# Exploring Computational Thinking across Disciplines through Student-Generated Artifact Analysis

Yifan Zhang, Amanda Mohammad Mirzaei, Lori Pollock, Chrystalla Mouza and Kevin Guidry
University of Delaware, Newark, DE
{ericzh, amirzaei, pollock, cmouza, krguidry} @ udel.edu

## ABSTRACT

To meet the demands of 21st century societies, it is essential that faculty across disciplines engage students with course activities and assignments that foster the development of computational thinking (CT). In this study, we address two pertinent questions: (1) What types of artifacts do students develop across different disciplines in response to CT-driven problem prompts? and (2) What types of CT skills do these artifacts demonstrate? To answer the questions, we examined 273 artifacts developed by undergraduate students across seven course assignments from four disciplines: mathematics, sociology, music, and English using a rubric developed to evaluate the following CT skills: abstraction, decomposition, data analysis, and algorithmic thinking. We found that a range of skills were reflected across student artifacts.

## CCS CONCEPTS

• **Social and professional topics** → **Professional topics** → **Computing education** → Computational thinking

## KEYWORDS

Computational thinking; undergraduate education

## 1 INTRODUCTION AND RELATED WORK

The goal of CT is to use skills derived from CS to efficiently solve problems in non-CS fields [1]. Studies indicate a positive effect of CT on student learning in postsecondary classrooms where faculty in non-CS disciplines infuse CT into their courses. [e.g., 2]. However, most studies focus primarily on student programming, which is not necessarily appropriate for all faculty interested in infusing CT across disciplines. This study addresses this gap by exploring student-generated artifacts in non-CS courses which implemented CT skills through a range of activities.

## 2 METHODS AND RESULTS

We analyzed 273 student artifacts from across mathematics, sociology, music, and English courses using a systematic coding scheme guided by a rubric [3]. The rubric helps illustrate the types of CT skills (decomposition, algorithmic thinking, data analysis, and abstraction) and the level of skill (Capstone, Milestone, Benchmark) in students' CT-infused assignments. This allows us to describe instances of students' CT skills at different levels.

## 3 CONTRIBUTIONS AND FUTURE WORK

Findings from this work provide insight into two tracks of CT research. First, they provide examples of assignments from non-CS courses which infused CT skills. This could help faculty identify and implement CT focused assignments in their own disciplines. Secondly, findings from this work provide examples of student work when students are faced with CT driven assignments in non-CS courses. By using the CT rubric to evaluate these assignments we are able to describe student strengths and weaknesses when presented with CT driven assignments. We found that students were most often given the opportunity to use decomposition or algorithm in these assignments. Further, these skills were often seen together in assignments, giving students the opportunity to practice both skills and make connections between them. The use of the CT-rubric was integral in being able to make these connections, however this work has prompted revisions to the rubric, which we hope to explore and write on in future work. Through this work we hope to inspire institutions and faculty to think about ways that CT skills can be infused into non-CS courses. We also hope that this work will further research into CT-based student artifacts as this will help researchers understand if and how students understand CT in non-CS courses.

## ACKNOWLEDGMENTS

This work was funded by the National Science Foundation under Award # 1611959.

## REFERENCES

[1] Czerkawski,B.C. & Lyman, E.W. 2015. Exploring issues about computational thinking in higher education. TechTrends, 59, 2, 57-65.

[2] Romero, M., Lepage, A. & Lille, B. 2017. Computational thinking development through creative programming in higher education. International Journal of Educational Technology in Higher Education, 14, 42.

[3] Pollock, L., Mouza, C., Guidry, K., & Pusecker, K. 2019. Infusing Computational Thinking Across Disciplines: Reflections & Lessons Learned. In Proceedings of the 50th ACM Technical Symposium on Computer Science Education (pp. 435-441).


*SIGCSE '21, March 13–20, 2021, Virtual Event, USA*

ACM ISBN 978-1-4503-8062-1/21/03.
https://doi.org/10.1145/3408877.3439594