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## Preview of Award 1721236 - Annual Project Report

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### Cover

|   |   |
|---|---|
| Federal Agency and Organization Element to Which Report is Submitted:   | 4900  |
| Federal Grant or Other Identifying Number Assigned by Agency:   | 1721236   |
| Project Title:  | Project MAPLE: MAKerspaces Promoting Learning and Engagement                      |
| PD/PI Name:   | Lisa A Bievenue, Principal Investigator<br>Maya Israel, Co-Principal Investigator |
| Recipient Organization:   | University of Illinois at Urbana-Champaign  |
| Project/Grant Period:   | 09/01/2017 - 08/31/2021   |
| Reporting Period:   | 09/01/2019 - 08/31/2020   |
| Submitting Official (if other than PD\PI):  | Lisa A Bievenue<br>Principal Investigator   |
| Submission Date:  | 12/04/2020  |
| Signature of Submitting Official (signature shall be submitted in accordance with agency specific instructions) | Lisa A Bievenue   |

### Accomplishments

#### \* What are the major goals of the project?

The aim of this project is to answer preliminary questions about instructional strategies to support students with learning disabilities in classroom-based makerspace activities. It seeks to address the following research questions: (1) what learning barriers are present during the design-redesign and problem/project process common to makerspace and early STEM experiences, especially for struggling learners, (2) how can instruction that supports metacognitive strategies be integrated within typical K-12 classroom makerspace activities to address those barriers, and (3) how can the effectiveness of those strategies be evaluated by measuring engagement and learning. We believe this work is particularly salient

given national efforts that inform DRK-12 research, such as the Reinforcing Education Accountability in Development (READ) Act, which stresses the development of comprehensive strategies to address key barriers to retention and completion ([HR601](#)).

**\* What was accomplished under these goals and objectives (you must provide information for at least one of the 4 categories below)?**

Major Activities:

Data analysis began in May of 2018 and is ongoing. Data is being coded using the Dedoose software, a collaborative platform for classifying, organizing and coding of qualitative data. The analysis is currently focused on identifying systemic, pedagogical, and student-level barriers encountered by struggling learners during makerspace activities. All observation and recorded data will be coded by at least 2 researchers and then triangulated with artifacts and an outside reviewer.

The team has produced an expanded coding guide, continues to add to and detail the accompanying terminology guide, and has collaborated as a 4-person team in the effort to code, cross-code, and triangulate data to ensure reliability. All research assistants were trained on the coding of qualitative data using *The Coding Manual for Qualitative Researchers* (Saldana, 2015).

Specific Objectives:

**Data Analysis Objectives for Year 3:**

Multiple instruments have been used to measure pertinent metacognitive processes. We anticipate a focus on persistence (attitudes about making), iteration (productive struggle) and intentionality (plan with incremental steps). Instruments include student observation protocols, teacher observation protocols, the Collaborative Computing Observation Instrument (C-COI), a teacher interview protocol, and an artifact-based interview protocol.

A summary of data and coding to date:

- 25 subjects with proper consent
- 24 subjects interviewed
- 22 subjects with artifacts for analysis
- 10 subjects with grade reports from all classes during quarter observed
- 13 subjects observed at least 5 times, 6 at least 3 times, 6 at least once
- 14 subjects with observations coded at least three times by at least two coders, all subjects' observations coded at least once by one coder
- 15 subjects within the target population of LD, ELL, or at-risk, 14 with observations coded at least three times by at least two coders
- 20 subjects with summary analyses at draft stage (awaiting additional coding)
- 6 teacher observations
- 6 teacher interviews
- 10 surveys from other teachers (math, science, language arts, social studies) of 10 subjects
- 2 student focus groups

Analysis is uncovering themes of barriers to successful implementation of classroom-based maker activities and barriers to student engagement.

**Dissemination Objectives for Years 3 and 4:**

- Websites with curricula and strategies, alongside other resources associated with our project. The website is in progress and will be published by end of spring 2021.
- Research findings via presentations and publications in peer-reviewed practitioner and research journals. Two papers have been accepted and presented at the FabLearn 2020 conference. One presentation was delivered at the Council of Exceptional Children 2020 conference.
- Research briefs that describe components of our work in progress.

- Webinars for those interested in accessible middle school makerspaces for diverse learners, focused on lessons we are learning and practical advice for bringing accessible and engaging makerspace instruction to broad audiences.

#### Significant Results:

Overall, our findings have so far highlighted several barriers to effective student-centered learning in school-based makerspace activities and classrooms. Barriers can be categorized as

- student barriers -- performance task avoidance and limited persistence,
- teacher barriers -- unprepared to implement instructional strategies such as modeling, scaffolding and prompting to meet the needs of students with disabilities or at-risk, and
- current practices in school barriers -- limited access to STEM for students with disabilities, technology failure, limited instructional time, and limited professional development.

#### Student barriers

The students rarely tried these activities on their own. One teacher explained that her struggling learners, especially those with disabilities, often exhibited learned helplessness, wherein they would not initiate or persist in learning activities independently. Another teacher stated that students with disabilities feared failure in his class and exhibited limited persistence. The students' fear of failure often meant that he had to work one-on-one with them to help them maintain effort and persistence. Classroom observations also showcased task avoidance. The students with disabilities were often observed exhibiting off-task behaviors (i.e., making noise, using phone, chasing one another) as compared to their peers who were also talking with their peers, but were doing so while also working on their projects. Teachers usually attempted to re-engage the students by verbally or physically intervening to redirect them. However, given the teacher and student ratio, it is challenging for teachers to re-engage all the students.

#### Teacher barriers

The classroom observations showed that it was too challenging for teachers to implement instructional strategies (e.g., explicit instruction, modeling, prompting) to meet the needs of students with disabilities or at-risk in maker activities. One teacher prepared directions for every class including the agenda on the smartboard, worksheets, and verbal directions. However, she was not seen providing any form of cues to the students to look at those directions, which often resulted in students asking the same question repeatedly. Similarly, during another teacher's project field note reflections indicated that instruction seemed to have been given too quickly for students to grasp the necessary steps. Most interactions appear to be depositing of information to the student instead of prompting techniques to determine how to figure out the solution. Another teacher had a student with a learning disability whose IEP accommodations included reduced reading load and additional time to complete assignments. Despite these mandated accommodations, observers noted that the teacher did not give any relevant accommodations or instructions.

#### Current practices in school barriers

##### Limited Access to STEM for Students with LD

The number of students with disabilities was fewer than expected in all four classes observed. Although some students with learning disabilities, or ELL, or at-risk, were included, there were no students with intellectual disabilities, behavior disorders, or other more moderate to severe disabilities. One teacher noted that most students with intellectual and developmental disabilities were "pulled out" of the STEM course to receive reading recovery instruction (or other specialized interventions) and did not have an opportunity to participate in the STEM class. Thus, although there were a few

students with disabilities in the STEM classes, the teachers did not have many experiences teaching students with disabilities in their classrooms. Another teacher, however, had an opposite experience in which she had more struggling learners in her class because most high-achieving students enrolled in courses such as foreign language or band. She reported that, “[A]s you’ve seen, we have some behavioral issue kids that are in there...I get one or two that are higher level and then most of them are not. They’re the ones who are struggling.” However, her class also did not include students with more significant needs.

#### Technology Failure

Across observations and interviews, teachers experienced technology challenges during maker activities. These challenges fell into four categories: (1) Technology failure, (2) lengthy bootup time, (3) internet stability issues, and (4) challenges associated with logging into systems such as Google classroom. For example, one teacher has a 3D printer in her classroom but the 3D printer did not always work reliably. Furthermore, some schools have used Chromebooks or PCs that have some internet connection issues and students constantly struggle to log-in, often mistyping or forgetting their login or password. As instructional time was limited (classes are only 40 minutes long), the technology challenges were viewed by teachers as problematic for implementation of the making activities.

#### Limited Instructional Time

Across four schools, a project usually took a week and each session lasted approximately 40 minutes. Setting up and wrapping up activities often took at least 10 minutes which left only 30 minutes for the activities themselves. Due to this limited time, there was not always time for student exploration and iteration. Ms. Morgan, for example, reported difficulty in facilitating tinkering due to time constraints. Furthermore, researchers observed that learners who needed additional support only received this instruction when they asked for one-on-one help as teachers dealt with 20 or more students per class. For instance, Mr. David explained that he was trying to provide accommodations for students with disabilities, but it took a lot of time to revise materials and instructions. He said, “I think a lot of teachers will say they can’t do [accommodations for students with disabilities] because they just don’t have time and that’s unfortunate” (May 16, 2018).

#### Limited Professional Development

Three teachers mentioned that there were limited opportunities for PD on either maker activities or inclusive instructional strategies. All four teachers were interested in learning different kinds of hands-on maker activities, but at the time of this study, they had not had opportunities to participate in any maker-related PD. During the interviews, researchers asked the teachers about their background and any PD that they received. One teacher reported, “No. There were no maker related activities or even things like STEM-based [professional development]” (May 16, 2018). Two teachers confided that they struggled executing new maker activities. One teacher reported that PD was not always presented in ways that teachers could easily apply new content into their classrooms. Similar to PD on maker activities, teachers did not report having opportunities to attend PD related to culturally responsive instructional strategies or inclusive instructional strategies.

One barrier we were able to somewhat address relates to limited pedagogical practices to address a broad range of learners in classrooms. Given the challenges faced by the teachers, the research team developed a new professional development framework to support inclusive maker K-12 classrooms by incorporating Universal Design for Learning principles.

A primary contribution of our PD model to the literature is the addition of effective instructional and behavioral strategies to support diverse learners, specifically targeting students with disabilities and at-risk. We found it was essential to incorporate not only fluency in making but address learner variability in PD sessions. To do so, the current study suggested addressing specific instructional strategies (i.e., UDL, explicit instruction, culturally responsive teaching, accommodations) during PD. Further, embedded coaching encouraged implementation of different instructional strategies into lesson plans.

Key outcomes or Other achievements:

We expect a major outcome to be a framework to represent, identify, and measure metacognitive strategies used by and promoted by makerspace activities. The beginnings of this framework is represented by a teacher/classroom observation rubric and a codebook for student interviews and observations. Working drafts of these are attached to this report.

A second expected outcome is a revised set of metacognitive strategies and support materials for implementing making experiences specifically for struggling learners. This is in progress and is scheduled to be completed spring 2021.

#### \* What opportunities for training and professional development has the project provided?

The research team was able to participate in conference-related professional development at FabLearn 2020, which was originally scheduled for March, 2020, but held on-line in October, 2020.

#### \* Have the results been disseminated to communities of interest? If so, please provide details.

Two reviewed papers were presented at FabLearn, 2020, and one at the 2020 Council for Exceptional Children:

Lee, C., Arnett, H., Samuel, N., Bievenue, L., Ginger, J., Israel, M. (2020). Towards an Inclusive Model of Makerspace Educator Professional Development: Implications for Students with Disabilities and At-Risk. FabLearn Conference, October 9-11, 2020, New York, NY.

Lee, C., Samuel, N., Israel, M., Arnett, H., Bievenue, L., Ginger, J., Perry, M. (2020). Understanding Instructional Challenges and Approaches to Including Middle School Students with Disabilities in Makerspace activities: A cross-case analysis. FabLearn Conference, October 9-11, 2020, New York, NY.

Lee, C., & Bentz, J. (2020). *Makerspace Professional Development Needs of Middle School Teachers: Implications for Including Students with Learning Disabilities*. Presentation with Q&A at the Council for Exceptional Children Conference, Portland, OR.

#### \* What do you plan to do during the next reporting period to accomplish the goals?

Plans are in place to complete the 2nd researcher coding of observation data, final data analysis, final research summary report, and at least one paper for journal submission.

#### Supporting Files

| Filename                                       | Description  | Uploaded By   | Uploaded On |
|--|--|---------------|-------------|
| Codebook for student interview_observation.pdf | Codebook for coding student interviews and observations        | Lisa Bievenue | 12/04/2020  |
| MAPLE Teacher-only Observation Guide 2017.pdf  | Rubric and guide for teacher observation in makerspace classes | Lisa Bievenue | 12/04/2020  |

## Products

**Books****Book Chapters****Inventions****Journals or Juried Conference Papers**

View all journal publications currently available in the [NSF Public Access Repository](#) for this award.

The results in the NSF Public Access Repository will include a comprehensive listing of all journal publications recorded to date that are associated with this award.

Lee, C., Samuel, N., Israel, M., Arnett, H., Bievenue, L., Ginger, J., Perry, M. (2020). Understanding Instructional Challenges and Approaches to Including Middle School Students with Disabilities in Makerspace activities: A cross-case analysis. FabLearn Conference, October 9-11, 2020, New York, NY.. Status = AWAITING\_PUBLICATION.

Lee, C., Arnett, H., Samuel, N., Bievenue, L., Ginger, J., Israel, M. (2020). Towards an Inclusive Model of Makerspace Educator Professional Development: Implications for Students with Disabilities and At-Risk. FabLearn Conference, October 9-11, 2020, New York, NY.. Status = AWAITING\_PUBLICATION.

**Licenses****Other Conference Presentations / Papers**

Lee, C., & Bentz, J. (2020). *Makerspace Professional Development Needs of Middle School Teachers: Implications for Including Students with Learning Disabilities*.. Council for Exceptional Children Conference. Portland, OR. Status = OTHER; Acknowledgement of Federal Support = Yes

**Other Products****Other Publications****Patent Applications****Technologies or Techniques****Thesis/Dissertations****Websites or Other Internet Sites****Supporting Files**

| Filename                   | Description  | Uploaded By   | Uploaded On |
|----------------------------|--|---------------|-------------|
| FabLearn_2020_paper_31.pdf | Lee, C., Samuel, N., Israel, M., Arnett, H., Bievenue, L., Ginger, J., Perry, M. (2020). Understanding Instructional Challenges and Approaches to Including Middle School Students with Disabilities in Makerspace activities: A cross-case analysis. FabLearn Conference, October 9-11, 2020, New York, NY. | Lisa Bievenue | 12/01/2020  |
| FabLearn_2020_paper_38.pdf | Lee, C., Arnett, H., Samuel, N., Bievenue, L., Ginger, J., Israel, M. (2020). Towards an Inclusive Model of Makerspace Educator Professional Development: Implications for Students with Disabilities and At-Risk. FabLearn Conference, October 9-11, 2020, New York, NY.                                    | Lisa Bievenue | 12/01/2020  |

| Filename          | Description   | Uploaded By   | Uploaded On |
|-------------------|---|---------------|-------------|
| CEC 2020 a_CL.pdf | Lee, C., & Bentz, J. (2020). Makerspace Professional Development Needs of Middle School Teachers: Implications for Including Students with Learning Disabilities. Presentation with Q&A at the Council for Exceptional Children Conference, Portland, OR. | Lisa Bievenue | 12/01/2020  |

## Participants/Organizations

### What individuals have worked on the project?

| Name            | Most Senior Project Role | Nearest Person Month Worked |
|-----------------|--------------------------|-----------------------------|
| Ginger, Jeffrey | PD/PI                    | 3                           |
| Bievenue, Lisa  | Co PD/PI                 | 1                           |
| Israel, Maya    | Co PD/PI                 | 0                           |
| Bentz, Johnell  | Faculty                  | 1                           |
| Perry, Michele  | Consultant               | 1                           |

### Full details of individuals who have worked on the project:

#### Jeffrey A Ginger

**Email:** ginger@illinois.edu

**Most Senior Project Role:** PD/PI

**Nearest Person Month Worked:** 3

**Contribution to the Project:** coding observation data, data analysis, development of papers

**Funding Support:** non

**Change in active other support:** No

**International Collaboration:** No

**International Travel:** No

#### Lisa A Bievenue

**Email:** bievenue@illinois.edu

**Most Senior Project Role:** Co PD/PI

**Nearest Person Month Worked:** 1

**Contribution to the Project:** coding observation data, data analysis, development of papers

**Funding Support:** none

**Change in active other support:** No

**International Collaboration:** No

**International Travel:** No

**Maya Israel****Email:** misrael@coe.ufl.edu**Most Senior Project Role:** Co PD/PI**Nearest Person Month Worked:** 0**Contribution to the Project:** development of papers**Funding Support:** n/a**Change in active other support:** No**International Collaboration:** No**International Travel:** No**Johnell Bentz****Email:** jbentz@illinois.edu**Most Senior Project Role:** Faculty**Nearest Person Month Worked:** 1**Contribution to the Project:** Consultant for metacognition.**Funding Support:** N/A**International Collaboration:** No**International Travel:** No**Michele Perry****Email:** mperry@perryandassociates.net**Most Senior Project Role:** Consultant**Nearest Person Month Worked:** 1**Contribution to the Project:** Evaluator**Funding Support:** N/A**International Collaboration:** No**International Travel:** No**What other organizations have been involved as partners?**

| Name                           | Type of Partner Organization | Location      |
|--------------------------------|------------------------------|---------------|
| Champaign Unit School District | School or School Systems     | Champaign, IL |
| Urbana Middle School           | School or School Systems     | Urbana, IL    |

**Full details of organizations that have been involved as partners:****Champaign Unit School District****Organization Type:** School or School Systems**Organization Location:** Champaign, IL**Partner's Contribution to the Project:**

Facilities

Collaborative Research  
Personnel Exchanges

**More Detail on Partner and Contribution:**

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**Urbana Middle School**

**Organization Type:** School or School Systems

**Organization Location:** Urbana, IL

**Partner's Contribution to the Project:**

Facilities  
Collaborative Research  
Personnel Exchanges

**More Detail on Partner and Contribution:**

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**Were other collaborators or contacts involved? If so, please provide details.**

Nothing to report

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## Impacts

**What is the impact on the development of the principal discipline(s) of the project?**

Nothing to report.

**What is the impact on other disciplines?**

Nothing to report.

**What is the impact on the development of human resources?**

Nothing to report.

**What was the impact on teaching and educational experiences?**

The MAPLE project provided opportunities for collaboration among experienced makers and educators involved in this project. Curriculum was co-developed and incorporated into learning experiences for the teachers middle school students. Educators continue to use these activities and lesson plans and project ideas are in the process of being posted on various websites for other teachers.

**What is the impact on physical resources that form infrastructure?**

Nothing to report.

**What is the impact on institutional resources that form infrastructure?**

Nothing to report.

**What is the impact on information resources that form infrastructure?**

Nothing to report.

**What is the impact on technology transfer?**

Nothing to report.

**What is the impact on society beyond science and technology?**

Nothing to report.

**What percentage of the award's budget was spent in a foreign country?**

Nothing to report.

## Changes/Problems

### **Changes in approach and reason for change**

Nothing to report.

### **Actual or Anticipated problems or delays and actions or plans to resolve them**

Nothing to report.

### **Changes that have a significant impact on expenditures**

Nothing to report.

### **Significant changes in use or care of human subjects**

Nothing to report.

### **Significant changes in use or care of vertebrate animals**

Nothing to report.

### **Significant changes in use or care of biohazards**

Nothing to report.

### **Change in primary performance site location**

Nothing to report.