2021

Collaborative NSF funded research at UNC addresses diversity in STEM-C

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Collaborative Research- Introducing High-School Students to Computational Thinking in Industrial Automation **is a three-year project funded by the National Science Foundation/ Division of Research on Learning (Award #1842342) through 2021.**

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Introduction

Females continue to be underrepresented in STEM-C fields. This holds true in mechatronics degree programs where currently fewer than ten percent enrolled are women. In this research project a collaborative coalition of universities, community colleges, and high schools in CO, VA, and ME actively seek to support the entry and success of under-represented populations in the field of mechatronics, and address outdated stereotypes and barriers in the process. Local partners include the University of Northern Colorado, Aims Community College, and Northridge High School.

What is mechatronics?

Mechatronics is a growing occupational field in manufacturing which encompasses mechanical engineering, electrical engineering, and computer science.

Overall project goal

The overall goal of this mixed methods research project is to encourage a larger and more diverse population of high school students to consider careers in mechatronics and to better prepare students who enter this career path.

Specific goals

- To develop computational thinking
- To recruit diverse students to STEM-C
- To increase manufacturing capacity

Research question

To what extent does working with *Make To Learn* activities encourage broader participation and retention of female and under-represented students in a career path in the field of mechatronics?

Make To Learn
Bringing the Art of Making to Learning

https://www.maketolearn.org/creating-art-animations-and-music/

Assessment

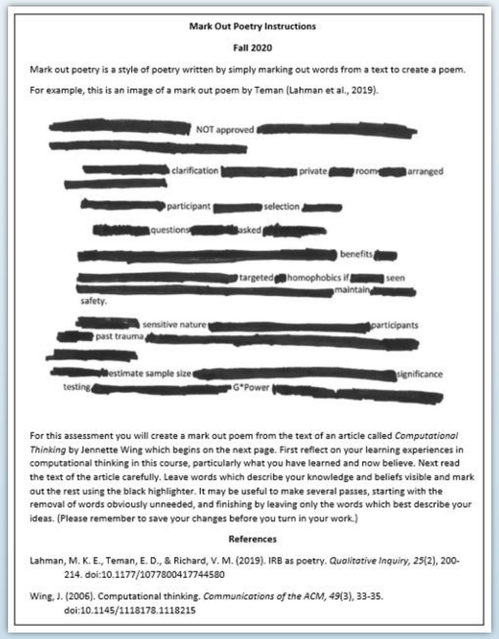
Mixed methods will be used to assess project outcomes.

- Observations
- Artifact analyses
- Task-based interviews
- STEM-C focused interviews
- Computational thinking assessment instruments

Assessment pilot in progress within the larger study: using mark out poetry to explore preservice teachers' understanding of computational thinking

Abstract: In this descriptive brief paper about work in progress, two science education university faculty and a post-doctoral researcher share an arts-based assessment developed to investigate students' understanding of computational thinking. The mark out poetry activity was designed for use in an NSF grant funded mixed methods, multi-partner STEM-C research project. Piloted in an undergraduate science teacher education course at a public university, the assessment is intended for later use with public high school juniors and seniors who are partnering in the grant's work, and likely have little experience with computational thinking. Collected data has the potential to inform the researchers about changes in participants' understanding of computational thinking over time, as well as the efficacy of the equity-based grant project. This paper includes instructions for the activity, an example of one undergraduate's work, and a preliminary analysis of the work of the five students in the pilot. This presentation may inform the work of constituents of technological, teacher education, and K-12 learning communities who want to broaden and deepen their assessment practices with the inclusion of qualitative, arts- and equity-based data collection and analysis. (Funding-NSF Grant 1842342.) ***Keywords***: arts-based, assessment pilot, computational thinking, equity-based, high school students, higher education, K-12, mark out poetry, qualitative, STEM-C, science teacher education

Mark out poetry assessment instructions for preservice teachers in the pilot



Mark Out Poetry Instructions

Fall 2020

Mark out poetry is a style of poetry written by simply marking out words from a text to create a poem.

For example, this is an image of a mark out poem by Teman (Lahman et al., 2019).

[redacted] NOT approved [redacted]
[redacted] clarification [redacted] private [redacted] room [redacted] arranged [redacted]
[redacted] participant [redacted] selection [redacted]
[redacted] questions [redacted] asked [redacted]
[redacted] benefits [redacted]
[redacted] targeted [redacted] homophobics if [redacted] seen [redacted] maintain [redacted]
safety.
[redacted] sensitive nature [redacted] participants
[redacted] past trauma [redacted]
[redacted] estimate sample size [redacted] significance
testing [redacted] G*Power [redacted]

For this assessment you will create a mark out poem from the text of an article called *Computational Thinking* by Jennette Wing which begins on the next page. First reflect on your learning experiences in computational thinking in this course, particularly what you have learned and now believe. Next read the text of the article carefully. Leave words which describe your knowledge and beliefs visible and mark out the rest using the black highlighter. It may be useful to make several passes, starting with the removal of words obviously unneeded, and finishing by leaving only the words which best describe your ideas. (Please remember to save your changes before you turn in your work.)

References

Lahman, M. K. E., Teman, E. D., & Richard, V. M. (2019). IRB as poetry. *Qualitative Inquiry, 25*(2), 200-214. doi:10.1177/1077800417744580

Wing, J. (2006). Computational thinking. *Communications of the ACM, 49*(3), 33-35. doi:10.1145/1118178.1118215

A section of the original article

Computational thinking builds on the power and limits of computing processes, whether they are executed by a human or by a machine. Computational methods and models give us the courage to solve problems and design systems that no one of us would be capable of tackling alone. Computational thinking confronts the riddle of machine intelligence: What can humans do better than computers? and What can computers do better than humans? Most fundamentally it addresses the question: What is computable? Today, we know only parts of the answers to such questions.

Computational thinking is a fundamental skill for everyone, not just for computer scientists. To reading, writing, and arithmetic, we should add computational thinking to every child's analytical ability. Just as the printing press facilitated the spread of the three Rs, what is appropriately incestuous about this vision is that computing and computers facilitate the spread of computational thinking.

Computational thinking involves solving problems, designing systems, and understanding human behavior, by drawing on the concepts fundamental to computer science. Computational thinking includes a range of mental tools that reflect the breadth of the field of computer science.

Wing, J. (2006). Computational thinking. *Communications of the ACM, 49*(3), 33-35. doi:10.1145/1118178.1118215

The same section marked out by an undergraduate student

Computational thinking builds on [redacted] computing processes, [redacted] Computational methods and models [redacted] solve problems and design systems [redacted] What can humans do better than computers? [redacted] What can computers do [redacted] What is computable? [redacted] fundamental skill [redacted] reading, writing, and arithmetic, [redacted] analytical ability. [redacted] solving problems, designing systems, [redacted] understanding [redacted] mental tools [redacted] computer science.

The transcription of the resulting poem (lightly edited for clarification)

Computational thinking builds on
computing processes.
Computational methods and models
solve problems and design systems.
What can humans do better than computers?
What can computers do?
What is computable?
Fundamental skill.
Reading, writing, and arithmetic, analytical ability.
Solving problems, designing systems,
understanding
mental tools
computer science.

Preliminary analysis

A preliminary constant comparative analysis of the shared content and themes of the undergraduates' poetry revealed overlapping word choices which likely hint at the understandings of computational thinking which were collectively held by the students. Repeated phrase choices commonly used in their poems included the following: "solve problems and design systems," "fundamental skill," "not just for computer scientists," "understanding human behavior," "mental tools," and "computer science." Additional data analysis is pending.