

# Pencil Puzzles as a Context for Introductory Computing Assignments in Diverse Settings

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## ABSTRACT

Assignments based on meaningful real-world contexts have been shown to be valuable in introductory computing education. However, it can be difficult to distinguish the value of a broad context from the value of a particular instantiation of that context. In this work in progress, we report on our initial findings gathered from deployments of different pencil-puzzle-based assignments. Specifically, we have investigated the use of pencil puzzles as a contextual domain, working with instructors at eight institutions to deliver assignments appropriate to their situation and aligning with their existing materials. We then evaluate the assignments using student grades and survey responses regarding student perceptions of the assignments including self-assessed learning, given a wide array of demographic variables. Our initial results show that while there was some dependency of student responses on their prior programming experience, and female students' feedback were more positive about one aspect, overall these types of assignments do not appear to put particular groups of students at a strong (dis)advantage.

## CCS CONCEPTS

• **Social and professional topics** → **Computing education**.

## KEYWORDS

Introductory computing, context, multi-site data collection

## Project Goals

It has been shown that introductory computing assignments with a framing context are generally beneficial to students (e.g. [2]). Our goal is to study the use of one particular context, namely pencil puzzles, at a variety of institutions with different student demographics. Pencil puzzles are paper-based puzzles such as sudoku which are designed to be solved by humans. While pencil puzzles were shown to have effects largely independent of student gender and prior experience [1], these results were based on implementation at a single university. This study could be expanded to other institutions but if it involves the same assignment, then it would be a study of the assignment rather than the entire contextual domain. Therefore, we recruited instructors at eight institutions and worked with them to design a pencil-puzzle-based assignment for

their introductory-level course. The assignments were different, but shared the context that we aim to study: pencil puzzles as an instructional domain encouraging computational thinking.

## Data collection and analysis

After each instantiation of a puzzle-based assignment, we surveyed consenting students about their perceptions of the assignment, asked a number of background questions, both demographic (gender, ethnicity) and academic/personal (prior experience in programming, interest in puzzles, college major, and more), and collected their grades. Our initial analysis focused on two statements in the survey: “I *appreciated* this assignment as a learning experience.” and “I felt that this assignment helped me to *learn* this week’s material.” When analyzing multiple courses with different puzzle-based assignments, there is an advantage in aggregating the data to produce significant numbers of each demographic group, but variability from course to course can mask any demographic dependencies if the data is simply combined. Thus, we chose to use a mixed-effects linear regression, which allows us to use all of the data in a single analysis, using the demographic variables as fixed-effect variables and the course ID as a random grouping intercept. This factors out the course-to-course variations and illuminates any demographic dependencies that are present across the entire data set.

## Results, Conclusions and Future Work

Our initial analysis surprisingly showed no significant effect of the course ID, implying that different assignments did not produce significant variability in survey results for these questions. The *appreciate* item showed no predictive dependence on any demographic variable, except for being higher for students with prior experience in programming. The *learn* item showed that female students felt they learned more than male students, as did students who had prior programming experience and those who like puzzles. However, these were moderate effects, and other variables, such as ethnicity and academic major, encouragingly did not show any predictive effect. In our ongoing work, we are analyzing the complete survey, using tools that will let us see which questions provide independent information, so that we can learn more about the value of these assignments and influence their future development.

## REFERENCES

- [1] Zack Butler, Ivona Bezáková, and Kimberly Fluet. 2017. Pencil Puzzles for Introductory Computer Science: An Experience- and Gender-Neutral Context. In *Proceedings of SIGCSE 2017*. 93–98.
- [2] Mark Guzdial. 2013. Exploring hypotheses about media computation. In *International Computing Education Research Conference, ICER '13*. ACM, 19–26.

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