"/> Technology-related <input type="checkbox"/> Missed earlier content (student absence) <input type="checkbox"/> Lack of foundational skills <input type="checkbox"/> Lack of language <input type="checkbox"/> Lack of confidence <input type="checkbox"/> Teacher absence <input type="checkbox"/> External disruption <input type="checkbox"/> Other:

Student Observation Rubric

Activity & Time	Student Metacognitive Strategies Observed					Student/Group Atmosphere	
Note time start/end or other marks of transition	<div style="display: flex; justify-content: space-between;"> <div style="width: 30%;"> <u>Thinking Strategies</u> <input type="checkbox"/> Think aloud (DSPEC) <input type="checkbox"/> Think aloud (DIND) <input type="checkbox"/> Self-question <input type="checkbox"/> Other: </div> <div style="width: 30%;"> <u>Doing/Refining/Iteration</u> <input type="checkbox"/> Creating/working on artifact: <input type="checkbox"/> Based on plan <input type="checkbox"/> without plan <input type="checkbox"/> Modifying using new materials or tools <input type="checkbox"/> Modify, re-mix existing design <input type="checkbox"/> Change a variable/feature to be different <input type="checkbox"/> Change a variable/feature to improve function or design <input type="checkbox"/> Other: </div> <div style="width: 30%;"> <u>Response to failure</u> <input type="checkbox"/> Takes a break <input type="checkbox"/> Restarts project <input type="checkbox"/> Strategic troubleshooting <input type="checkbox"/> Laughs it off <input type="checkbox"/> Gives up <input type="checkbox"/> Seeks help from teacher <input type="checkbox"/> Seeks help from peers <input type="checkbox"/> Watches peers work <input type="checkbox"/> Alters approach (e.g., change tool) <input type="checkbox"/> Other: </div> </div>					<input type="checkbox"/> Students engaged <input type="checkbox"/> Students asking questions <input type="checkbox"/> Students having fun (smiling) <input type="checkbox"/> Students excited <input type="checkbox"/> Students anxious (pacing, obsessing, thumping, etc.) <input type="checkbox"/> Students bored (blank look, not engaged) <input type="checkbox"/> Students confused (hesitation, facial expr.) <input type="checkbox"/> Students off-task <input type="checkbox"/> Students focused <input type="checkbox"/> Students upset <input type="checkbox"/> Student's head on desk <input type="checkbox"/> Other:	
Configuration							
<input type="checkbox"/> Whole class <input type="checkbox"/> Small groups <input type="checkbox"/> Pairs <input type="checkbox"/> Individual <input type="checkbox"/> Other:	<u>Planning/Ideation</u> <input type="checkbox"/> Drawing a plan <input type="checkbox"/> Discussing a plan <input type="checkbox"/> Writing a plan <input type="checkbox"/> Editing a plan <input type="checkbox"/> Reviews goals silently <input type="checkbox"/> Reviews goals with peers <input type="checkbox"/> Other:						
Movement							
Student(s) moving around room/area (circle one) with a clear purpose? (Y/N) Purpose: (select one or more) <input type="checkbox"/> Ask questions of teacher <input type="checkbox"/> Ask questions of peer(s) <input type="checkbox"/> Pick up materials <input type="checkbox"/> Move to new station <input type="checkbox"/> Use equipment (printer, etc.) <input type="checkbox"/> Think <input type="checkbox"/> Anxiety <input type="checkbox"/> Other:	Student Engagement					Barriers	
		Almost none of the time	Little of the time	Half of the time	Much of the time	Almost all of the time	
	With adults	1	2	3	4	5	<input type="checkbox"/> Technology-related <input type="checkbox"/> Missed earlier content <input type="checkbox"/> Lack of foundational skills <input type="checkbox"/> Lack of language <input type="checkbox"/> Lack of confidence <input type="checkbox"/> Teacher absence <input type="checkbox"/> External disruption <input type="checkbox"/> Other:
	With peers	1	2	3	4	5	
	With materials	1	2	3	4	5	
	Complexity*	Non-engaged 1	Unsophisticated 2	Average 3	Advanced 4	Sophisticated 5	
*Nonengagement = inappropriate behavior, zoning out; Unsophisticated = repetitive play, casually looking around; Average = following routines, participating; Advanced = talking, creating; Sophisticated = symbolic talk, pretending, persisting.							

Resources We Can Share

Draft proposal

Makerspace literature collection

Current data-collection instruments

Curricular materials developed with teachers

Our experiences so far