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Engaging Elementary Students in Computer Science Education Through Project-Based Learning

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Abstract

As interests and initiatives for accessible computer science education continue to grow, efforts to integrate computer science (CS) instruction into K-12 classrooms in the US are dramatically increasing. Curriculum, legislation, and standards across the nation are quickly evolving as they seek to incorporate CS instruction and related concepts into classrooms in order to make computer science education accessible for all K-12 students. In the state of XXXXX specifically, each public school is required to include computer science in the school's curriculum for students in grades K-12 beginning July 2021 (SEA 172 (2018)) (making it one of only seven states with formal statewide computer science standards). This work in progress describes an effort to provide students and teachers with a developmentally appropriate and engaging project to satisfy this legislative mandate, and introduce young students to related CS concepts within a classroom setting. We describe the 13-week in-class project-based program, including its modules, sequencing and present a student's lived experience through the intervention as they designed, built and automated model clubhouses. Within the classroom setting, students were eager to show off their designs and talk about how they overcame various setbacks, obstacles, and difficulties along the way. An emphasis on these types of challenging activities and the results of this intervention may provide insight into students' perceptions of, and abilities related to computer science and related STEM (Science, Technology and Engineering, and Mathematics) skills, which can aid educators in understanding how to best-prepare students for future success as technologically literate citizens, while helping move them towards a greater interest and engagement in computer science.

Research Objective

Our research objective centered on investigating students' perceptions of Computational Thinking and related STEM skills and careers before, and after, a thirteen-week project-based intervention. More specifically, we followed the experience of students as they engaged in applying acquired knowledge to design, build, and automate a model clubhouse. This work in progress emphasizes the qualitative and quantitative findings of one student's perceptions before and after the thirteen-week project-based program.

Methods

The project-based intervention, referred to as *The SMART Clubhouse Unit*, was implemented within a multi-age 4th and 5th grade classroom of a public elementary school (grades K-5; ages 5-12) located in the XXXX, USA. The class consisted of 24 students (14 males and 10 females), ages 9-11. The research team met with the class during one semester of school for a total of 21, 90-minute class periods over the course of 13 weeks. Lessons and activities took place within the student's regular classroom and a multi-use lab space adjacent to the classroom. All students (n = 24 students) enrolled in the class were included in the outlined intervention, but in line with the nature of this work in progress, the preliminary data presented here includes information detailing only one student, Jamie (pseudonym used for student's privacy).

Prior to beginning the intervention, a modified version of the Student Attitudes toward STEM survey (S-STEM) [1] was created. The S-STEM survey, which collects student data related to thoughts and feelings regarding STEM (Science, Technology and Engineering, and Mathematics) subjects and related careers, was modified to include a section related to computational thinking, in line with our research objectives. The final administered survey (Appendix A) was divided into four sections (Math, Science, Engineering and Technology, and Computational Thinking) and consisted of 45 five-point Likert scale (coded as: Strongly Disagree: -2; Disagree: -1; Neither Disagree or Agree: 0; Disagree: 1; Strongly Agree: 2) questions.

The thirteen-week intervention consisted of pre-surveys, design, build, and automation activities, post-surveys, and semi-structured interviews with randomly selected students and the classroom teacher at the conclusion of the intervention (Appendix B includes a classroom schedule of the intervention). Day 1 of the intervention was used to introduce students to the intervention by showcasing a completed clubhouse (created ahead of time by a researcher). Additionally, the team distributed supplies, and assent and consent forms to students. On Day 2, the research team administered the developed instrument to all students in order to better understand students' initial perceptions of, and abilities related to CS and related STEM skills. In order to protect the identity of students throughout the intervention, unique identifiers for each student were created prior to beginning the intervention; these unique identifiers were used throughout the intervention on all student surveys, educational material, clubhouses, interviews, and consent and assent forms.

All activities used throughout the intervention were self-developed by the team prior to beginning the intervention with students. The intervention itself was divided into two portions: "Architecture & Construction," and "Programming and Automation". Students engaged in activities surrounding the topics of scaling, blueprints, building codes, framing components and proper wall framing techniques as they designed and built their model clubhouse. Halfway through the intervention, students transitioned to the "Programming and Automation" portion of the intervention. Students engaged in activities surrounding the topics of sequencing, physical components, programming basics (if/then statements, loops etc.), sensors and nesting. The last two days of the intervention were used to discuss home manufacturing with students as they added finishings (floors, furniture etc.) to their clubhouses.

At the conclusion of the intervention, students again completed the developed instrument, following the same protocols used for the pre-survey. Additionally, several randomly chosen students were invited to participate in a semi-structured interview with a researcher to discuss their experience throughout the project. In total, nine students were randomly selected to participate, and additional assent and consent forms were obtained. Semi-structured interview procedures [2] were used by a member of the research team who asked the students several open-ended questions (see Appendix C) in an effort to better understand their perceptions of STEM, CS and related topics (e.g., construction). Clarifying questions were asked by the researcher, as needed, to further explore information surrounding the students' experiences.

Findings

Preliminary findings, taken from all associated data sources—both quantitative and qualitative—are presented here in line with several codes that emerged from the data analysis. The survey results for Jamie —both pre- and post-intervention— were compared first to identify any changes and then compared with the emergent codes from the qualitative interviews.

Quantitative Findings.
Jamie's responses were analyzed to find changes from the pre to post survey data (Appendix D includes a table of Jamie's pre- and post-survey responses), and to compare against the average class responses (Appendix E includes a table of Class Pre- and Post-Survey Results for the Computational Thinking questions of the survey). In line with the scope of this paper, we will only report the findings of the Computational Thinking questions (Questions 33-45) of the survey; this emphasis on one section of the modified survey follows our intentions of better understanding Jamie's perceptions of Computer Science before and after the intervention.

Pre-survey data suggested that Jamie had very positive perceptions towards Computational Thinking before beginning the intervention, Agreeing or Strongly Agreeing with all items within this section. Specifically, Jamie "Agreed" (Denoted as "1" in the table) with 4 items on the pre-survey: Question 33: *I can break down large ideas into smaller problems*., Question 35: *When I observe a pattern, I can identify the rules of the pattern*., Question 38: *I can develop instructions for solving a problem or completing a task*., and Question 44: *I can visualize collected data to better understand something*. Additionally, Jamie "Strongly Agreed" (Denoted as "2" in the table) with the other 9 items (Questions: 34, 36, 37, 39, 40, 41, 42, 43, & 45) in the Computational Thinking section of the survey.

Post-survey data revealed however, that Jamie became increasingly uncertain or disagreeable with some of the Computational Thinking items after the intervention. Of the thirteen questions asked within this section, Jamie responded the same or similarly (e.g., changing from Agree to Strongly Agree) to eight of them. There were five questions however, that Jamie had a large change in response to from the pre- to post-survey. These questions are detailed below.

Question 34: I like to find patterns and trends in things. Jamie's presurvey data indicated she "Strongly Agreed" with the above statement. On the postsurvey however, Jamie indicated that she "Strongly Disagreed" with the statement, suggesting a potentially significant negative change. Post survey data revealed that the overall class average did not have a negative change, as counts for each level of agreeableness were the same for pre and post surveys; Strongly Disagree: 1, Disagree: 0, Neither Agree nor Disagree: 6, Agree: 11 and Strongly Agree: 4.

Question 35: When I observe a pattern, I can identify the rules of the pattern. Similar to Q34, Jamie's presurvey data indicated she "Agreed" with the above statement. However, on the postsurvey Jamie indicated that she "Strongly Disagreed" with the statement; this further hints at Jamie feeling less confident in her ability to identify the rules of an observed pattern after the intervention.

When looking at the average class responses as a whole, data revealed that some students had become slightly more unsure of their ability to identify the rules of a given pattern after the intervention. Pre survey data indicated that 1 student Disagreed with the question, while 2 students Neither Agreed nor Disagreed. Post survey data however, revealed increases in these numbers, as 1 student (Jamie) indicated that they Strongly disagreed with the statement, and 4 students Neither Agreed nor Disagreed.

Question 36. I am curious about how computers, machines, and electronic devices work. Jamie's presurvey data indicated she "Strongly Agreed" with the above statement. On the postsurvey however, Jamie indicated that she "Disagreed" with the statement, suggesting that her curiosity towards how computers, machines and electronic devices work, decreased during the time frame covered by the intervention.

When looking at the average class responses as a whole, data revealed that some students' curiosity about how computers, machines, and electronics devices work had decreased after the intervention. Pre survey data indicated that 3 students Disagreed with the question, while 3 students Neither Agreed nor Disagreed with the question. Post survey data however, revealed increases in these numbers, as 1 student indicated that they Strongly disagreed, 5 students Disagreed, and 2 students indicated that they Neither Agreed nor Disagreed with the question.

On several other questions, Jamie's answered changed from "agreed" or "strongly agree" to "neither agree nor disagree" when comparing the pre- to the post-survey. While potentially not as significant, these more subtle changes are similarly worthy of note and potentially hint at larger ways in which Jamie's perceptions of, and skill in, computational thinking was influenced during the intervention. These questions are further discussed/detailed below.

Question 38. I can develop instructions for solving a problem or completing a task. Jamie's presurvey data indicated she "Agreed" with the above statement. On the postsurvey however, Jamie indicated that she "Neither Agree nor Disagree" with the statement, suggesting that she became increasingly unsure of whether she could develop instructions for solving a problem or completing a task.

When looking at the average class responses as a whole, data revealed that some students' perceived abilities of developing instructions for solving a problem or completing a task had also decreased after the intervention. Pre survey data indicated that 2 students Strongly Disagreed with the question, while 7 students Neither Agreed nor Disagreed with the question. Post survey data however, revealed increases in these numbers, as 1 student indicated that they Strongly disagreed, 4 students Disagreed, and 5 students indicated that they Neither Agreed nor Disagreed with the question.

Question 42. I can program something to perform a task. Jamie's presurvey data indicated she "Strongly Agreed" with the above statement. On the postsurvey however, Jamie indicated that she "Neither Agree nor Disagree" with the statement, suggesting that she became increasingly unsure of whether she could program something to perform a task.

When looking at the class average responses as a whole, data revealed that some students' perceived abilities of programming something to perform a task had actually increased after the intervention. Pre survey data indicated that 3 students Disagreed with the question, while 6 students Neither Agreed nor Disagreed with the question. Post survey data however, revealed decreases in these numbers, as 2 students indicated that they Disagreed, and 5 students indicated that they Neither Agreed nor Disagreed with the statement.

Qualitative Findings.
Preliminary findings from the semi-structured interview (questions can be found in Appendix C) with Jamie were used to further explore and understand her perceptions related to computational thinking before and after participation in the thirteen-week intervention. Holistic coding approaches [3] — in which a single code/idea (reflective of the overall idea of its contents) is applied to a unit of data— were used to analyze her responses. (Example of Holistic Code applied to represent data excerpts from student interview can be found in Appendix F.) Below we describe ideas and observations derived from Jamie's interview which may relate to the quantitative findings.

Idea 1: The student faced challenges during the programming portion of the intervention.
Jamie discussed some of her experiences programming, stating:

> *That if one tiny little thing is wrong, your whole entire problem could be wrong…I was using different variables because I thought I didn't have that variable [made]. So then I'd have two different variables and then something wouldn't work for my coding.*

Later in the interview, Jamie mentioned another instance of a challenge faced during programming, stating:

> *So computers don't really ... they don't like listen. If one single thing is wrong, then they can't do beyond that. If you have ... So I kept on messing up on the nesting because I had the forever block with if temp read greater than 35, so the temp read greater than 35 then everything would turn on. But if it wasn't like that, then everything would work below, like everything else would work.*

Jamie's challenges through the programming portion of the intervention may provide insight into the significant changes discussed in the quantitative findings. Jamie's changes in responses (negatively) after the intervention may indicate that the challenge of the tasks presented in the intervention resulted in her becoming increasingly uncertain of her abilities in computational thinking.

Idea 2: Jamie believed she could overcome challenges faced while programming. When asked what her biggest take away from the experience was, Jamie stated that:

> *Even though some things can be hard, you can always figure them out if you try… When we did the doorbell...because I found that kind of hard because I hadn't really had any experience with coding. And so, I thought that was kind of hard. But then I figured out at the end that it was actually easier than I told myself it was… I'm a little better at [coding] than I was when I started because I've learned so many new things about it.*

These statements, made by Jamie, may help to reinforce responses to several questions on the post-survey; for example, Jamie's post-survey data indicated that she "Strongly Agreed" with Questions 41 (*I believe that girls/boys can be good at computational thinking)* and she "Agreed" with Question 45 (*I believe I can be successful in computational thinking).* Despite the challenges she faced during the process of automating her clubhouse, Jamie's interview suggests that this had not significantly impacted her perception of her ability to "be good at" or "succeed" in computational thinking.

Idea 3: Jamie was able to explain computational thinking principles. When asked what was something that she learned about technology while working on this project, Jamie demonstrated an understanding of computational thinking principles as she responded:

> *Computers don't really tell you if an apple or a orange is better. They more follow like the commands, like in code and it's not on or off, it's one or zero… Like if you walk up to a computer and you ask, 'Which is better an apple or an orange? They can't just tell you that.*

These responses demonstrate a fundamental understanding of elements of logic which need to be in place for a computer to execute a command - an important finding given the trending negativity in several of her responses to questions around computational thinking on the post-survey.

Discussion & Conclusion

For this work and progress, we specifically investigated the experience of Jamie - one student enrolled in a 4th/5th multi-age class in a midwestern elementary school. Interestingly, Jamie's interview responses suggested that she developed, matured, and improved in her own computational thinking skills. Further, her perceptions of her own ability--as derived through a thematic analysis of her interview responses--suggest she was increasingly confident in her own capacity to perform computational thinking tasks. However, when compared with her responses to the modified S-STEM questionnaire, Jamie was not as confident as the interview themes would suggest. For example, on several questions Jamie's pre- and post-study questionnaires responses demonstrated a negative trend (towards less confidence in her own capacity to accomplish computational thinking tasks). While a perfect understanding of Jamie's experience is beyond the scope of our efforts, we believe these findings are significant and may serve as a starting point for additional efforts in this area. If students "enjoy" computational thinking experiences, projects, and interventions why would their perceptions of confidence in these areas go down? What aspect of Jamie's experience led to these marked decreases in confidence and were they related directly to the intervention or something else?

As interests and initiatives for accessible computer science education continue to grow, efforts to integrate computer science (CS) instruction into K-12 classrooms in the US are dramatically increasing. This work in progress, which described Jamie's experiences with one such effort may provide insight into future efforts around students' perceptions of, and abilities related to computational thinking and related CS skills. Further analysis is still needed to identify changes in the remaining class member's perceptions before, and after, the intervention. We hope these results from our work in progress will foster further research, effort, and conversation around these topics.

References

[1] Friday Institute for Educational Innovation (2012). *Student Attitudes toward STEM Survey-Upper Elementary School Students,* Raleigh, NC: Author.

[2] Berg, B. (2009). *Qualitative research methods for the social sciences*. New York, NY: Pearsons://doi.org/10.1145/2677087

[3] Saldaña, J. (2013). *The coding manual for qualitative researchers* (Second ed.). London: SAGE.

Sea 172

Appendix A
Modified S-STEM Survey

Directions: There are lists of statements on the following pages. Please mark your answer sheets by marking how you feel about each statement. For example:

Example 1:	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
I like engineering.	○	○	○	○	○

As you read the sentence, you will know whether you agree or disagree. Fill in the circle that describes how much you agree or disagree.

Even though some statements are very similar, please answer each statement. This is not timed; work fast, but carefully.

There are no "*right*" or "*wrong*" answers! The only correct responses are those that are true *for you*. Whenever possible, let the things that have happened to you help you make a choice.

PLEASE FILL IN ONLY ONE ANSWER PER QUESTION.

Math

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
1. Math has been my worst subject.	○	○	○	○	○
2. When I'm older, I might choose a job that uses math.	○	○	○	○	○
3. Math is hard for me.	○	○	○	○	○
4. I am the type of student who does well in math.	○	○	○	○	○
5. I can understand most subjects easily, but math is difficult for me.	○	○	○	○	○
6. In the future, I could do harder math problems.	○	○	○	○	○
7. I can get good grades in math.	○	○	○	○	○
8. I am good at math.	○	○	○	○	○
9. I believe that boys can be good at math	○	○	○	○	○
10. I believe that girls can be good at math	○	○	○	○	○

Science

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
11. I feel good about myself when I do science.	○	○	○	○	○
12. I might choose a career in science.	○	○	○	○	○
13. After I finish high school, I will use science often.	○	○	○	○	○
14. When I am older, knowing science will help me earn money.	○	○	○	○	○
15. When I am older, I will need to understand science for my job.	○	○	○	○	○
16. I know I can do well in science.	○	○	○	○	○
17. Science will be important to me in my future career.	○	○	○	○	○
18. I can understand most subjects easily, but science is hard for me to understand.	○	○	○	○	○
19. In the future, I could do harder science work.	○	○	○	○	○
20. I believe that boys can be good at science	○	○	○	○	○
21. I believe that girls can be good at science	○	○	○	○	○

Engineering and Technology

Please read this paragraph before you answer the questions.

***Engineers** use math and science to invent things and solve problems. Engineers design and improve things like bridges, cars, machines, foods, and computer games. **Technologists** build, test, and maintain (or take care of) the designs that engineers create.*

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
22. I like to imagine making new products.	○	○	○	○	○
23. If I learn engineering, then I can improve things that people use every day.	○	○	○	○	○
24. I am good at building or fixing things.	○	○	○	○	○
25. I am interested in what makes machines work.	○	○	○	○	○
26. Designing products or structures will be important in my future jobs.	○	○	○	○	○
27. I believe that boys can be good at engineering and technology	○	○	○	○	○
28. I want to be creative in my future jobs.	○	○	○	○	○
29. Knowing how to use math and science together will help me to invent useful things.	○	○	○	○	○
30. I believe I can be successful in engineering.	○	○	○	○	○
31. I am curious about how electronics work.	○	○	○	○	○
32. I believe that girls can be good at engineering and technology	○	○	○	○	○

Computational Thinking

Please read this paragraph before you answer the questions.

Computational Thinking *is a problem-solving process that is used in many areas such as developing computer applications. Those who work with computational thinking may program a device to perform a function, develop a program to play a video game, or automate (make something happen without human help) a process.*

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
33. I can break down large ideas into smaller parts	○	○	○	○	○
34. I like to find patterns and trends in things.	○	○	○	○	○
35. When I observe a pattern I can identify the rules of the pattern.	○	○	○	○	○
36. I am curious about how computers, machines, and electronic devices work.	○	○	○	○	○
37. I feel good when I design or make something that uses technology.	○	○	○	○	○
38. I can develop instructions for solving a problem or completing a task.	○	○	○	○	○
39. I can use models and simulations to see how things work.	○	○	○	○	○
40. I like to collect data to help me make a decision.	○	○	○	○	○
41. I believe that girls can be good at computational thinking	○	○	○	○	○
42. I can program something to perform a task.	○	○	○	○	○
43. I believe that boys can be good at computational thinking	○	○	○	○	○
44. I can visualize collected data to better understand something.	○	○	○	○	○
45. I believe I can be successful in computational thinking.	○	○	○	○	○

Appendix B
Classroom Schedule for the Intervention

Topic	Day	Class Schedule
Introduction/ Setup	1	• Introduce project, overview/ purpose, show clubhouse • Consent/assent forms
	2	• Pre-Questionnaires • Smart Homes (architecture, trends, needs) • Brainstorming Ideas- what could my clubhouse look like?
Architecture / Construction	3	• What's the process of creating a building from start to finish? • What are blueprints? • Scaling activity • Floor Plans
	4	• Proper Wall framing guidelines- why do we have building codes? • Framing basics (wall, window, door) • Wall Framing stations
	5	• Model supplies, scale, plans • Review safety • Begin framing base
	6	• Framing Workday (Wall 1)
	7	• Workday (Wall 2)
	8	• Workday (Wall with door)
	9	• Workday (Wall with window)
	10	• Finish building Walls • Assemble clubhouse
Computer Programming & Automation	11	• Programming basics • Robot cup stacking activity • Directions Packet o conditional statements (if/then)
	12	• Components (physical) o LEDs, Motors, Wires, Sensors & circuits
	13	• Micro:bit basics o Start/Wait, Loops, Conditionals (if/then), High/low (on/off), input/output & variables

	14	• Programming Doorbell
		    o Touch sensor
		    o Buzzer/Tone

	15	• Programming LED Light
		    o Light sensor
		    o LED

	16	• Programming Thermostat and Fan
		    o OLED screen
		    o Fan
		    o Temperature sensor

	17	• Introduction to Nesting
	18	• Nesting Workday
	19	• Nesting Workday
Manufacturing	20	• Manufacturing processes, materials, & automation • Home manufacturing: Siding, brick, finishing • Workday Thingiverse / TinkerCAD
Wrap-Up	21	• Review projects- what did we learn? • Post Questionnaires • Interviews

Appendix C
Semi-Structured Interview Questions for Students

1) Tell me about your experience with the SMART clubhouses project
    - What did you like, dislike, etc.?
    - What was hard, easy, fun, exciting, challenging?
2) What did you learn about **Science** while working on this project?
    - Would you consider a career in **Science** after an experience like this?
3) What did you learn about **Math** while working on this project?
    - Would you consider a career in **Math** after an experience like this?
4) What did you learn about **Technology** while working on this project?
    - Would you consider a career in **Technology** after an experience like this?
5) What did you learn about **Engineering** while working on this project?
    - Would you consider a career in **Engineering** after an experience like this?
6) What did you learn about **Computer Science** while working on this project?
    - Would you consider a career in **Computer Science** after an experience like this?
7) What did you learn about **Construction** while working on this project?
    - Would you consider a career in **Construction** after an experience like this?
8) Can you see yourself using any of this information again?
9) Is there anything else you would like to share with me about this experience with the Smart Clubhouses?

Appendix D
Jamie's Pre- and Post-Survey Results

Category	Question	Pre-Survey					Post-Survey				
		-2	-1	0	1	2	-2	-1	0	1	2
Mathematics	Q1		X						X		
	Q2					X		X			
	Q3		X							X	
	Q4				X		X				
	Q5			X						X	
	Q6				X				X		
	Q7					X		X			
	Q8				X				X		
	Q9					X					X
	Q10					X					X
Science	Q11					X					X
	Q12				X						X
	Q13			X							X
	Q14				X						X
	Q15				X					X	
	Q16					X					X
	Q17			X							X
	Q18	X					X				
	Q19				X						X
	Q20					X					X
	Q21					X					X
Engineering and Technology	Q22					X			X		
	Q23					X			X		
	Q24				X					X	
	Q25					X		X			
	Q26					X	X				
	Q27					X					X
	Q28					X				X	
	Q29					X			X		
	Q30					X		X			
	Q31					X			X		
	Q32					X					X
Computational Thinking	Q33				X					X	
	Q34					X	X				
	Q35				X		X				
	Q36					X		X			
	Q37					X				X	
	Q38				X				X		
	Q39					X					X
	Q40					X					X
	Q41					X					X
	Q42					X			X		
	Q43					X					X
	Q44				X					X	
	Q45					X				X	

Appendix E
Class Pre- and Post-Survey Results: Computational Thinking

		Pre-Survey					Post-Survey				
		-2	**-1**	**0**	**1**	**2**	**-2**	**-1**	**0**	**1**	**2**
Overall	**Q33**	0	2	4	14	2	0	2	3	14	3
	Q34	1	0	6	11	4	1	0	6	11	4
	Q35	0	1	2	14	5	1	0	4	13	4
	Q36	0	3	3	8	8	1	5	2	7	7
	Q37	0	1	5	6	10	0	2	2	9	9
	Q38	2	0	7	11	2	1	4	5	9	3
	Q39	0	2	7	6	7	2	2	5	9	4
	Q40	0	2	7	10	3	1	1	7	9	4
	Q41	0	0	2	3	17	1	0	2	5	14
	Q42	0	3	6	10	3	0	2	5	9	6
	Q43	1	0	2	5	14	1	0	1	7	13
	Q44	0	2	6	10	4	0	3	5	11	3
	Q45	1	1	5	8	7	1	0	3	12	6
Boys	**Q33**	0	2	3	6	1	0	2	1	8	1
	Q34	1	0	3	6	2	0	0	1	9	2
	Q35	0	1	1	7	3	0	0	2	9	1
	Q36	0	2	1	6	3	0	2	1	3	6
	Q37	0	0	3	4	5	0	1	1	4	6
	Q38	2	0	4	5	1	0	4	3	3	2
	Q39	0	2	4	2	4	0	2	4	5	1
	Q40	0	0	4	7	1	0	0	5	6	1
	Q41	0	0	2	1	9	1	0	2	3	6
	Q42	0	2	3	7	0	0	1	4	6	1
	Q43	0	0	2	1	9	1	0	1	4	6
	Q44	0	1	5	4	2	0	2	4	6	0
	Q45	1	0	3	4	4	1	0	1	8	2
Girls	**Q33**	0	0	1	8	1	0	0	2	6	2
	Q34	0	0	3	5	2	1	0	5	2	2
	Q35	0	0	1	7	2	1	0	2	4	3
	Q36	0	1	2	2	5	1	3	1	4	1
	Q37	0	1	2	2	5	0	1	1	5	3
	Q38	0	0	3	6	1	1	0	2	6	1
	Q39	0	0	3	4	3	2	0	1	4	3
	Q40	0	2	3	3	2	1	1	2	3	3
	Q41	0	0	0	2	8	0	0	0	2	8
	Q42	0	1	3	3	3	0	1	1	3	5
	Q43	1	0	0	4	5	0	0	0	3	7
	Q44	0	1	1	6	2	0	1	1	5	3
	Q45	0	1	2	4	3	0	0	2	4	4

Appendix F
Example of Holistic Code applied to represent data excerpts from student interview