Undergraduate Students' Sense of Empowerment in Programming-Based Mathematical Explorations

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Introduction

- Papert (1971) emphasized the importance of using constructionism-based approaches that encourage student-centred explorations and the creation of shareable objects for the learning of mathematics.[1,2]
- Through the integration of computer programming in mathematics courses, students can be given the opportunity to employ computational thinking practices in explorations of mathematical phenomena.[1]
- Students (newcomers) are empowered to learn mathematics when they engage in a community of practice through legitimate peripheral participation, gradually taking up the real practices of working mathematicians (elders).[1,3,4]
- This poster will explore students' feelings of empowerment following their first creation of a program to test their own mathematical conjectures.

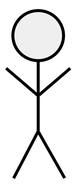
Context

- Brock University's Mathematics Integrated with Computers and Applications (MICA) course sequel teaches undergraduate students to utilize computer programming for mathematical explorations and applications.
- Assignments, or "exploratory objects" (EO), encourage students to pose and explore mathematical questions by creating programs and communicating their results, similar to the work of mathematicians.[5]
- This poster draws from data collected from participants in the Year 1 course (MICA I) after completing their first EO. MICA I aims to build students' confidence in programming, with scaffolded and engaging assignments.
- The data was collected in Year 1 of a five-year study exploring students' experiences in learning programming for mathematical investigations.*

Preliminary Results: Student Empowerment Through Their First Programming-Based Math Exploration

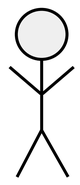
Through the creation of sharable computer programs, students are empowered as they are able to contribute to the knowledge of their chosen mathematical phenomena through participation in the activities of professional mathematicians.[2,3]

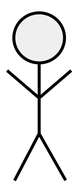
These excerpts are from interviews following students' completion of their first programming-based math exploration assignment. This assignment challenges students to pose a conjecture about primes or hailstone sequences and explore it through the design and use of a computer program.



"Finishing my program made me feel like a professional, like I could have a job creating software to do or teach mathematics." **- Hannah**

"I told a friend about my data because I was really excited about the patterns I found. I kept testing values until it crashed." **- Ashley**





"I want to build on what I've learned. I know this is the beginning of what programming can do, and I want to see where it goes." **- Jim**

Which quote do you think best illustrates a sense of empowerment to explore mathematics through programming?

Samples of Student Work

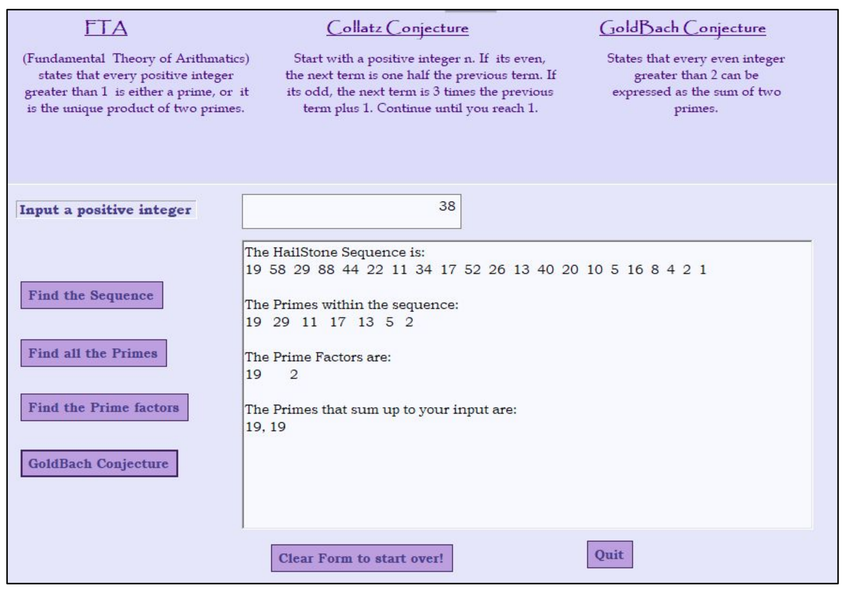


Figure 1: The interface of Hannah's project with sample data. Her conjecture asked whether, if given a composite integer and its hailstone sequence, one could find its prime factors using the Fundamental Theorem of Arithmetic, and its prime composites using the Goldbach Conjecture?

Integer	Hailstone Length	Modified Length	Multiple of 3?	Power of 2?
33	26	Infinite	Yes	No
145	116	11	No	No
836	41	15	No	No
7854	83	Infinite	Yes	No
7411	163	23	No	No
5565	116	Infinite	Yes	No
46552	145	22	No	No
555852	177	Infinite	Yes	No
49844136	80	Infinite	Yes	No
16	4	4	No	Yes
32	5	5	No	Yes
1024	10	10	No	Yes
262144	18	18	No	Yes
67108864	26	26	No	Yes

Figure 2: A sample of Ashley's data table collected using her program, highlighting patterns she discovered in the process. Ashley's exploration compared the hailstone sequence length of an integer, *n*, with the length of a modified sequence: if odd, *n' = 3n*, if even, *n' = n/2*.

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Educating for the 21st Century: Post-secondary Students Learning Computer Programming for Mathematical Investigation, Simulation, and Real-World Modelling

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