

Curricula Analysis and Field Study Design and Publication

Final Report

Spring 2018

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COMS 3998 W 028

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# Abstract

Our goal for this project was to implement a means of data collection and analysis to better improve the SAGE's (Social Addictive Gameful Engineering) user-centered design aspect within the "Gameful Affinity Space" and "Field Study Design and Publication Strategy" epics, in particular, Curricula Integration, Learning Metrics, and SAGE Feasibility Study. In this report we will describe the progress made in the Sage Feasibility Study and Publication, Curricula Integration, and Gameful Direct Instruction epics. The features and stories we have completed so far are the Parson's Puzzle Library (26), Curricula Analysis (27), User Centered Design | codeHER (325), Semi-Structured Interview Protocol (347), Survey and Distribution Plan (341), IRB Training and Conflict of Interest Document (356), Pre-distribution Volunteer/Teacher Survey (366), and Curriculum Presentation (30). Feasibility Publication (340) is currently underway.

# Introduction

Our motivation for this project is to update the way students interact with SAGE's UX/UI as well as a concentrated effort to gather and analyze student and teacher feedback. We want to incorporate user feedback analysis when implementing SAGE's features to better present its mission of infusing computational thinking in 6-8 curricula. We are motivated by the need to bring SAGE out into the real world into diverse classrooms, preparing surveys and setting up parameters to make the best use of experimentation time. This data will help both the team members working on various epics throughout future semesters as well as help gauge current attitudes towards the work that has been done in the past with SAGE. Within the Field Study Design and Publication Strategy epic, meanwhile, we will collect and analyze user feedback from volunteers, teachers, and students before and after classroom sessions, ensuring seamless integration along the way.

In this report we will describe the completed tasks made in the Sage Feasibility Study and Publication, Gameful Affinity Space, Curricula Integration, and Gameful Direct Instruction epics.

## Related Work

### 2.1) Hour of Code Impact Studies

Code.org, a digital playground with the mission of expanding access to computer science in schools and increasing participation by women and underrepresented minorities with online gameful instruction, releases its impact studies on the research portion of its website [4]. The page assess the impact of Hour of Code programs, a global movement by Computer Science Education Week and Code.org reaching tens of millions of students in 180+ countries through a one-hour introduction to computer science and computer programming. The website details its user count, number of hours students spent on their learning materials, analysis of quantitative and qualitative data about the projects, as well keeping an emphasis on demographic information. On the research portion of their website, this data is presented and areas for improvement are identified.

#### I like computer science

When examining the largest changes from pre- to post- for the statement, “I like computer science”, the findings suggest that female students’ attitudes towards computer science were the most positively impacted by the Hour of Code activities.

Table: 5 largest increases in perception shift for “I like computer science”

Student Gender	Age Group	Prior Experience	N	Pre Hour of Code likert-scale rating	Post Hour of Code likert-scale rating	Absolute change in % who agree
Female	High school	Never done an Hour of Code	158	2.42	2.78**	20.3%
Female	High school	All	265	2.59	2.88**	17.7%
All	High school	Never done an Hour of Code	513	2.64	2.91**	11.1%
Female	All	Never done an Hour of Code	644	2.76	3.06**	10.1%
Female	Middle school	Never done an Hour of Code	286	2.66	2.98**	9.4%

Figure 2.1: Data from “The Hour of Code: Impact on Attitudes Towards and Self-Efficacy with Computer Science”

One of the most interesting observations appears to corroborate the hypothesis that an exposure to informatics since the early age is important to attract students independently from their gender. Findings showed that after completing one Hour of Code activity students report liking computer science more, feel that they are better able to learn computer science, and are better at computer science than their peers.

Below is a graph representation created by Stanford researcher Chris Piech evaluated the various computer programs that students submitted to two computer programming puzzles from our popular Hour of Code tutorial, which is better viewed upon visiting the website as it is an animation: <http://stanford.edu/~cpiech/demos/research/blossoms.html>. This graphic shows 509,405 students solving the third challenge in the code.org hour of code, where the pink dots are students, and the bigger the dot the more number of students did the problem. The black dots are partial solutions. The node where students turn green is the correct answer. Only the top 200 most common partial solutions (out of 10,293) are shown, and the graphs displays students move from one partial solution to the next as they try to get to the answer while the black lines are what experts say students should do. Their research team is trying to show how you can discover the expert policy just by observing how students move about the space of partial solutions[8].



Figure 2.2: Data from 2 puzzles from Hour of Code 2013 [8]

## 2.2) An Emergent Approach for Studying Serious Games

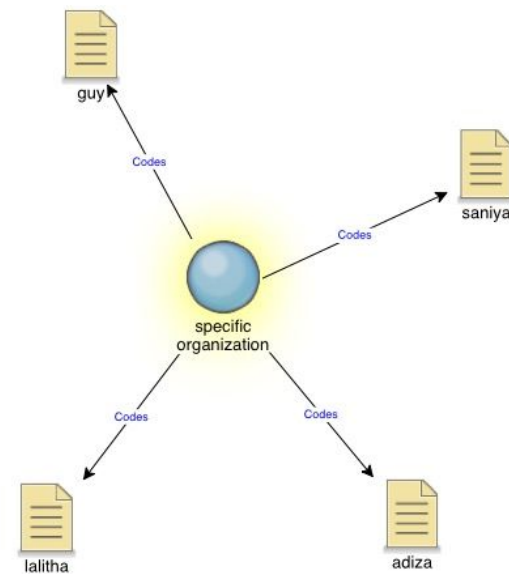
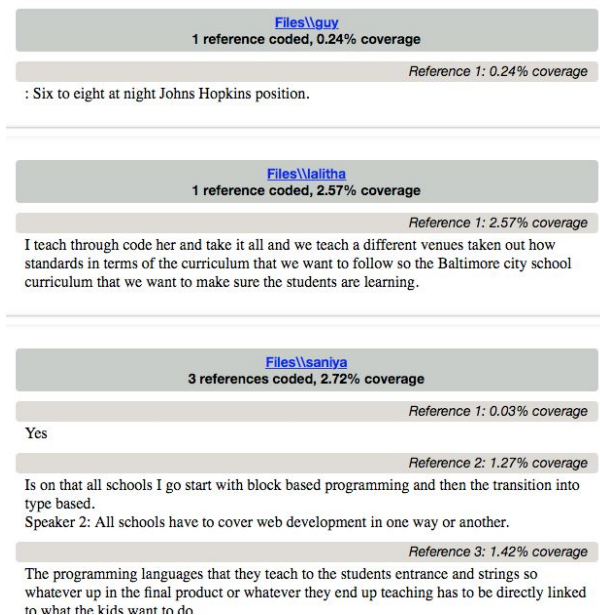


Figure 2.3: Aggregated data and visualizations from NVIVO transcript analysis

Much of the field work format was grasped from the research from Matthew Sharritt's *Serious Educational Game Assessment* (SEGA.) Much of his work chronicles his techniques for qualitative analysis surrounding the user experience for game players. Sharritt emphasized open ended inductive experiments to then begin deductive hypothesis testing. In his methods, the research and the researcher's hypothesis dictate or predetermine what is most important.

He goes on to take from many different fields such as ethnomethodology and, a crowd favorite, grounded theory which is heavily utilized in the Field Studies analysis work. Matthew further describes his work to be something that is a "hybrid" in guiding researchers to find patterns in participant behavior and measure engaging learning experiences.

## 2.3) Khan Academy

Khan Academy is an online learning platform geared towards democratizing education by making it more accessible via instructional videos. Similar to SAGE, Khan Academy has an instructor dashboard where teachers can assign lectures and delegate assignments to their students. In delegating assignments, instructors can toggle between subjects. Within each subject, instructors have the ability to assign entire sections or certain subsections across different sections. This grants instructors freedom to mix and match different parts of the curriculum to assign to the students. The user interface consists of a drop-down tree menu and checkboxes for the options.

Content
Assignments
Progress
Activity
Roster
Settings

Chemistry
Assign

Atoms, compounds, and ions

Chemistry is the study of matter, and all matter is made up of atoms. We will learn about elements, atomic number and mass, isotopes, moles (chemistry moles, not the animal), and compounds.

Introduction to the atom

In chemistry, we will often be thinking about the world on a much smaller scale than you can see with the naked eye. Here we will learn about atoms and elements, tiny particles that make up the world around us. What are atoms, and what kind of properties do they have? How do we weigh and count atoms? We will answer those questions in this section!

Ions and compounds

Atoms can lose or gain electrons to form ions, or combine in specific ratios to form compounds. In this tutorial we will learn about how ions and compounds are formed, visualized, and measured.

Names and formulas of ionic compounds

Anions and cations can combine to form ionic compounds such as sodium chloride (table salt) and sodium bicarbonate (baking soda). In this tutorial, we will be learning how to name ions and ionic compounds from the formula, and how to find the formula from the compound name.

Quiz 1 • See student view

- Introduction to the atom
- Ions and compounds
- Names and formulas of ionic compounds

Quiz • 5 questions

Mass spectrometry

Learn how mass spectrometry can be used to detect isotopes, atoms of the same element with different numbers of neutrons.

Unit test • See student view

Test your student's understanding on Atoms, compounds, and ions.

Unit test • 9 questions

## Accomplishments

This semester, we focused on preparing to bring SAGE into the classroom in the most effective way, partnering with other organizations that would find SAGE relevant to their coursework, visiting these sites and conducting interviews, and analyzing the data gathered.

### 3.1 Instructor Dashboard - Mission Management

This semester, we aimed to revamp the Instructor Dashboard to better present computational thinking concepts. We modeled the UI off of Gavi Rawson's wireframes [2].



**SAGE**

## Create Mission

Mission Name

Mission Description

Backstory for the Mission

Please select the Focus of this mission from below

Sequences	Conditionals	Loops
Problem Statements Instructions Recipe Algorithms	Dynamic Sequences Boolean Logic If If/Else	Samples Instances Repeating Sequences Looping Forever Conditional Looping

Reset
Save
Add New Focus

user =

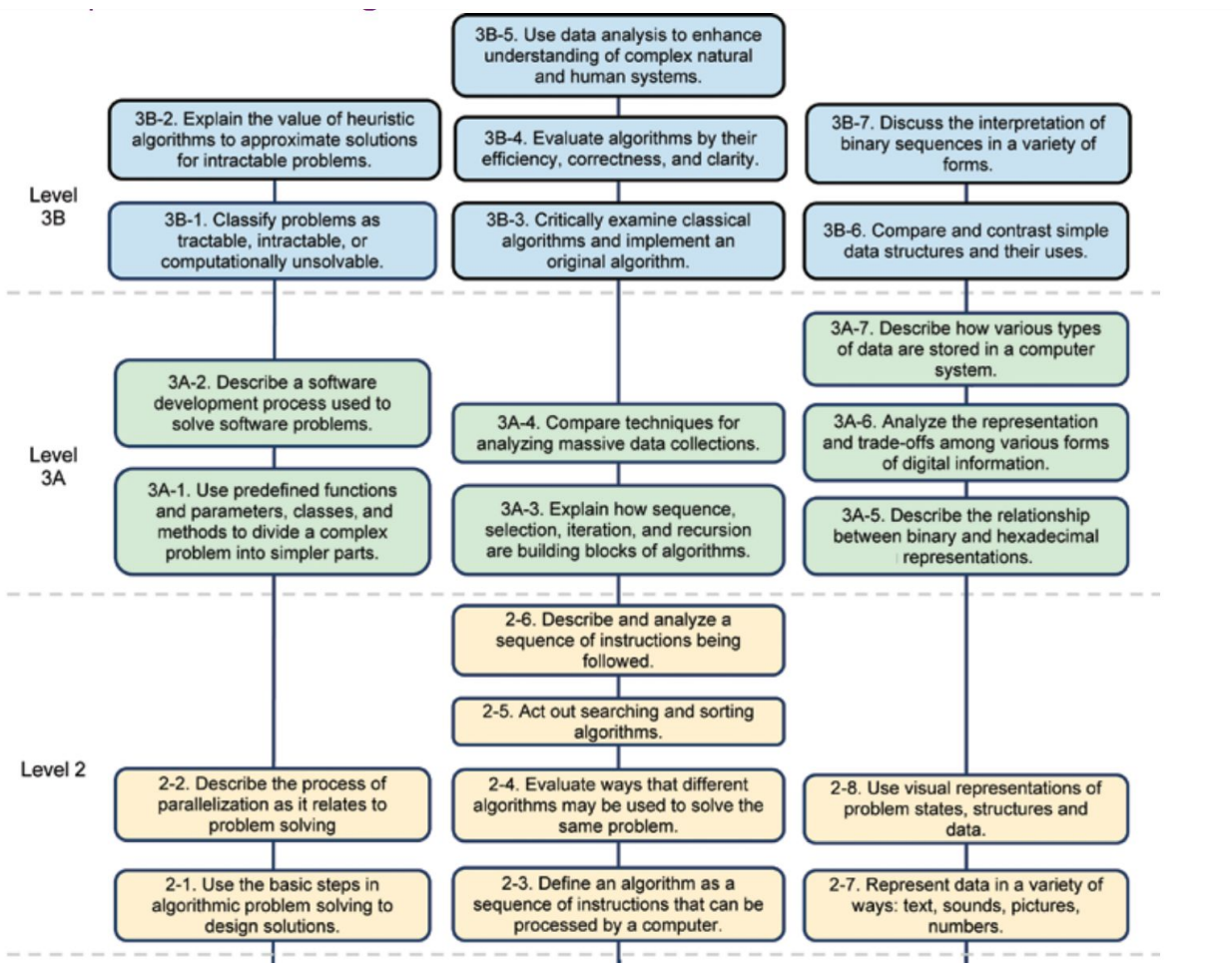
Moving away from the traditional tree structure, the presentation of the computational thinking concepts was separated into a list structure. On hover, a description of each concept appears which reinforces the curriculum within the dashboard. Code written for the instructor dashboard thus far has been included below:

```

<? instructor_addFocus.html x
1  <form novalidate class="simple-form" name="LPform">
2    <div class="c1">
3      <div></div>
4      <div class="head1">
5        <h2>Add New Focus</h2>
6      </div>
7
8      <input type="text" name="AFconcept" ng-model="AF.concept" placeholder="Computational Thinking Concept" ng-required="true"/><br />
9      <input type="text" name="AFitem" ng-model="AF.item" placeholder="Curricular Item" /><br />
10     </div>
11     <button ng-click="submitForm()" value="Save" >Save</button>
12  </form>

```

## 3.2 Curricula Analysis




Before going into classrooms, we compiled a list of computational thinking standards across the United States and noted similarities and differences within each state's official procedures in order to better understand the needs of teachers when we do receive responses regarding the direction of Scratch. These standards are currently stored within the Field Study and Design Publication 2018 google drive folder, with various graphics such as the one above included in order to better-visualize the national standards we hope to align and improve with the use of SAGE.

## 3.3 IRB Training and Protocol

### 3.3.1 IRB Documentation

The Institutional Review Board (IRB) is an administrative body established to protect the rights and welfare of human research subjects recruited to participate in research activities conducted under the auspices of the institution with which it is affiliated. In order to conduct studies on-site with human subjects, a few members within SAGE have gone through the training and approval process, which takes roughly one to two hours per researcher to complete. The field studies we conduct as well as the materials we use in conducting the studies must closely follow IRB protocol and thus several iterations of the IRB protocol have been underway in terms of solidifying specific questions, interview personnel and the environment in which the interview must take place. Throughout the progression of these changes and decisions, the protocol has been tracked and amended on RASCAL and the documents used were regularly uploaded and updated so expedited review process could be granted. SAGE therefore currently has expedited IRB approval for its fieldwork.



## RASCAL Human Subjects

[Logout](#) | [Help](#) | [Human Subjects](#) | [Animal Care](#) | [Proposal Tracking](#) | [Consent Forms](#) | [HIPAA Forms](#) | [Haz Mats](#) | [Administration](#) | [Training Center](#) | [Conflict of Interest](#) | [My Rascal](#)

**IRB-AAAR7711**  
**Status: Approved**


**Attachments**  
HIPAA Forms

**Protocol Actions**  
Copy Protocol  
File New Protocol-Specific COI


**Protocol View**  
Print Menu  
View Datasheet  
View History  
Add Correspondence  
View Correspondence

**Human Subjects**  
Protocol Overview

<b>Abbreviated title</b>	SAGE   Feasibility Study	<b>Protocol Number</b>	AAAR7711
<b>Originating Department</b>	ENG Computer Science (521300X)	<b>Protocol Initiator</b>	Jeffrey Bender (jrb2211)
<b>Protocol Year</b>	1 Modification 00	<b>Date Created</b>	02/11/2018 10:12:17
<b>Principal Investigator</b>	Gail Kaiser (gek1)	<b>You are</b>	Lalitha Madduri (lm3302)

**Attach Documents**  
Help   
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View Document	File Name	Document Type	Date Attached	Attached I
<a href="#">Email Content</a>	feasibility_recruitment_email.pdf	Recruitment Material	04/14/2018	Jeffrey Bender
<a href="#">SAGE Primer for Recruitment (revised)</a>	sage__primer.pdf	Recruitment Material	04/14/2018	Jeffrey Bender
<a href="#">SAGE Primer for Recruitment</a>	sage_primer.pdf	Recruitment Material	04/07/2018	Jeffrey Bender
<a href="#">Semi-structured Interview Protocol Questions</a>	Semi-structured Interview Protocol Questions.pdf	Study Material/Instrument	03/22/2018	Lalitha Madduri
<a href="#">Teacher Survey</a>	Teaching and Learning with Scratch - Google Forms.pdf	Study Material/Instrument	03/14/2018	Jeffrey Bender

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In finalizing the IRB Protocol, certain systems such as medium of contact and informed consent policies had to be established. For example, grounded theory, a general way of thinking about conducting qualitative research that describes, either explicitly or implicitly, the purpose of the qualitative research, the role of the researcher(s), the stages of research, and the method of data analysis, is being used to gain specific insights on user feedback from volunteers, instructors and students. The largest factor in establishing an analysis on qualitative data surrounds selecting what qualifies for further analysis and what does not. The selection of the most frequently occurring patterns are those that may qualify for further investigation. In particular our tool of choice happened to be the qualitative analysis tool NVivo.

### 3.3.2 Distance Partnership with codeHER and TeCanal

In conducting in-person field studies, two student-run nonprofits that teach computer science to a varied demographic of youths, both incorporated and located within Maryland. Field studies will be conducted in the outreach venues through which these nonprofits operate.

CodeHER is a non-profit organization that aspires to close the gender gap in computer science by targeting girls in their late elementary and middle school years. All of our programs have one goal: to expose girls to technology and spark a passion in engineering that stays with them throughout their high-school and college years. CodeHER utilizes websites such as Code.org in order to manage classrooms and teach computational thinking skills, and dabbles in using Scratch, Python, and Blockly.

TeCanal is also a student-founded nonprofit organization tackling the issues of poor STEM education and lack of access to technology in low-income communities. As its name suggests, Te(ch)Canal aims to be a “canal”, or link, between technology and the communities that will benefit from it, connecting youth in all communities together in pursuit of a unified goal: STEM education for all. TeCanal mainly teaches computational thinking through Scratch and Code.org’s Hour of Code modules in simplified lessons. The target demographics include children of all genders, individuals with disabilities, low-income minorities, and immigrants ranging from elementary school-middle school. The teachers thus have more problems to tackle

than simply teaching computational thinking, but their experience is extremely valuable in ensuring that SAGE is an inclusive platform that addresses issues in various communities.

## 3.4 Survey Development and Distribution

### 3.4.1 Pre-Distribution Survey

Before we began distribution and development of the formal survey we will be sending out for the purposes of using within the publication, we created and distributed a pre-distribution survey and the SAGE official survey for teachers and volunteers through codeHER and TeCanal. The pre-distribution survey was developed by referencing the UCD HURIE literature as well as a compilation and analysis of CT curriculum standards across US public schools to give the researchers a bit of foresight before the distribution of the survey in order to examine sample responses regarding the way teachers approach CT lessons.

### 3.4.2 Teaching and Learning with Scratch Survey

The survey itself was adapted by Jeff, Johan, our team, and others in the group in order to assess educators teaching styles, familiarity with Gameful Learning and overall impression of Scratch as a tool to use in education computational thinking. The survey aims to surface opportunities for improving teaching and learning with Scratch with a focus on grade 6-8 students. The responses are reported in an aggregated and anonymized manner regardless of whether identifying information is provided. The South Bronx Early College Academy teachers, who SAGE partnered with to conduct semi-structured interviews and user centered design sessions this semester, all took part in this survey, as well as various student teachers from non-school-affiliated organization.

The distribution of this survey began in February, but currently it has been incentivized and pushed to various Columbia computer science organizations, Facebook groups, e-mailing lists, and beyond in order to reach the goal of garnering 200 responses so that proper statistical analysis can be done on the data for the publication. The survey is currently at around forty responses, including all versions distributed.

### 3.5 Semi-Structured Interviews

Semi-structured interview protocol was developed by researchers who had experience teaching computational thinking to children through various organizations. These interviews employed questions that elaborated on the Teaching and Learning with Scratch survey, drawing upon the personal experiences of each interviewee to see if SAGE's features would be received by current teachers with positive feedback. The interview questions spanned instructional paradigm, gameful learning, formative assessment, summative assessment, and a call to action. The direction in which the interviewer wanted to take these questions was up to them, making each interview unique in its delivery and information gathered. The questions used can be found in the google drive as well as the RASCAL page.

Following the distribution of the pre-distribution survey and survey, field studies comprising one-on-one semi-structured recorded interviews were initiated in the codeHER and TeCanal classrooms in Maryland as well as remotely. During this time, seven or eight full-length interviews were completed, some recorded through a microphone and others transcribed if the interviewee did not provide consent to record the session. Within this timespan, we were able to get interviews from individuals who taught through TeCanal, codeHER, Girls Who Code, and independent tutors. After the semi-structured interviews in codeHER and TeCanal were completed and analyzed without much breadth, various researchers visited the South Bronx Early College Academy to conduct one-on-one semi-structured interviews with teachers from the school. These interviews lasted, on average, 30-45 minutes. As a whole, instructors were hopeful of the direction SAGE was going in and eager to use the features that SAGE is currently implementing, especially intelligent hinting and class creation and management.

### 3.6 User-Centered Design Sessions

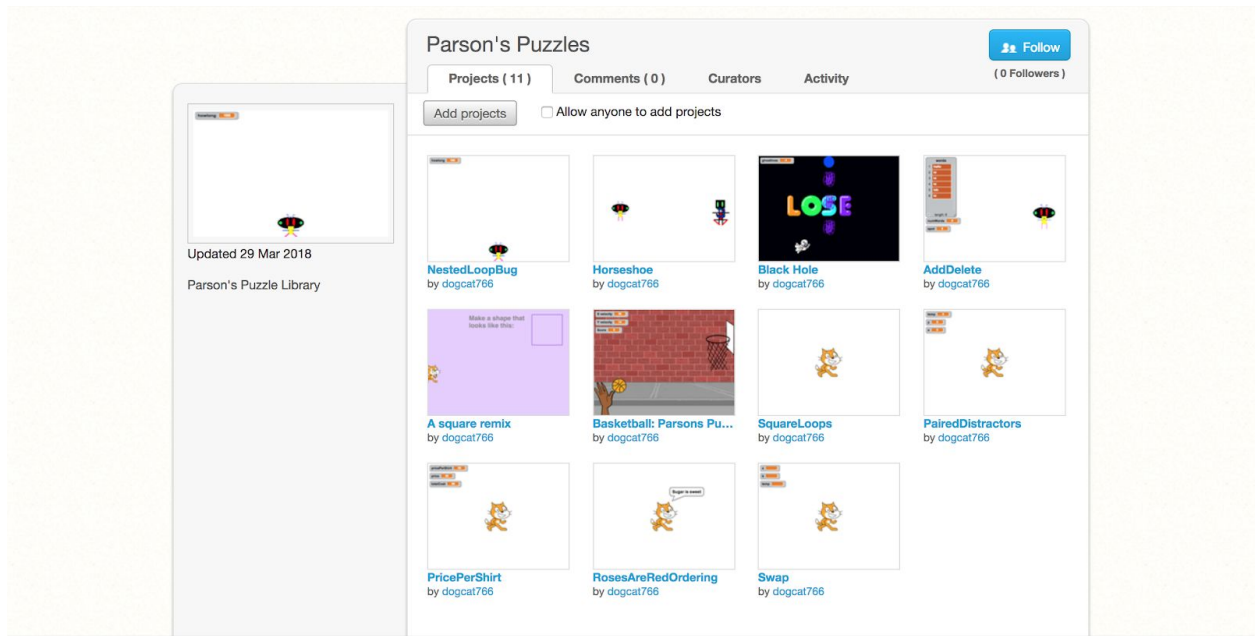
User-centered design is an iterative design process in which designers focus on the users and their needs in each phase of the design process. UCD calls for involving users throughout the design process via a variety of research and design techniques so as to create highly usable and

accessible products for them, while our user-centered design process was developed from the HURIE method [8]. User-centered design sessions included a pre-prepared course to take the interviewee through the SAGE instructor and student dashboard, exploring SAGE's features while getting real-time feedback on which features they would or would not use. The basic skeleton used for the UCD sessions is included in the feasibility report google drive folder.

The demonstrations in UCD sessions are limited by the bugs present in the instructor dashboard on the developer website. When we conducted UCD, we emphasized the working portions as well as the potential that some of the in-progress tools, such as intelligent hinting, have. UCD sessions were conducted with the CEO and COO of codeHER, the CEO of TeCanal, two of the researchers within this group, experienced TeCanal volunteers, and a Columbia student well-versed in teaching Scratch at a coding bootcamp for children. After these initial sessions, the researchers conducted an hour-long UCD session with the SBECA teachers, exploring the student and instructor dashboard and fielding questions and suggestions for the framework. In total, around five UCD sessions were done with varying group size, with overwhelmingly positive feedback towards SAGE's features. Aspects that teachers liked as a whole were the class creation and management features, the instruction blocks, the ability to limit the palette, and the prospect of a video library for independent student tutorials and learning.

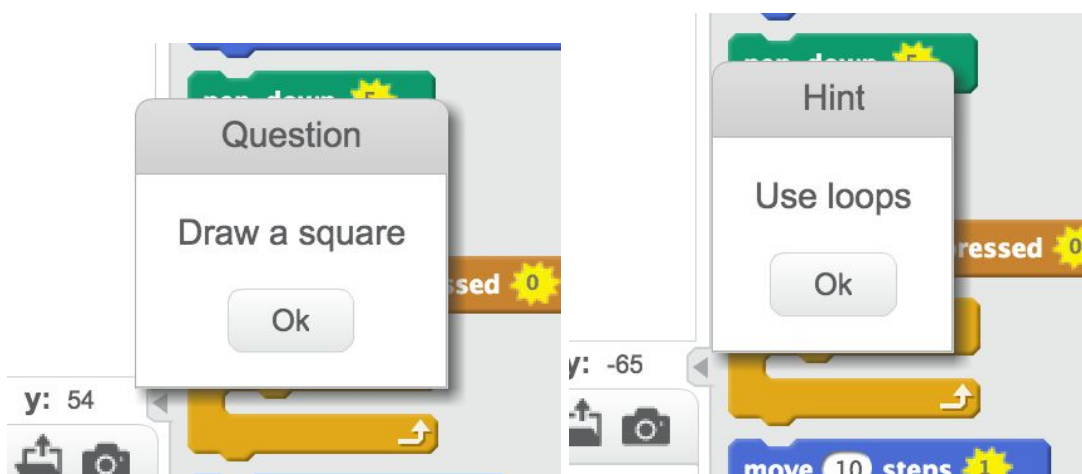
### 3.7 Parson's Puzzle Library

In a Parsons puzzle, the student is provided scrambled code and asked to reassemble the program based on a problem specification. Parson's Puzzles were created within the affinity space and quests on the instructor dashboard in design mode to build a gameful direct instruction library and use as demonstrations when time comes with further UCD sessions. These puzzles are created referencing literature as well as a thorough compilation and analysis of the computer science curriculum state standards across the United States. Parson's Puzzles are being built such that they are embedded within SAGE. The puzzles are created in design mode with their purpose and answers documented in a separate document and saved as .sb2 files. This puzzle library aims to hit various CT concepts, such as looping, conditionals, and more.



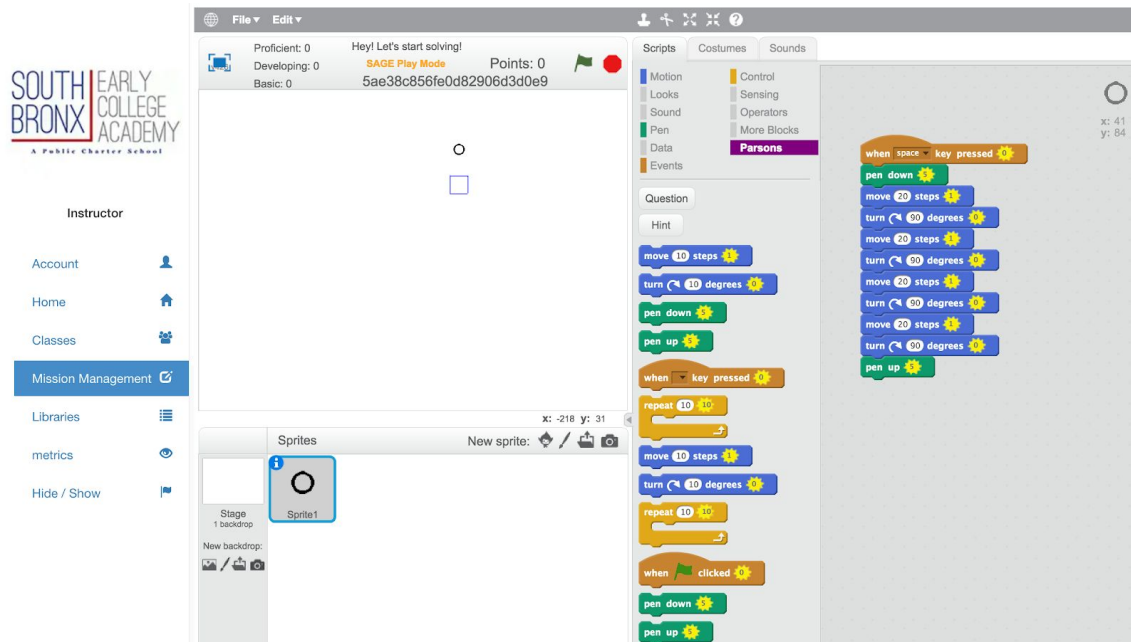
The original Parson's Puzzle library was built on the original Scratch website, and the .sb2 files were saved while there was no saving functionality within SAGE. Then, with the help of Johan, the puzzles were migrated over to SAGE with the appropriate point values assigned and instructions included, with documentation currently being updated as the Parson's Puzzles are being migrated over for use in future UCD sessions.

A simple example of a Parson's puzzle is shown below. Below is the Parson's section of the palette provided to the student, displaying the objective and providing hints for the student to get a higher number of points.



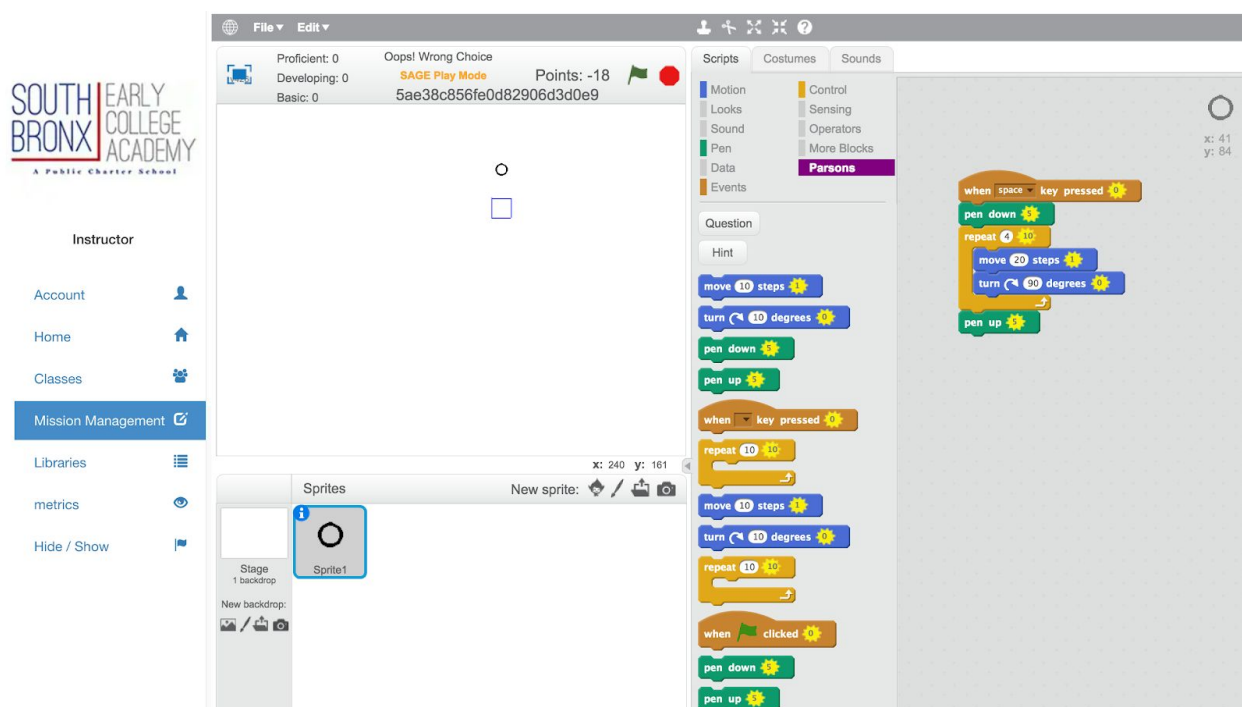


The student will have a selection from the blocks chosen by the instructor, shown on the Parson's pane. These blocks need to be used and arranged properly to solve the objective. First shown is the naive solution, repeating the same blocks to draw the square by drawing each side



four times.

After that is the optimal solution for this Parson's puzzle, utilizing a loop, which gives the student more points.



### 3.8 Field Study Analysis

Building from the progress set in place from semi-structured interviews is the analysis of the data, semi-structured interviews and user centered design sessions were be leveraged for their empirical data. The first and most intuitive step was documenting participants responses. Manually written transcription in addition to natural language processing techniques were leveraged in order to assess feedback, using a Watson Speech-to-Text API to transcribe the recorded field studies and compiling them to analyze later on. In terms of analysis, in some ways, transcripts require abstraction of data. In addition to assessing what is recorded on the transcript, there are elements that are insightful from the actual interaction. Shown below is a word cloud created from compiling a stripped and cleaned compilation of all the statements said during each semi-structured interview protocol, showing the frequency each term came up in the interviewee's responses. Though informal, this cloud helps analyze the direction to be heading in when conduction future UCD sessions as well as what to expect.



The data has more formally been analyzed through Grounded Theory, a general method of comparative analysis where we made consistent comparisons across interviews and grasp general themes from users' responses. Moreover, general trends and commonalities were identified particularly pertaining to easily comparable points of reference (e.g. age groups, teaching environments, teaching history among others.)

The fieldwork was conducted through in-person voice recordings as well as transcriptions. Meanwhile, surveys were distributed through Google Forms. The data will be analyzed through Grounded Theory, a general method of comparative analysis where we can make consistent comparisons across interviews and grasp general themes from users' responses.

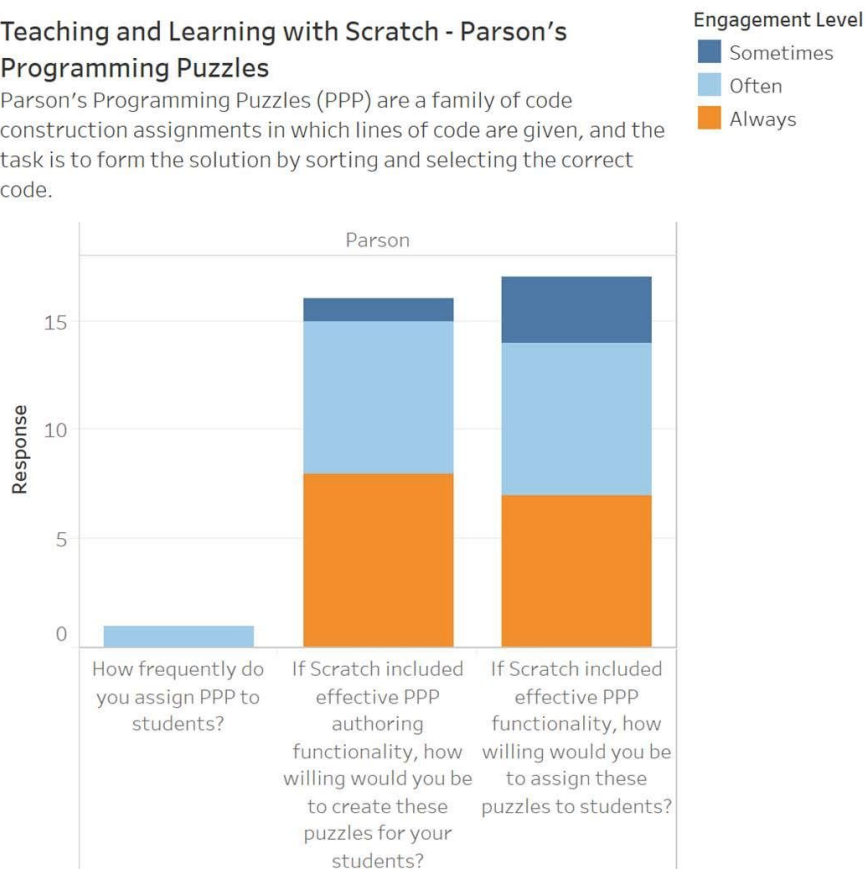
A major step in configuring the selection of tools and establishment of processes is in selecting tool of choice. Our option were IBM's Speech to Text, Mozilla Deep Speech, or Carnegie Mellon Sphinx Toolkit. Through trial and error ultimately IBM's Speech to Text tool, NVivo and Carnegie Mellon's sphinx toolkit were selected and utilized. There are still several things to work toward in preparation for the coming semesters as moments have been slightly disheveled. Though success was made a streamlined process for recording and transcribing sessions with both teachers and volunteers should be established given we utilized several tools over the course of Sprint 5. However, there was in fact use of an established toolkit / establishment of processes that operates with the already existing SAGE ecosystem. After data analysis was complete, we derived clear and concise graphs as well as commentary for the data we've gathered for the publication. A similar, if not exact, process was used for the User Centered Design sessions as well.

Shown below are some of the graphs created from the Teaching and Learning with Scratch survey developed in conjunction with Johan. A majority of the respondents heavily incorporate Scratch in the curriculum (>50%), and most aim to teach Computer Science, while Data Analysis, Representation, and Collection are underrepresented among the 9 CT concepts. Virtually nobody uses Parsons Puzzles but virtually all are interested to create and utilize them for the sake of teaching computational thinking, something that other websites have not incorporated in their frameworks for virtual playgrounds with code. Instructors overall feel somewhat capable to provide prompt guidance to individuals. For ITS to truly bring value, we

should aim for a bigger pain point since being overwhelmed does not seem to be that much of a hindrance. Constructionist games seem to be a staple of instructor's curriculum, but deeper questions can be asked on the level satisfaction and perceived effectiveness of the instructor-created CVG. Another good question might be asking the amount of time instructors spent in making/testing/iterating through a CVG and the quantity of CVGs deployed per class.

### Teaching and Learning with Scratch - Parson's Programming Puzzles

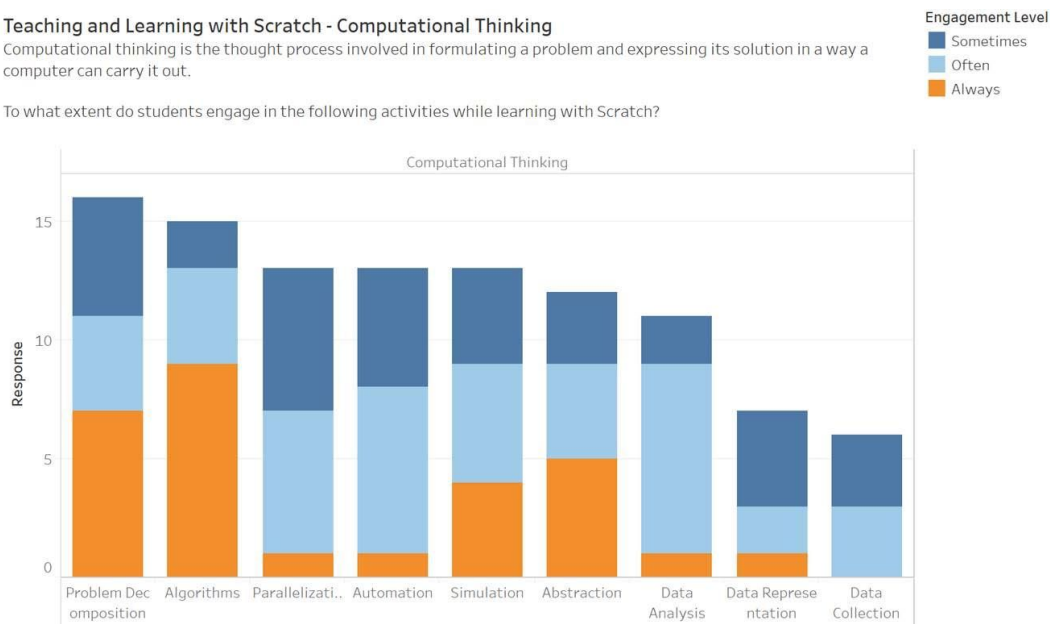
Parson's Programming Puzzles (PPP) are a family of code construction assignments in which lines of code are given, and the task is to form the solution by sorting and selecting the correct code.



### Teaching and Learning with Scratch - Computational Thinking

Computational thinking is the thought process involved in formulating a problem and expressing its solution in a way a computer can carry it out.

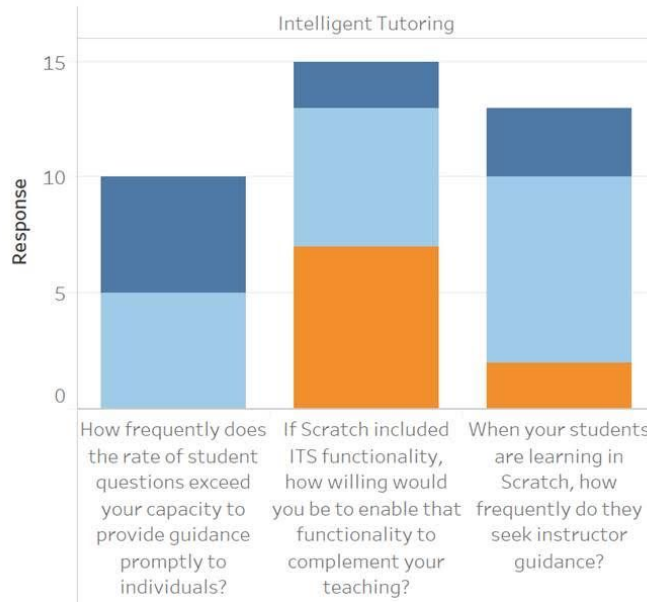
To what extent do students engage in the following activities while learning with Scratch?



## Teaching and Learning with Scratch - Intelligent Tutoring Systems

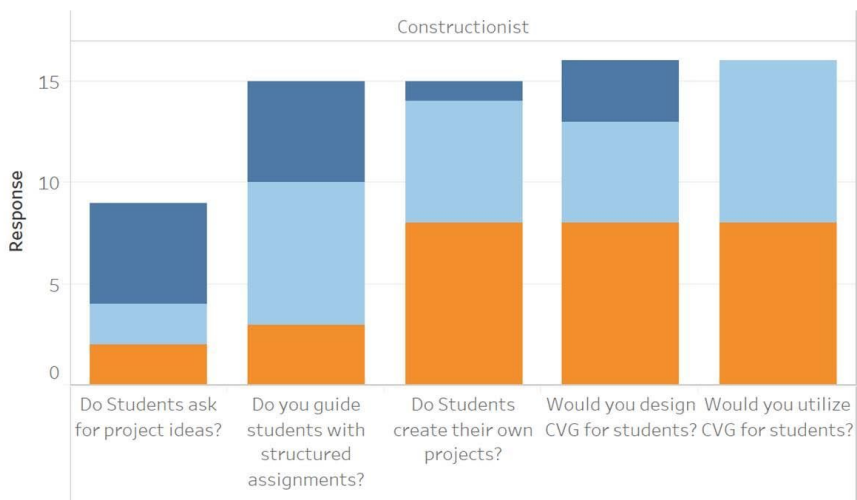
An intelligent tutoring system (ITS) provides immediate and customized instruction and feedback to students by a variety of delivery mechanisms such as just-in-time hints, on-demand information, and next-activity selection

### Engagement Level



## Teaching and Learning with Scratch - Constructionist Video Games

Constructionist Video Games (CVG) are designed environments in which players construct personally meaningful artifacts in order to overcome conflicts or obstacles resulting in quantifiable outcomes.

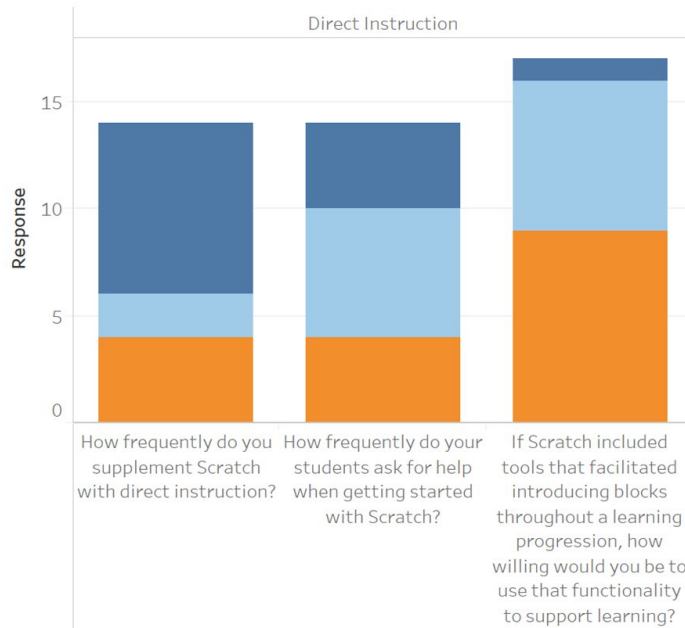


### Teaching and Learning with Scratch - Direct Instruction

Direct instruction involves the explicit teaching of a skill-set through lecture, presentation, and demonstration

#### Engagement Level

- Sometimes
- Often
- Always



## Documentation

All the materials used within the field studies can be found in the 2018 Sage Feasibility Study folder within Google Drive. Included within are transcriptions, audio files, the surveys, UCD and semi-structured interview protocol, and locations in which we conducted field studies in Maryland and beyond.

In terms of Parson's Puzzles, the Parson's Puzzle Library stored on Scratch itself can be found at <https://scratch.mit.edu/studios/4945809/>. Instructions to play the Parson's Puzzles are documented in the instructor dashboard. One example is <http://dev.cu-sage.org/instructor/#/coursePage/59f8c6fdc1bfb23c4ced8e20/course/5ae26cadce27be8135c0f946a/Assignment/1/id/5ae26d8cc27be8135c0f946b/Instruction>. Documentation for the Parson's Puzzles can be found here: <https://gudangdaya.atlassian.net/wiki/spaces/SAGE/pages/396918803/Parson%27s+Puzzle+Library>.

## Future Work

Future work includes converting the UI of the dashboard to the Material-UI framework. This semester marked the transition to Material-UI from its traditional Bootstrap and AngularJS frameworks. In order to forge a sense of cohesion, the use of Material-UI must be consistent across the platform. Standardizing the UI not only introduces consistency so the user can focus on their goal as opposed to the differing UI implementation, it also enforces familiarity since the framework borrows from Google's Material Design [3]. Other teams have already followed this paradigm. Other future work also includes the full integration of the “add focus” feature within SAGE so that instructors have the ability to curate their own curriculum paths.

The next steps in field studies are to test SAGE's features within the student populations at various schools. codeHER and TeCanal are enthusiastic to utilize this framework as soon as possible, and impact studies made in the classroom long-term and short-term should be assessed between the ways the students learn without the aid of SAGE and with the aid of SAGE. Inspired from Code.org's impact studies, we might also see how various demographics respond to the use of SAGE and tweak it to make it more accessible for all communities that will be using this framework in the future. Additionally, a video library on how to use SAGE and its features, especially Parson's Puzzles, is currently in the works due to high demand from instructors during the field studies. This will hopefully facilitate future UCD sessions.

In terms of analysis of the field studies, we can further refine the UCD, semi-structured interview protocol, and survey distribution processes to gain more insight into the data that we currently have. Asking more nuanced questions not only to gauge the current impact of SAGE, but also utilizing that data to improve the workflow of the teams in future semesters, would be extremely helpful to ensure that SAGE is going in the right direction. The data that we currently have needs to be graphed and analyzed in a visually appealing and persuasive format for the design publication to come.



## Conclusion

Once the Parson's Puzzle video library and the game library is built upon, it will be a unique tool that distinguishes SAGE from other major "code playground" platforms across the web, and it should be a feature that researchers place more emphasis on in the coming semesters. Integration of the video library and games will be needed to be done in a more seamless way, as well as being able to overcome roadblocks such as incorrect point tallying and unreliable saving functionality. Thus, the work on the Parson's Puzzles should be well-documented both inside and outside the instructor dashboard as progress is made on these features.

Significant progress has been made this semester in bringing SAGE into the classrooms to see real-world instructor feedback on its features and functionality as well as the direction SAGE is going. This momentum must definitely be built upon in following semesters for more effective semi-structured interview and UCD sessions throughout various schools across New York, and hopefully beyond. With the development of UCD aimed towards the children that will be using SAGE, the progress in the Field Study and Feasibility Publication epic will only grow, leading researchers in the right direction as we continue to build the framework. The data and analysis compiled thus far will be refined and then presented in an impactful way as we move towards the completion and presentation of the publication in the near future.

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