Early Childhood STEM Education: What Preparation Matters?
By Sharon Brusic, Nanette Marcum-Dietrich, & Janet White
ITEEA Conference – March 12, 2020

Agenda

- Welcome & Introductions
- Overview of the iSTEM4ToYS Project
- Research Methods
- Initial Results
- Conclusions & Recommendations
- Questions & Answers
Researchers

- **Dr. Sharon Brusic**
  - Applied Engineering, Safety & Technology Dept.
  - Technology & Engineering Education
- **Dr. Nanette Marcum-Dietrich**
  - Educational Foundations Department
  - Science Education
- **Dr. Janet White**
  - Mathematics Department
  - Mathematics Education
- **Dr. Jennifer Shettel** (not presenting today)
  - Early, Middle & Exceptional Education Dept.
  - Early Childhood Education
- **Justin Egresitz** (not presenting today)
  - Graduate Assistant
  - Technology & Innovation
This material is based upon work supported by the National Science Foundation under Grant No. DUE-1611652. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.
Overall Research Goal

To investigate selected research-based components of an undergraduate integrative STEM (iSTEM) program for early childhood education majors (PK-4)
iSTEM4ToYS Research Question

What experiences in the ISEM program prompt undergraduates to include iSTEM concepts in education courses that are not part of the ISEM minor (e.g., literacy, teaching of reading, math pedagogy, science pedagogy, field experiences, student teaching)?
iSTEM4ToYS: Five Program Features

1. Development of an iSTEM Laboratory and Resource Center (iSTEM LRC),
iSTEM4ToYS: Five Program Features

2. Coursework that engages learners in problem-based, inquiry-based, and design-based learning experiences that build deeper understandings of STEM concepts,
Coursework

ERCH 110
Introduction to Early Childhood Education

ERCH 190
Introduction to Integrative STEM Pedagogy
(Prerequisite: ERCH 110)

ITEC 344
Product Design
(Prerequisites: ERCH 110 & 190)

EDTE/ERCH 290:
Children’s Engineering
(Prerequisites: ERCH 110 & 190)

EDTE 490/690
Integrative Learning using Experiential Strategies
(Prerequisites: ERCH 110, ERCH 190, ITEC 344, & EDTE/ERCH 290)

EDTE/ERCH 495:
Integrative STEM Education Practicum
(Prerequisites: ERCH 110, ERCH 190, ITEC 344, EDTE/ERCH 290, & EDTE 490)
iSTEM4ToYS: Five Program Features

3. STEM focused practicums with children,
iSTEM4ToYS: Five Program Features

4. STEM professional development opportunities, and
iSTEM4ToYS: Five Program Features

5. Access to STEM-related community resources.

Image source: http://www.lancastersciencefactory.org/
Methods
Research Design

Mixed Methods

- End-of-semester (EOS) survey
- Qualitative research methodology (CIT)
  - Student interviews (self-report and faculty recommendations)
  - Used semi-structured CIT protocol
● How often have you integrated STEM concepts and activities into lesson plans in non-ISEM courses or field experiences?
● Please describe an instance where you used your STEM knowledge and skills in a class.
● MU offers many STEM-related workshops and presentations on campus. How many of these events have you attended since you started at MU?
● Etc.
Quantitative Analysis of Survey

- Data collected from End-of-Semester (EOS) iSTEM surveys
- 5 semesters, Spring 2017 - Spring 2019
- N=287 iSEM minors
Critical Incident Technique (CIT)

"A set of procedures for collecting direct observations of human behaviour in such a way as to facilitate their potential usefulness in solving practical problems and developing broad psychological principles”

Flanagan (1954, p. 327)
A Critical Incident (CI)

"Any observable human activity that is sufficiently complete to permit inferences and predictions to be made about the person performing the act"

Flanagan (1954, p. 327)
Quantitative Analysis of Survey

- 3 Questions cross tabulated with a variety of independent conditions:
  - How comfortable do you feel in integrative STEM at this point in time?
  - How often have you integrated STEM concepts and activities into lesson plans in non-ISEM courses or field experiences?
  - Have you sought out STEM-related opportunities in your personal or professional life since starting at MU?
- ANOVA test for Association run at $a=0.05$
- Almost all activities in the program showed a statistically significant association
CIT - How Students Were Selected for Interview

1. Used End-of-Semester Survey
2. Filtered to include all students who stated they did anything STEM related or showed any sign of involvement (i.e., attended open lab, went to a community event, presented at a conference)
3. Sorted through data and filtered out only those who appeared to be doing things of their own accord and not as a course requirement
4. Cross referenced the names on this list with the Faculty Recommendations
5. Created list of potential interviewees (additive but not a reduction; served as a way confirm more that they should be interviewed)
# EOS Survey - Participants

<table>
<thead>
<tr>
<th>ISEM Minors</th>
<th>Spring 2017</th>
<th>Fall 2017</th>
<th>Spring 2018</th>
<th>Fall 2018</th>
<th>Spring 2019</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey Responses</td>
<td>57 (65.5%)</td>
<td>44 (58.7%)</td>
<td>74 (74%)</td>
<td>56 (61.5%)</td>
<td>56 (58.9%)</td>
<td>287 (124 unique individuals)</td>
</tr>
<tr>
<td>N</td>
<td>87</td>
<td>75</td>
<td>100</td>
<td>91</td>
<td>95</td>
<td></td>
</tr>
<tr>
<td>Interviews</td>
<td>7</td>
<td>7</td>
<td></td>
<td>11</td>
<td></td>
<td>25</td>
</tr>
</tbody>
</table>
Initial Results
iSTEM4ToYS Research Question

What experiences in the ISEM program prompt undergraduates to include iSTEM concepts in education courses that are not part of the ISEM minor (e.g., literacy, teaching of reading, math pedagogy, science pedagogy, field experiences, student teaching)?
Percentage of students who integrated STEM concepts and activities into non-ISEM courses or field experiences based on number of ISEM courses (N=287)
Percent of students who integrated STEM concepts and activities into non-ISEM courses or field experiences based on number of times iSTEM Laboratory and Resource Center (iSTEM LRC) open labs attended (N=284)

![Bar chart showing the percentage of students who integrated STEM concepts and activities into non-ISEM courses or field experiences based on the number of times they attended iSTEM LRC open labs. The chart compares Level 1 (0-2 times in LRC) and Level 2 (3-5 times in LRC).]
Percent of students who integrated STEM concepts and activities into non-ISEM courses or field experiences based on STEM-related job or teaching roles (N=280)
CIT - Analysis

- Total of 25 Interviews
- Created interview lists
- Conducted, recorded, & transcribed interviews
- Each interview lasted between ~30-45 min
- Created code book
- Coded the interviews using Nvivo software to identify critical incidents
## iSTEM4ToYS Research Question

<table>
<thead>
<tr>
<th>Node</th>
<th>Students</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impactful Experiences</td>
<td>25</td>
<td>322</td>
</tr>
<tr>
<td>Integration Evidence</td>
<td>24</td>
<td>63</td>
</tr>
<tr>
<td>Barriers-Integration</td>
<td>18</td>
<td>46</td>
</tr>
</tbody>
</table>
Impactful Experiences

- Specific courses, professors, activities, or assignments
- Professional development experiences
- Indication that their perspectives on STEM had grown or changed as a result
“When I had the Product Design class, we built a wooden toy. The type of higher-order thinking that I had to use really challenged me and having to do all of the steps made me really think twice about everything I did and analyze everything which was really, really cool. I just loved the deeper level of thinking that it involved because I don’t really get that in a lot of my classes and it really challenged me. I like that.”
“Children’s Engineering was memorable for me. We made automatons and for me, at first, it was very challenging because I couldn’t figure out how to do it. I think as a teacher, you have to go through the struggle first so that then you can help the kids and understand what they’ll be going through.”
“...the biggest one that stands out to me was last semester we had a Code.org workshop where someone from Code.org came in and it was like a full day thing and we got curriculum from them so I found that to be really awesome.”
“But by going to those different extracurricular activities and having the classes themselves, they just helped build off each other and I really was understanding it as I was going through these workshops in conjunction with the classes themselves.”
“...the Chair for Your Mother [professional development session]...one of the first ones that I went to. And I think that I went to it before I took any of my STEM courses in the minor, so that was kind of like my “ah-ha!” moment, like this is how I’m going to be able to use STEM, this is why I joined the minor. And I just thought that it was a really good experience.
Integration Evidence

- Some difficulty identifying specific examples
- Indication that they considered what they were learning in STEM as they prepared for other classes
“I definitely find myself making a lot of my lesson plans more project-based rather than filling out a worksheet and things like that. And I try to make my lessons plans a lot more interactive and engaging rather than just lecture.”
“So for a lot of our courses we have to create lesson plans….and I try and make it where some STEM is included. So it’s not just them sitting and getting information, it’s kind of hands on.”
Barriers to Integration

- Lack of time to “fit it all in”
- Lack of STEM understanding by non-iSTEM professor or mentor teacher
“Seeing the big picture is kind of hard. It’s overwhelming to see how much of it would take up your time as a teacher and if schools would even let you have that much time to do it.”
“I think it would be scary to try for the first time to just do your own STEM lesson and have no help with it.”
Conclusions: What Matters Most?

Based on Quantitative Data

- Taking more courses in the STEM minor
- More visits to the iSTEM LRC
- Having a STEM-related job/role
Conclusions: What Matters Most?

Based on Qualitative Data (Interviews)

- Some courses were more impactful than others (e.g., Product Design, Children’s Engineering)
- Immersion in project-based learning
- Participation in STEM programs/activities
- Experience with STEM materials/resources
Recommendations

- iSTEM Coursework specifically designed for the target age range
- iSTEM Coursework that incorporates traditional and experiential learning opportunities
- Access to iSTEM materials/resources to explore and use with children
Questions?

Thank you for your participation!