

# Towards a Progressive Model for Metacognitive Strategies and Makerspace Learning



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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?

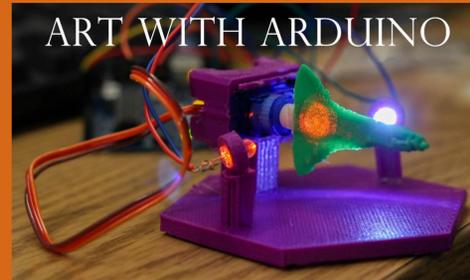
This summer we conducted observations and instructor interviews for several summer camps comprised of ~60 youth ages 9-14. Data collection focused primarily on investigating instructional design, artifact analysis and interpretation of process. The camps studied included several themes, including computational 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)



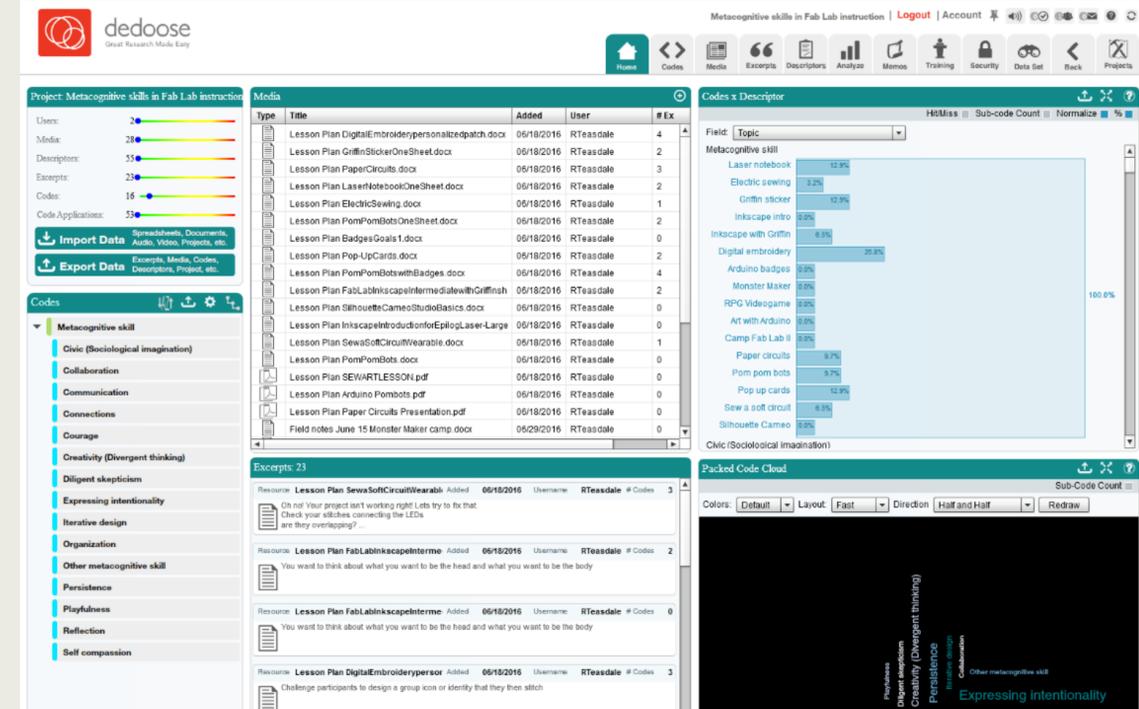
Arduino Artistic Automation (A)



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...
<b>Persistence</b>	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?
<b>Connections (networking)</b>	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?
<b>Self-compassion</b>	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?
<b>Courage</b>	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?
<b>Creativity (divergent thinking)</b>	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?
<b>Playfulness</b>	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?
<b>Organization</b>	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?
<b>Communication</b>	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?
<b>Iterative design</b>	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?
<b>Diligent Skepticism</b>	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?
<b>Collaboration</b>	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?
<b>Reflection</b>	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?
<b>Civic (Sociological Imagination)</b>	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?