Using Mark Out Poetry to Explore Preservice Teachers' Understanding of Computational Thinking: A Pilot In Progress

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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

In keeping with the conference goal of including presentations which highlight innovative examples of assessment in K-12 and teacher education, science education faculty and a post-doctoral researcher from a public university offer this brief paper which describes an arts- and equity-based qualitative assessment pilot which explores students' understanding of computational thinking. The development of a mark out poetry (Kleon, 2010; Lahman et al., 2019) activity is detailed from inception to implementation in a small pilot (n = 5) in both narrative and illustrations. Figures include an example of an undergraduate preservice teacher's mark out poetry process which includes a step-by-step look at the text of the original document, the mark out version, and the resulting poem.

Context and Motivation of the Study

This pilot is situated in a current NSF grant funded mixed methods STEM-C equity-based research project in the Rocky Mountain West, USA [NSF Grant 1842342]. The project involves a multi-site, multi-state collaboration of constituents in higher education and high schools and its goal is to attract and prepare a diverse population for a career path in mechatronics. Mechatronics is a field in manufacturing which incorporates mechanical engineering, electrical engineering, and computer science (Bradley, 2010) in which the National Science Foundation (2019) reports diversity is underrepresented.

The authors support increased usage of qualitative arts- and equity-based assessment methods to understand individual experiences and program efficacy in the field of science, particularly in the area of STEM-C. As researchers and science teacher educators, they are motivated to model for preservice teachers, as well as university and K-12 colleagues, how to develop, pilot, and employ such methods in both face-to-face and virtual environments. This presentation offers one such example which may be generalizable to the work of others.

In order to develop and pilot an arts- and equity-based assessment of students' understanding of computational thinking for use in the project, the post-doc qualitative researcher partnered with a co-PI for the grant, a science teacher educator who incorporates experiential STEM-C content in her undergraduate courses for preservice teachers. A mark out poetry activity was developed and piloted in the fall semester of 2020 in a virtual learning environment as part of a final exam for a group of five undergraduate preservice teachers. This 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.

Literature Review

Theoretical and Conceptual Frameworks

The multimodality of mixed methods research is "both a theoretical framework and an analytic methodology for understanding how people make meaning" (Halverson, Bass, & Woods, 2012, p. 4). Arts- and equity-based qualitative data collection and analysis may be included as part of a balanced multimodal investigative strategy to assess individuals and evaluate programs in educational settings which employ the nested theoretical frameworks of constructionism (Papert, 1991), constructivism (Mertens, 2010), and interpretivism (Rossman & Rallis, 1998), such as this grant's work. The power of story and art to move and change people is rooted in neuroscience (Armstrong, 2013; Haven, 2007; Starr, 2013) and poetic writing as a qualitative investigative method is supported by a body of interdisciplinary evidence-based scholarship (Mazza, 2017).

Rationale/significance of Study to the Field of Teacher Education

In a world where much educational assessment is quantitative, particularly in the sciences, many teacher educators and preservice teachers have not encountered qualitative inquiry as a valuable way to understand students' knowledge and experience and program efficacy. Exposure to arts- and equity-based qualitative methods may pique the interest of current and future educators enough to inspire further exploration in these areas and perhaps integrate new assessment approaches into their teaching practices. Central to this outcome is the availability of literature about how to create and use informative qualitative assessments. It is expected this brief paper, and future work rooted in this pilot, will contribute to that knowledge base in science teacher education by articulating how one such qualitative activity, using mark out poetry to assess understanding of computational thinking, was thoughtfully developed, and executed with meaning.

Mark Out Poetry

Description of Mark Out Poetry

Kleon (2010) developed *newspaper blackout poetry* during a period of writer's block. At a time when the artist and writer could not find words of his own, he reached for a nearby stack of newspapers filled with the words of others. He began the subtractive process of redacting a newspaper page by marking out words with a black permanent marker. The words which remained became poems, some of which had an illustrative quality as well. Authors who later wrote about this method as a poetic form of qualitative research data suggest the name of this process may more sensitively be called *mark out poetry* (Lahman et al., 2019), the label adopted for this project.

Appropriateness of Mark Out Poetry as an Assessment Method

The mark out poetry process is an appropriate arts-based way to investigate the grant participants' understanding of computational thinking because poetic writing used as assessment may "engage students' imagination and creativity...in deeper and more meaningful levels of learning" which prepares them for "future practice" (Jack, 2017, p. 10). Equity related advantages of this approach are that there are no hidden administrative needs which disrupt teacher-student relationships; the valuable information gathered is formative rather than summative; and teachers may see students holistically (Uhrmacher as cited in Hansen, 2007, p. 154).

The Foundational Document Used for Mark Out In This Pilot

A literature search was conducted for a several page article written with accessible language by an academic expert on computational thinking to use as the document to mark out to create a poem. *Computational Thinking* by Wing (2006), found in the *Communications of the ACM*, was chosen as the foundational document. The article's Flesch-Kincaid Grade Level is 11 as factored in Word's readability statistics feature.

Instructions Given to Preservice Teachers

The instructions for the mark out poetry assessment (see Figure 1) were given to the preservice teachers as part of their final exam in an online class titled SCI 365 *Advanced Physical Science Concepts*. The undergraduate lecture/laboratory course is described in the university's catalog as follows: "Application of advanced physical science concepts to everyday life. This course will delve into both state and national standards and train future teachers how to integrate science into other disciplines." In this class, experiential learning "maker" activities which exposed students to computational thinking included block coding, Arduino kits, and the design and execution of 3D printed objects.

Figure 1.

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).

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.)

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

One Step-By-Step Example from an Undergraduate

Along with the instructions, the students received the full article about computational thinking by Wing (2006) as a Word document. This enabled students to use the black highlighter in Word as a way to mark out the content they did not want to include in their poems. Once students finished marking their documents, they uploaded them into the online learning platform from which they were retrieved by the faculty member, and shared with the qualitative researcher who formatted them as poems and lightly edited them for clarification (line breaks and punctuation). An example of each step of the process follows in Figures 2, 3, and 4.

Figure 2.

A Section of the Original Article (Wing, 2006, p. 33)

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.

Figure 3.

The Same Section Marked Out by an Undergraduate

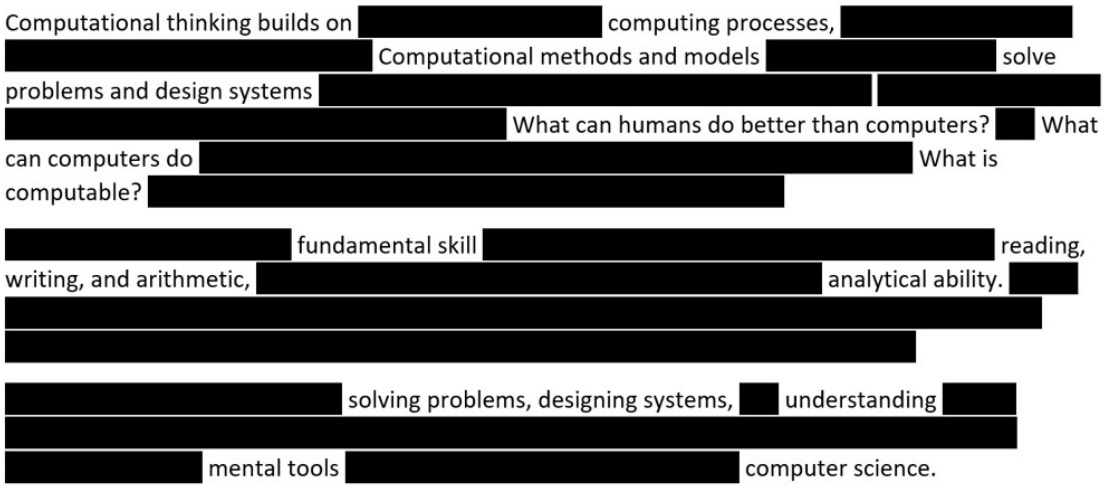
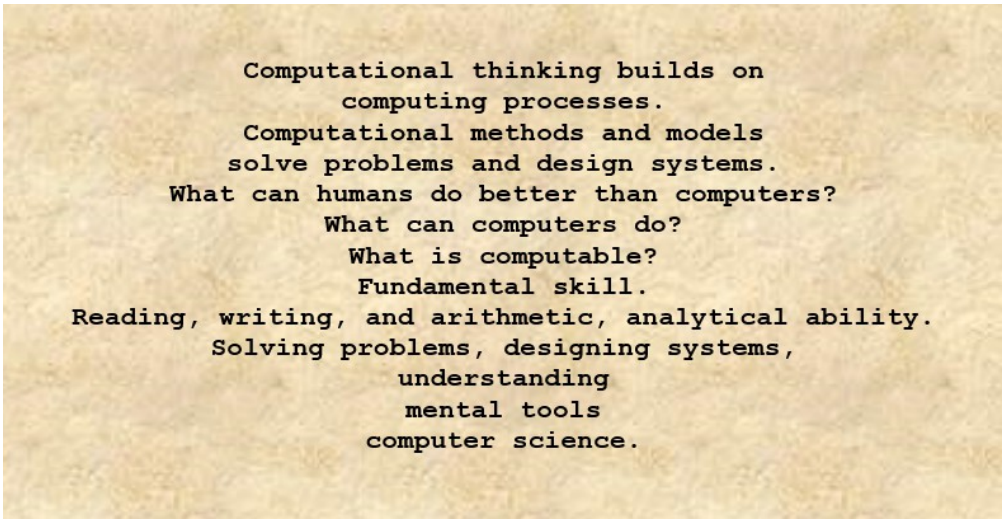


Figure 4.

The Transcription of the Resulting Poem from the Section (Lightly Edited for Clarification)



Preliminary Results Which Warrant the Authors' Point of View

When presented with mark out poetry as an assessment activity, the preservice teacher undergraduates shared with the second author that they were already familiar with the process because they had encountered mark out poetry in other courses and media at large. 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. In an end of the semester group discussion via Zoom, the undergraduates agreed the exercise was a welcome departure from other more standard types of assessment which they were completing in the final exams of their other courses. They also shared that they might consider using this kind of arts- and equity-based assessment with children in their own future classrooms because it was an enjoyable way to force reflective thinking and engage their brains in different ways.

The Scholarly Significance of the Work, Implications, and Final Thoughts

The tentative plan is to pilot this mark out poetry assessment next with the grant's local public high school junior and senior participants who are beta testing maker activities similar to those preservice teachers completed in their coursework. This will happen before the end of 2020-2021 academic year, and then if all goes well, the activity will be used as a pre-/post assessment for a student group in the 2021-2022 academic year. The further development and dissemination of this work is timely and significant given that there are many ways of knowing which may remain hidden in the educational assessment and evaluation of individuals and programs if quantitative research in the sciences continues to dominate the field. Educational leaders suggest magnifying student voice is one equity-focused way to unearth and understand multiple ways of knowing (American Educational Research Association, 2020, December 15; National Academies of Sciences, Engineering, and Medicine, 2019, 2020). Employing qualitative arts-based multimodal data collection and analysis (Janesick, 2015) which embody reflective, equity-based practices is one way to magnify student voice. Scholarship for practitioners about how to apply these ideas as activities in teacher education programs (Ferguson, 2017) and K-12 (Ladenheim, 2014) settings is warranted if educators and scholars value the collective wisdom gathered by using qualitative and quantitative inquiry in tandem. This brief paper begins a contribution to these research lines and may inform the work of constituents of

technological, teacher education, and K-12 learning communities who want to broaden and deepen their assessment practices.

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