< CARRIE LINDEMAN >

EXPERIENCE

Instructional Designer · eCornell · Spring 2016 – current
Creating learning tools, video annotations, assessment, and accessories for online courses.

Computer Science Writer · Shmoop · Fall 2016 – current
Writing test prep questions for AP Computer Science.

Tutor · Ithaca College · Fall 2016
Individual and group tutoring of students in Java and Python computer science courses.

Teaching Assistant · Ithaca College · 2014 – 16
Assisted in developing course, educating students, and grading assignments for Java, Python, and media design courses.

CS Researcher · Ithaca College · Summer 2016
Worked on an intelligent tutoring system for introductory Python course. Wrote in Java and Javascript. Created content for online textbook.

Teaching Assistant · CTY Summer Camp · Summer 2015
Assisted in creating activities and teaching middle to high school students computer science.

Web Programmer · Graphcom Inc. · Summer 2015
Used HTML, CSS, and PHP to make edits to web pages and eMailers.

Treasurer · IC Women in Computing · 2015 – 16
Created budgets and help plan events and travel for club members.

SKILLS

Programming	**Media Editing**
Java	Adobe Premiere
Python	Adobe After Effects
JavaScript	Adobe Photoshop
Web Programming	Articulate Storyline

PASSIONS

eLearning

STEM Education

Innovative Technology

EDUCATION

Emerging Media B.S.

Ithaca College

Minor: Mathematics

GPA: 3.9

CONTACT ME

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CarrieLindeman.github.io

AWARDS

- *Dean's List for the Roy H. Park School of Communication every semester*
- *Peggy Ryan Williams Award for Academic and Community Leadership*
- *Member of the Phi Kappa Phi and Lambda Pi Eta Honor Society*
- *Member of the Oracle Honor Society of Ithaca College*
- *Presidential Scholar at Ithaca College*
- *Grace Hopper Celebration of Women in Computing Scholar 2016*

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References

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Teaching Assistant Supervisor	jasonayoder@gmail.com	(410) 735-6277	Center for Talented Youth
Ed Novak			
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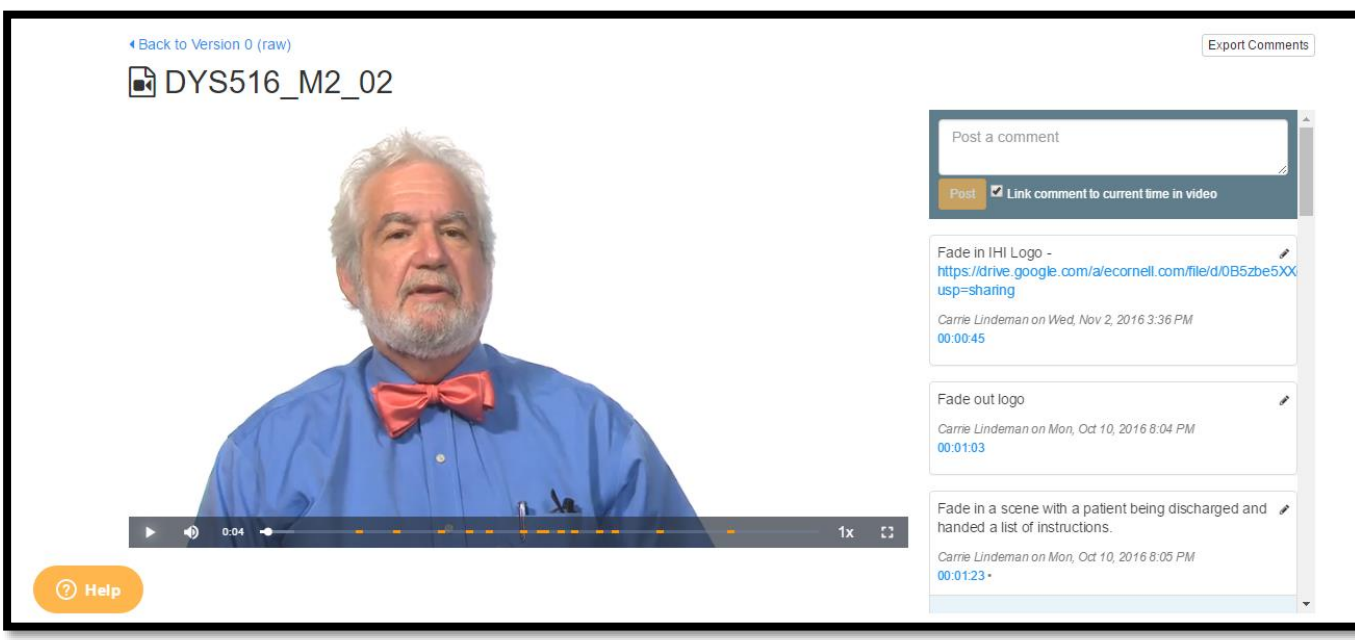
Storytelling Professor	enonas@ithaca.edu	(607) 274-1875	Ithaca College
Nate Prestopnik			
Emerging Media Professor	nprestopnik@ithaca.edu	(607) 274-3602	Ithaca College
Chrissy Guest			
Video Production Professor	cguest@ithaca.edu	(607) 274-3331	Ithaca College

During my time as an intern and contracted employee at eCornell I have had a range of responsibilities. Most importantly I have gained experience in a professional work environment. I have learned how to work on multiple projects at the same time and to balance responsibilities from different supervisors. The quality of my materials and my growth while at eCornell illustrates my work ethic.

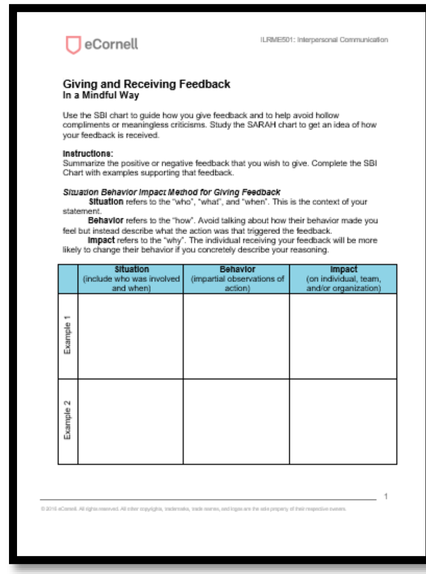
Skills Utilized: applying instructional design principles, writing, Microsoft Office

Examples:

One of my key responsibilities was to annotate videos of professors' lectures. I watch the videos and look over notes from the video shoot. Based on this information I describe the animations that should occur at given timecodes. This is a combination of finding and creating graphics for the videos and coming up with and describing actions or scenarios that should be animated. Each video is approximately 3 to 5 minutes and is about 60-80% animated.



Another opportunity has been to make learning activities for the courses. While assisting instructional designers in course development I have made activities for the learners to exercise what they have learned through reading and watching material. These activites range from self-reflection to professional development but they are all geared towards achieving a learning goal.


eCornell ILRME501: Interpersonal Communication

Giving and Receiving Feedback
In a Mindful Way

Use the SBI chart to guide how you give feedback and to help avoid hollow compliments or meaningless criticisms. Study the SARAH chart to get an idea of how your feedback is received.

Instructions:
Summarize the positive or negative feedback that you wish to give. Complete the SBI Chart with examples supporting that feedback.

Situation Behavior Impact Method for Giving Feedback
Situation refers to the "who", "what", and "when". This is the context of your statement.
Behavior refers to the "how". Avoid talking about how their behavior made you feel but instead describe what the action was that triggered the feedback.
Impact refers to the "why". The individual receiving your feedback will be more likely to change their behavior if you concretely describe your reasoning.

	Situation (include who was involved and when)	**Behavior** (impartial observations of action)	**Impact** (on individual, team, and/or organization)
Example 1			
Example 2			

1

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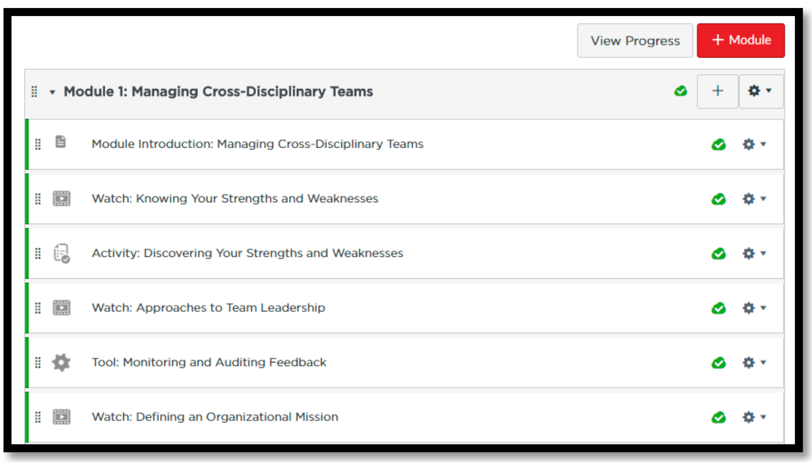
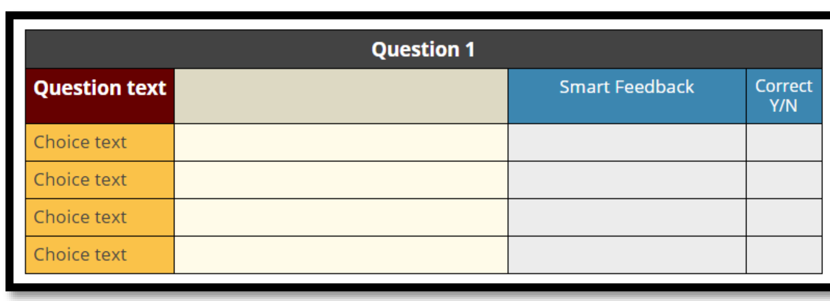


I additionally work on creating course shells in Canvas, writing glossaries, and working on course planning documents. These tasks give me a firm understanding of the core points of the courses I am working on.

Finally, I have recently begun my work on assessment at eCornell. I review a subsection of a full course and create multiple choice assessment questions to reveal student understanding and long-form questions to show reflection and application of material.



Question 1			
Question text		Smart Feedback	Correct Y/N
Choice text			
Choice text			
Choice text			
Choice text			

As a contracted employee of Shmoop I work on a per project basis. This means I write questions for different practice exams or lessons. So far my experience has included creating material for AP Computer Science exams. These exams are created to evaluate a student's understanding of computer science principles, data structures, programming in Java, and more. After writing the questions and example code I rank the question's difficulty and tag the topics focused on in the question.

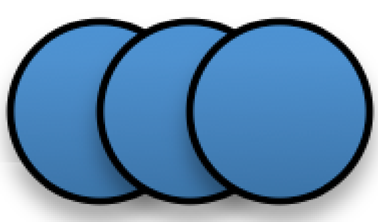
Skills Utilized: Java programming, writing, applying instructional design principles

Example:

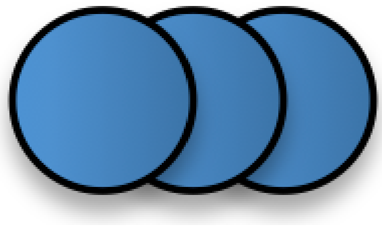
Assume there is a function **`drawCircle(double x, double y, double r)`** that draws a circle at a given coordinate and with a given radius. Now consider the following code segment.

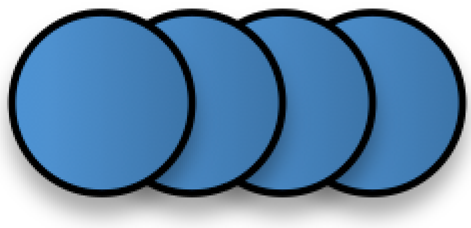
```
public static void recurseCircle(double x, double y, double r, int numCirc){
       if(numCirc == 0){
              return;
       }
       drawCircle(x, y, r);
       recurseCircle(x-r, y, r, numCirc – 1);
}
```

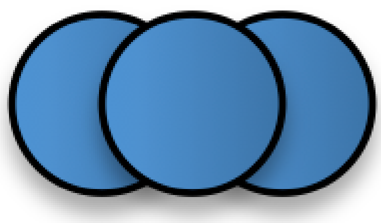
Which of the following drawings represents the output if numCirc has the argument of 3?

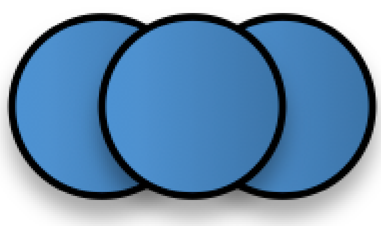


A.

B. 

C. 

D. 

E. 

The correct answer is (B).

Answer (B) is the only image that could have been made from this code. The first circle drawn (bottom of the pile) is to the right and all of the circles drawn on top of that are to the left. Based on the order that the **`drawCircle`** function is called and recursive call is made it the first circle drawn should be farthest to the right.

Once you acknowledge that the recursive function will draw circles to the left because of the **`x - r`** in the recursive call it is easy to eliminate (D) (E). This means the first circle drawn is the right most circle. The next tricky part about this program is the order of the drawing and of the recursive call. Because the recursive call comes after the draw, the first thing drawn should appear in the "back" of the image (A). The value of numCirc starts at three so only three circles should be drawn (C).

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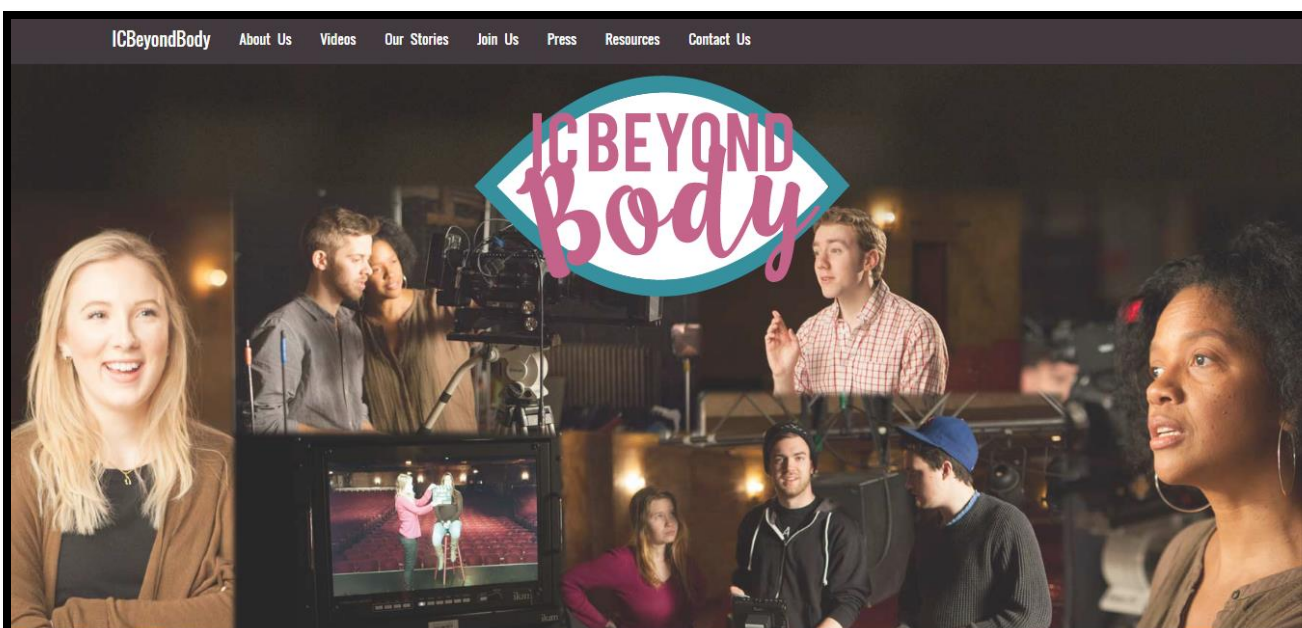
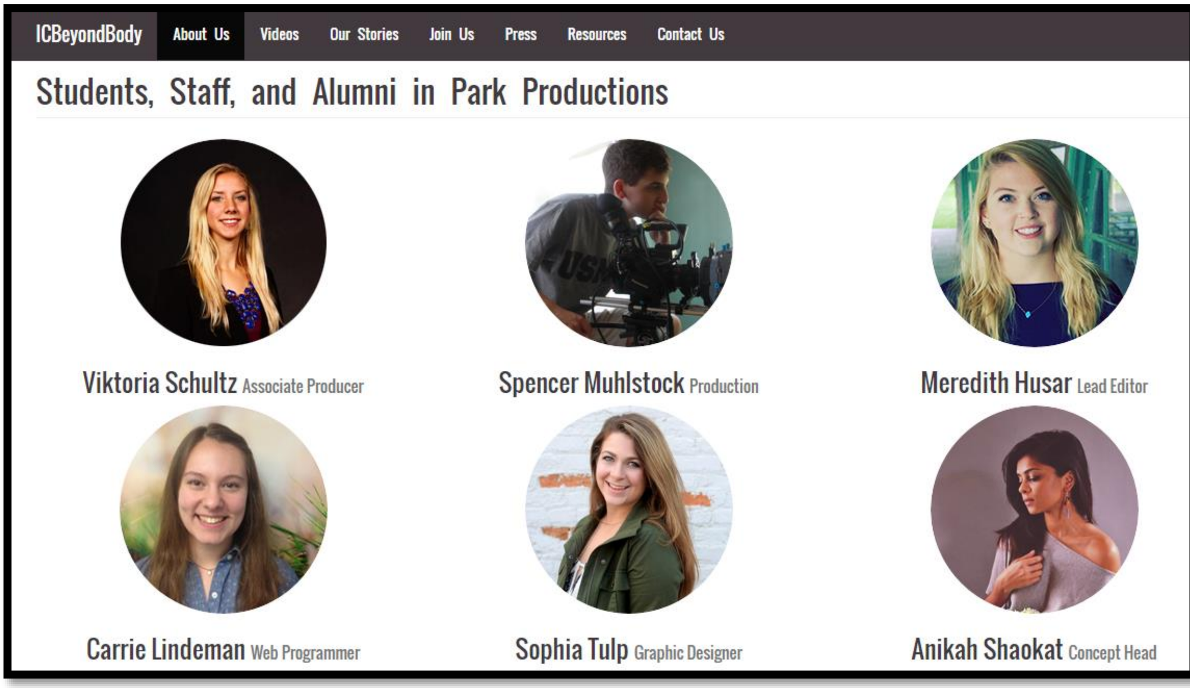
I became a member of the Park Productions Staff at Ithaca College in January 2016. This is a production lab funded within Ithaca College that creates independent projects. I was hired to create a website for a project/campaign that the production staff had created. The campaign focused on finding meaning and self-worth beyond physical appearance. The project included numerous videos from students and professors, social media, and online resources for individuals looking for more information about self-esteem. I collaborated with the teams and vision heads to make the website reflect their ideas.

Please visit at www.ICBeyondBody.com

Skills Utilized: HTML, CSS, JavaScript, Adobe Editing Suite

Examples:




ICBeyondBody
About Us
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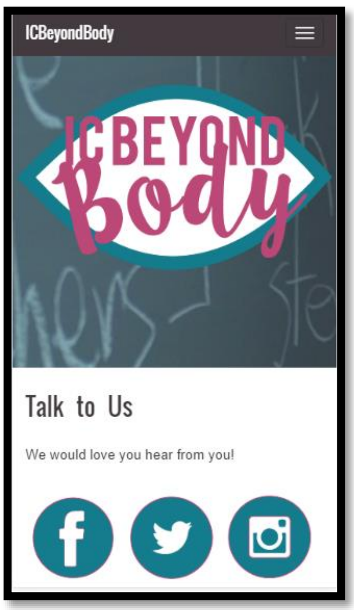
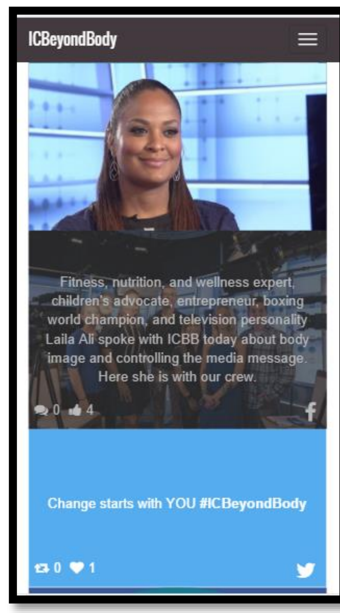
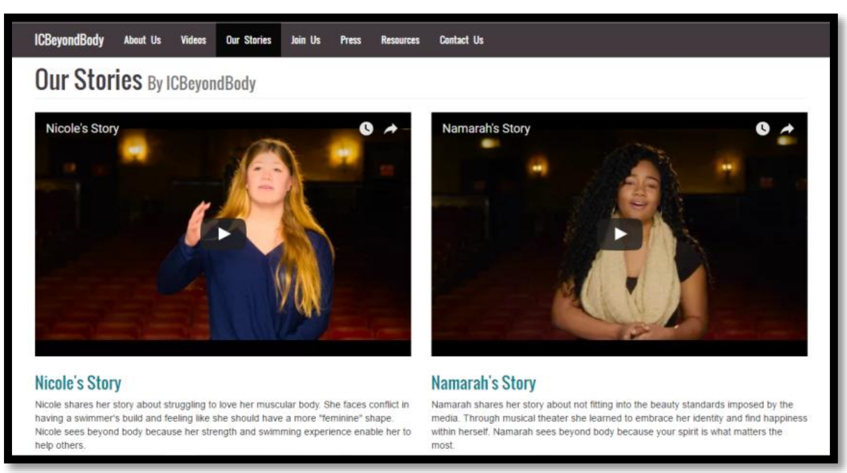
Our Stories
Join Us
Press
Resources
Contact Us
Students, Staff, and Alumni in Park Productions
Viktoria Schultz Associate Producer
Spencer Muhlstock Production
Meredith Husar Lead Editor
Carrie Lindeman Web Programmer
Sophia Tulp Graphic Designer
Anikah Shaokat Concept Head


ICBeyondBody
ICBEYOND Body
Talk to Us
We would love you hear from you!


ICBeyondBody
Videos By ICBeyondBody
ICBB Talks with the Producer...
ICBB Talks with the Producers of '2,000 Meters Out'
IC Beyond Body sat down with three of the producers '2,000 Meters Out' - a documentary that follows Emily Morley, a rower on the Ithaca College women's crew team, throughout her journey to the 2016 Olympics.


ICBeyondBody
Fitness, nutrition, and wellness expert, children's advocate, entrepreneur, boxing world champion, and television personality Laila Ali spoke with ICBB today about body image and controlling the media message. Here she is with our crew.
0 4
Change starts with YOU #ICBeyondBody
0 1


ICBeyondBody
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Our Stories By ICBeyondBody
Nicole's Story
Namarah's Story
Nicole's Story
Nicole shares her story about struggling to love her muscular body. She faces conflict in having a swimmer's build and feeling like she should have a more "feminine" shape. Nicole sees beyond body because her strength and swimming experience enable her to help others.
Namarah's Story
Namarah shares her story about not fitting into the beauty standards imposed by the media. Through musical theater she learned to embrace her identity and find happiness within herself. Namarah sees beyond body because your spirit is what matters the most.

ELEARNING MODULES

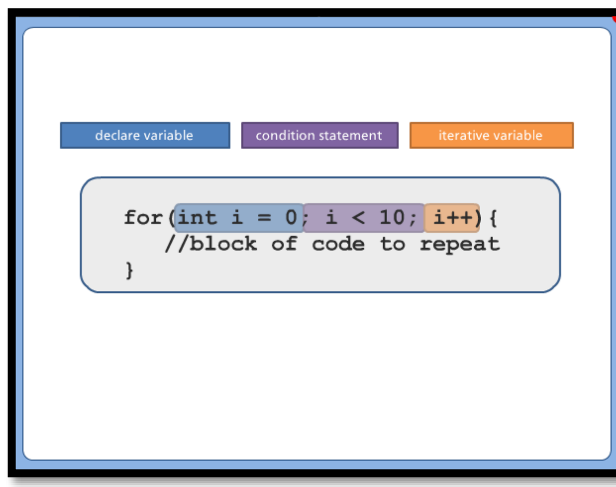
As a part of my eLearning course at Ithaca College I created a few educational modules. I individually created two learning modules about computer science and participated in the development of an online capstone course at Ithaca College. These modules cover a single lesson and expect pre-existing knowledge.

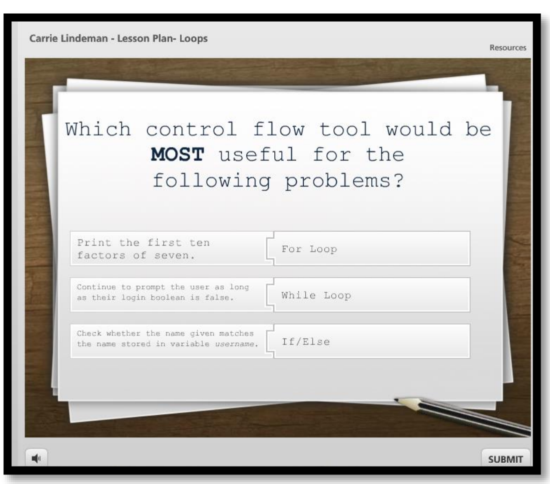
Please visit at www.CarrieLindeman.github.io/

Skills Utilized: Articulate Storyline, Adobe Editing Suites, writing, computer science knowledge

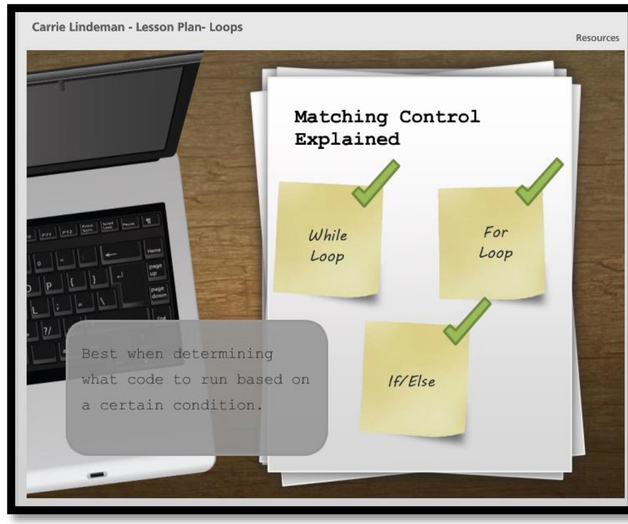
Examples:

I created graphics that the learner could reference as a tool to learn Java syntax. These tools are available throughout the lesson to help the learner understand the purpose of syntax instead of just memorizing characters.

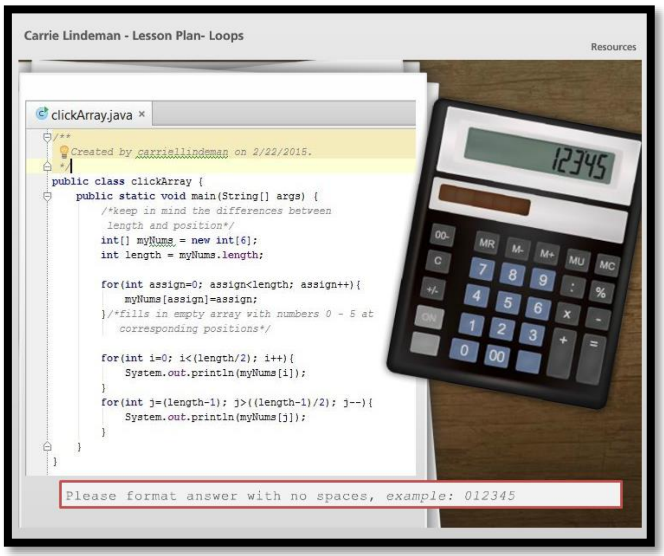




Throughout the lesson the learner is prompted to complete self evaluation through interactive activies. This is an example of a matching activity that assesses the learner's understanding of overarching concepts.

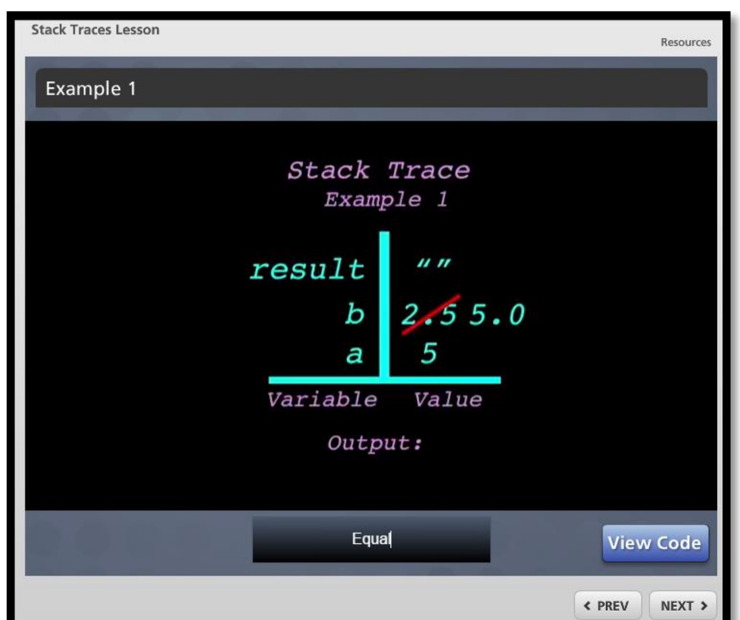


After completing the matching activity the learner is given an in-depth explanation for the correct answers.

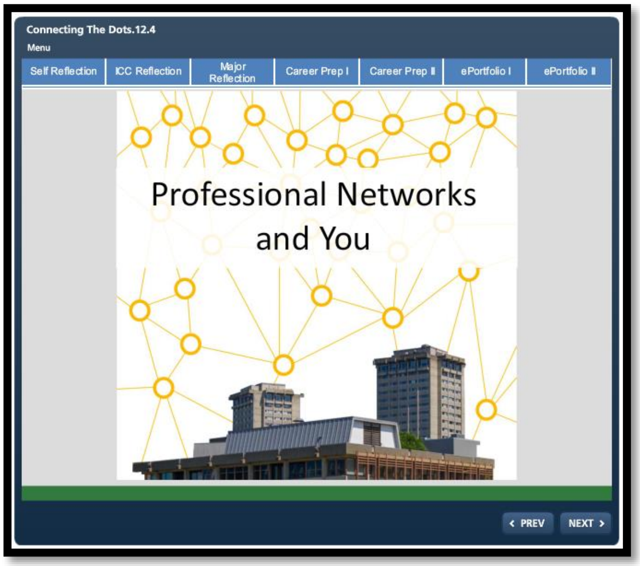


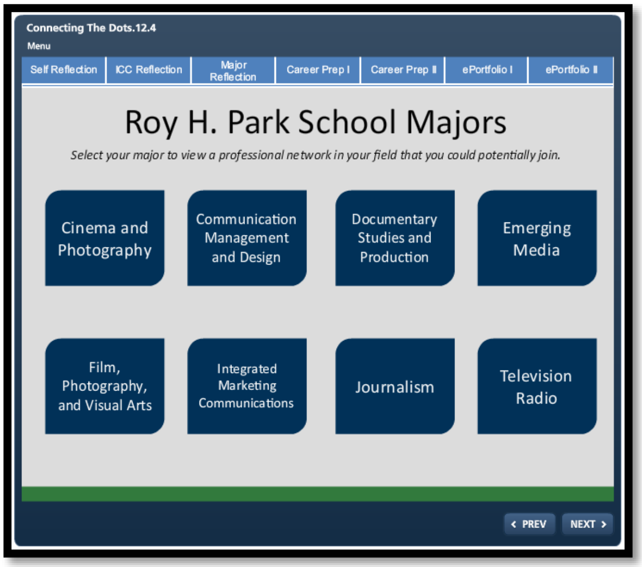
This activity asks the learner to trace through the code provided and figure out what the program will print. Once they have completed the trace they can input the answer and check if they are correct.

In a different lesson I actually included videos I created. I animated a video that goes through the steps of creating a trace for different levels of complication. The module allows the user to toggle between the video and the code to follow along with the process.



And finally, I worked on the Connecting the Dots Capstone course for the Roy H. Park Communication School at Ithaca College. This is a required online course for all senior students of the Communication school. It guides them through a reflections of their work while at IC, their career preparation, and the development of their ePortfolio.





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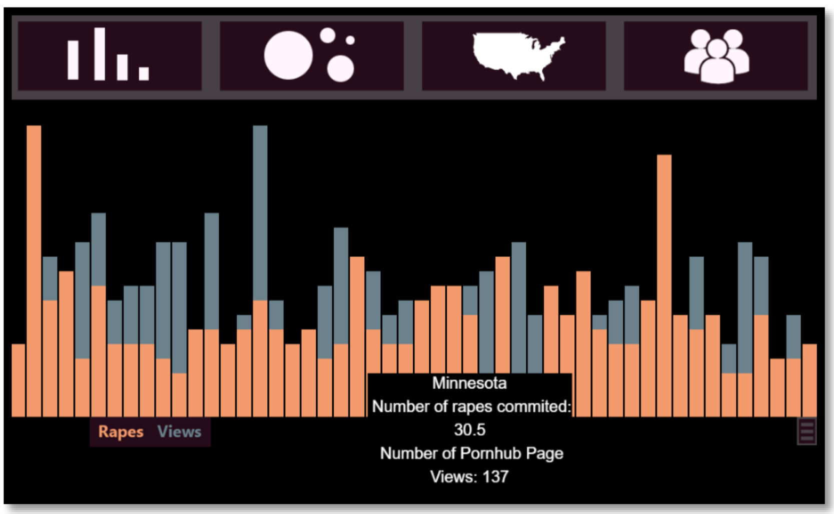
INTERACTIVE MEDIA

Throughout my time at Ithaca College I have created a wide range of interactive media for various class assignments. These projects were some of my favorites that I created.

Please visit at www.CarrieLindeman.github.io/

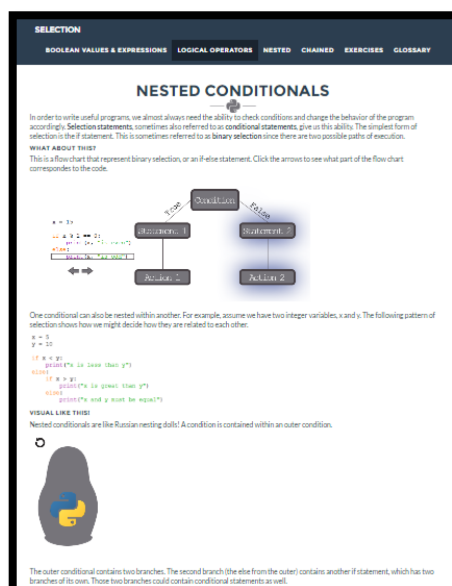
Skills Utilized: HTML, CSS, JavaScript, Phaser, Adobe Editing Suites

Examples:

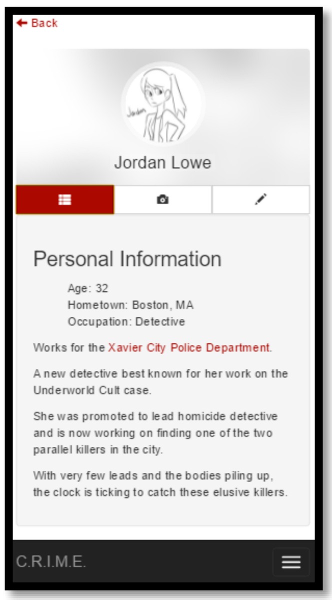


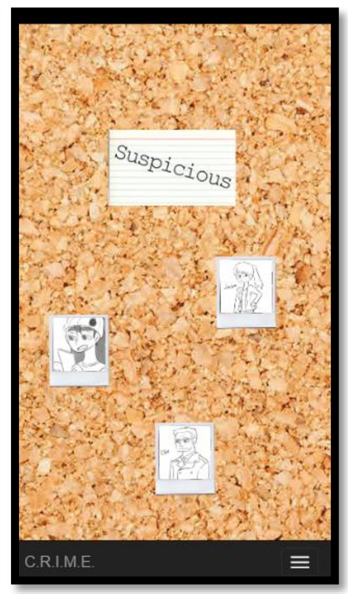
I created an interactive data visualization that compared the rates of pornography viewed per state and the number of sexual assaults per state.

I was given the assignment to create a small piece of what I considered to be an "emerging media". I created a pseudo intelligent tutoring system. After each chapter the student is asked how confident they feel about the topics they just read. If they responded that they were not confident they then are prompted to review the chapter but now the chapter has interactive review material. The subject matter is introductory Python programming, specifically studying selection and if statements. I adapted material from an open source textbook and designed the interactive elements and feedback. The interaction was created using JavaScript and Phaser.



Another assignment was to create an interactive piece of art. On the left is a static fairytale scene that I created in Adobe Photoshop. Clicking on the sun reveals an interactive, mysterious fairytale world. The stars twinkle, particles and a glow emit from the sword, the user can draw pictures in the sky, and even fly the dragon with their arrow keys.





My junior year capstone group project was creating a proof of concept media platform. We called the media platform X-Screen. Our platform was aimed at getting the attention of the viewer both though traditional television and a companion app. The show is expanded upon and made more interactive through this app. My team members wrote a pilot episode of a mystery show and I created a prototype app that followed along with the show. The users could read background information about the characters, catalouge suspicions, and view show locations on a map.

< CARRIE LINDEMAN >

RAY TRACING GRAPHICS RENDERER INDEPENDENT STUDY

I participated in an independent study with Ithaca College professor Paul Dickson where we built a ray tracing graphics renderer. I worked for a semester with Paul to analyze the mathematics behind the model and wrote the code to output the graphics. The ray tracer that we built used object oriented programming. An object is an instance of a class that has attributes, accessors, and mutators.

In my ray tracer I had lines, spheres, planes, light points, and more. The light points were added so that the objects placed in our virtual world could actually be seen. This is where some of the physics of computer graphics rendering were applied. I adjusted the numbers in my program to make the lighting look realistic but there is a lot of mathematics and research that goes into capturing the physics used in graphics renderers.

A ray tracer works by having a given perspective position or "camera" that sends a ray through every pixel of an image. If a frame of the movie is 1080x1920 pixels then the camera sends out 2,073,600 rays, which explains why ray tracing graphics takes so long and takes so much RAM. A ray has a starting point and travels infinitely in a direction. Sending out a ray means that every position between the camera and the last object in the virtual world is checked to see if it intersects with an object. If the ray intersects with an object then it sets that value of the pixel to be the color value of the objects. Lighting and physics may alter the color of the pixel as well.

Skills Utilized: C++ programming, mathematics

Examples:

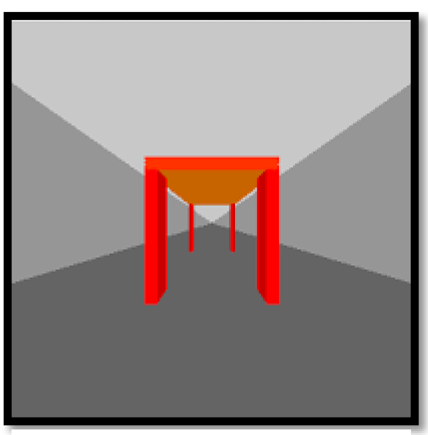
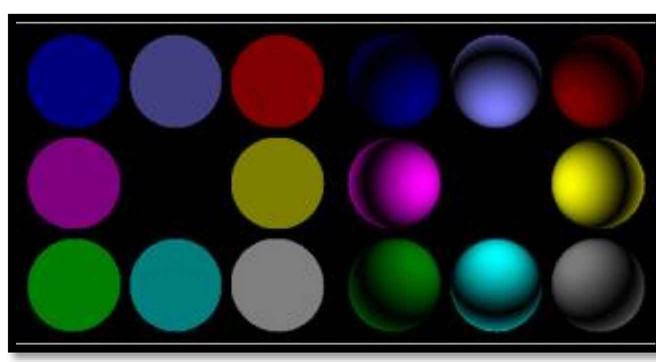


Image created from my ray tracing graphics renderer featuring planes.



Images of spheres renderer before and after

Assessment of Students' Conceptual Understanding: Unleashing the Power of the Interactive Textbook

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ABSTRACT
Online, interactive textbooks are continually gaining popularity in computer science courses. We present a system for automated analysis that can harness the power of these textbook/practice systems in order to provide information about high-level conceptual understanding to educators. This information can be used to support individual students and to improve course content. The basis of our system is a Concept Graph, an artifact representing the concepts to be taught during the course, and their interrelations. We offer our working version of this Concept Graph for an Introductory Computer Science course, both as an artifact for consideration by the community, and as a basis for understanding our system. We describe the manner in which our system uses these Concept Graphs to provide useful information to educators.

CCS Concepts
• Social and professional topics ~ Computer science education •Applied computing ~ E-learning •Applied computing ~ Computer-assisted instruction •Applied computing ~ Computer-managed instruction

Keywords
Computer Science education; Intelligent Tutoring Systems (ITS); Expert Knowledge base (EKB); ELearning; Automated Assessment

1. INTRODUCTION
Online, interactive textbooks are gaining popularity in computer science education. These systems provide the benefit of allowing students to practice concepts as they are presented. The increase in out-of-classroom instruction can potentially allow for a blended learning environment, where students learn many of the basic principles from the textbook and practice environment. Educators can then focus more class time on collaborative work, discussion, and more challenging subjects. However, the educator gains less information about their students' grasp on these core concepts that are learned at home.

Often, these online interactive systems are accompanied by a minimal set of tools that allow educators to see the submitted answers to questions, and aggregated information about the class as a whole. However, the systems rarely offer the educator any indication of students' understanding of high-level concepts, as the systems do not generally include any type of information that would facilitate that process.

We present a system that offers information about students' understanding of high-level concepts based on their work within an online interactive system. This information is not a magic solution, but rather a system that allows educators to specify the important concepts, their interrelation, and their relation to the exercises that students complete. In this way, we combine the educator's understanding of the course material with the data from the online practice environment. This tool supports educators in their attempts to help individual students and to improve their curriculum overall.

We now present a scenario to offer the reader a glimpse into the potential uses of the tool (Section 2). We then present the underlying technology that provides the functionality described (Section 3). We discuss interesting implications of this work, including another scenario demonstrating the use in improving course content (Sections 4 and 5). We discuss our grounding in ELearning theory (Section 6), and conclude by describing our plans for using and improving the system (Section 7).

2. ASSESSING AND SUPPORTING STUDENTS
Here we describe a hypothetical scenario to demonstrate our system's potential. This scenario describes the expected context, manner of use, and productive outcomes of the system, allowing the reader to see the purpose of the tool and the manner in which the tool supports assessment of student performance.

Imagine Professor Sinclair, the instructor of an Introductory Computer Science course, grading quizzes from the past week. She notices that her student, Jeffery, who has generally performed well, failed this week's quiz. She decides to consult our automated textbook assessment tool to see if she can identify Jeffery's misconception. When she opens the tool, she focuses on the visualization of Jeffrey's knowledge about the current topics (Figure 1).

This quiz was focused on the use of if statements and the professor notices that Jeffery's assessment reflects a mediocre score for the concept *If Statement*. However, she also notes that the associated concept for *Boolean Expressions* has an even worse rating. The system reflects the relationship between these two concepts, in that a problem with the concept of boolean expressions contributes to a problem with the concept of if statements. Therefore the rating on *Boolean Expressions* (red)

SIGCSE '16, Month 1–2, 2016, City, State, USA.

DOI: http://dx.doi.org/10.1145/12345.67890

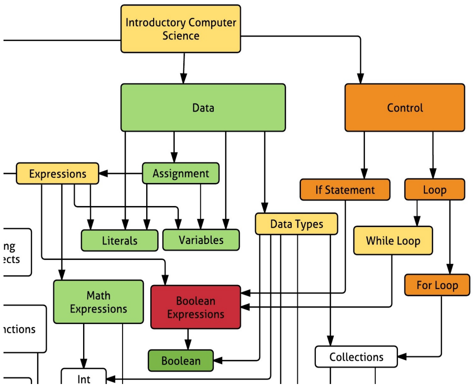

Figure 1. The information shared with the instructor as the she examines a specific student assessment.

lowers the rating of *If Statements* (orange) and eventually also lowers the rating of *Introductory Computer Science* (yellow). She clicks the *Boolean Expressions* node to see with which related textbook exercises Jeffrey has struggled. A pattern in Jeffrey's answers reveals a clear misconception of boolean expressions. After this quick and pointed use of the assessment tool, Professor Sinclair is able to give effective feedback to Jeffrey about his specific misconception.

This basic scenario describes one use case of our assessment tool, and demonstrates a practical application for an educator. The tool provides the ability to quickly see an overview of the concepts presented in a given class, along with assessment of a given student's theoretical understanding on those concepts based on real data from student performance. We now describe in detail the technology and the content development necessary to make this tool function as described in this scenario. We can then discuss the additional benefits and alternative uses of this system.

3. Underlying Technology

Figure 1 represents a partial graph of certain concepts covered in an Introductory Computer Science course and their interrelations. Our system requires such a graph of the concepts covering the entire course in question. We refer to this graph as a *Concept Graph*, which is a type of Expert Knowledge Base (EKB). EKBs are a common tool used in Intelligent Tutoring Systems (ITSs) research [1]. We use this Concept Graph to automatically analyze the information collected from an online textbook in order to produce assessment of high-level concepts based on low-level information about student performance. This high-level information can be used by educators to quickly and easily offer pertinent feedback to students, as described in the scenario above. There have been other attempts at similar assessment techniques, particularly Butz et. al. [2]. However, to our knowledge these attempts have been left undeveloped and unused in real classrooms.

We now present the details of our system in order to clarify the inner workings of its assessment mechanism. We must consider the online learning tool from which it takes low-level student performance information, the structure and content of the Concept Graph, and their interconnection. Then we can consider the analysis system that aggregates data and offers assessment of student performance based on the relevant Concept Graph.

3.1 The Learning Environment

The learning environment used by the students is an online, interactive textbook system called Runestone Interactive[1] [3]. This system presents mixed media for instruction (text and video) interleaved with practice exercises (Figure 2). Exercises include multiple choice questions, drag and drop questions, a live Python debugging tool, and text areas where Python code can be written and executed.

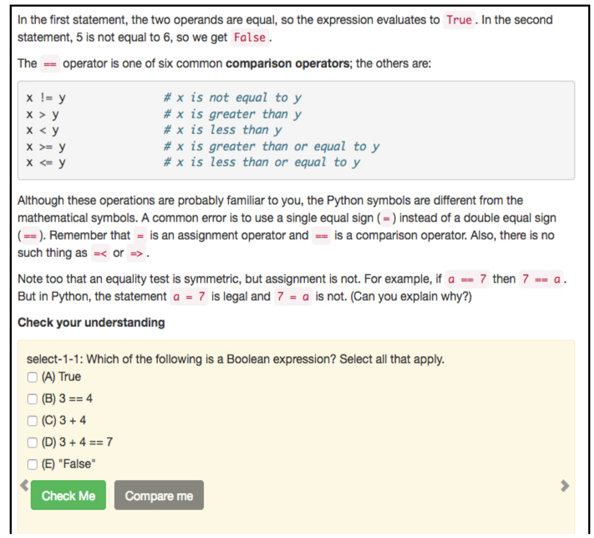

Figure 2. A screenshot showing the learner's view of the Runestone Textbook.

Specifically, we are focused on the flagship textbook of this system "How to Think Like a Computer Scientist," which presents introductory programming in Python. This textbook system is used in our curriculum to promote blended learning, where students work independently online as well as in the classroom. Students are expected to read and complete exercises that introduce a topic for homework. They attend class where the topic is covered in more detail, and finally return to the text to complete more challenging exercises for practice and to help cement ideas.

The content of the textbook (including the exercises) is defined by text files, and therefore developing and changing content is technologically simple. The system logs all user actions to a database, and provides these data in XML format upon request. We use these data as the input to our automated analysis system.

3.2 The Concept Graph

The purpose of the Concept Graph is to make explicit all concepts that are expected to be taught in class, as well as the relationships between these concepts. These concepts could be at any level of granularity that the educator chooses. The end product is a Directed Acyclic Graph (DAG). Below is the current version of our concept graph designed for our Introductory Computer Science course in Python (Figure 3). Nodes in the graph are concepts taught in the course, and edges represent roughly the relationship "is a part of." For example, the node for *If Statement* has an edge connected to *Boolean Expression* because an understanding of boolean expressions is a part of an understanding of if statements.

[1] http://runestoneinteractive.org

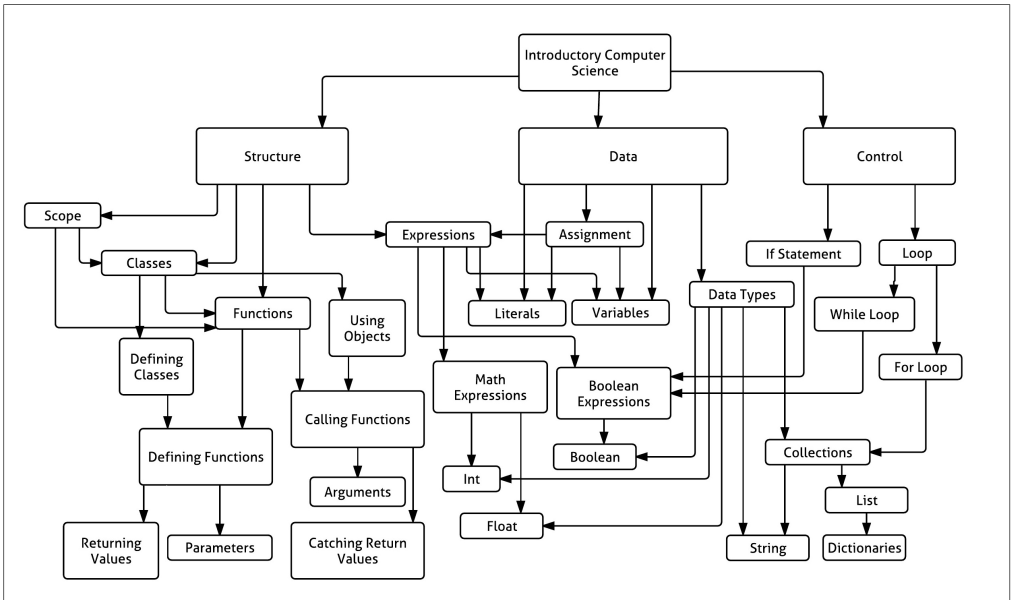

Figure 3. The Concept Graph the subject Introductory Computer Science.

Nodes without parents are generally high-level, abstract concepts, and nodes without children are generally low-level, concrete concepts. The graph transitions from concrete to theoretical because the graph is assessing a student's understanding of an abstract concept based on their estimated understanding of lower-level concepts. These estimates originate from actual student performance data provided by the textbook. The means by which the textbook data is connected to the concept graph are discussed in Section 3.3.

Note that we refer to this artifact as the "current" version of the concept graph. The creation of such an artifact is obviously subjective and prone to debate, even within a single team or by a single author. The concepts can be at any level of granularity, and the decision of when such a graph is "correct" or "complete" is difficult. This reflects the flexibility, subtlety, and challenge that every educator must face when deciding the content and organization of a given course. However, there is no need for this artifact to be perfect, and it can be iteratively improved with ease. The graph itself is defined in a text file (in JSON format) by a list of nodes and a list of edges, and therefore is easily editable. The real demonstration of a "correct" graph is the usefulness when an educator employs the system in the realistic setting of their class.

Considering this complex authoring task, any educator considering the creation of this graph might be (rightly) concerned about the effort involved and the ambiguity of its form. To address this concern and offer a simple example solution, a default graph can be automatically built from the textbook source files of any text authored in the Runestone system. A textbook is inherently structured into chapters and subsections. A graph can then be created simply by using the names of these chapters and subsections to create the graph structure (Figure 4).

This automation offers default functionality of the assessment system without need of further authoring work. The default structure can then also be modified by the author to suit their needs. The trade-offs of using an automatically constructed Concept Graph versus editing or constructing one's own Concept Graph are discussed in Section 4.1.

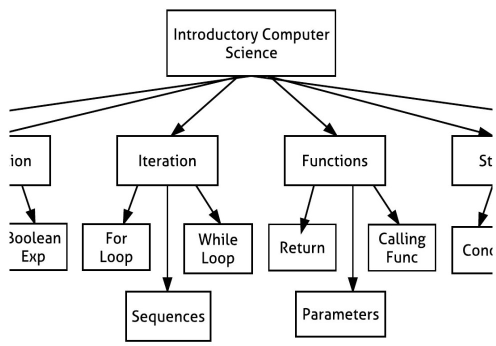

Figure 4. A portion of the automatically generated concept graph from the Runestone Textbook.

3.3 Connecting Concept Graph to Data

As previously stated, the exercises in the learning environment are defined by text files, and data from these exercises are recorded in a database and retrievable in an XML format. These data must now be linked to nodes in our Concept Graph to assess the student's understanding of high-level concepts. This connection can be made in two different ways.

The first and simplest way is to rely on the automated Concept Graph created from the textbook source files. When parsing the source files of subsections, the questions within those subsections can automatically be linked to the corresponding nodes. In this way, a fully functional Concept Graph including connections to the data source can be automatically created.

When a Concept Graph differs from the textbook source, the connection from exercises to the nodes in the graph must be specified. This is accomplished by tagging the exercises in the text source with the names of concepts from the Concept Graph. Authoring then is the rather intuitive task of tagging each exercise in the text with the concepts from the graph that are relevant to that exercise. The exercises are generally connected with lower level concepts, but the system allows for exercises to be connected to any node in the graph. Questions can even be tagged with high-level concepts such as data types. For example, this might be appropriate for a question that asks students to differentiate many different data types.

Again, the trade-offs between automation and manual authoring are discussed in section 4.

3.4 The Automated Assessment System

Now that the data source, the Concept Graph, and their connection are established, we consider the manner in which we use this structure to offer automated assessment. We employed, altered, and extended open-source software originally developed for an unrelated project, the Metafora Project[2]. This software was developed to conduct automated analysis across many different computer-based learning tools [4], and therefore provides a basis for collecting and analyzing individual actions in XML format [5]. It offers a web-based framework (built on Google Web Toolkit, GWT[3]) in which analysis can be coded in java on the server-side and all available data can be viewed, filtered, and explored in a web client. These data range from the low-level actions by the student to high-level analysis performed by the system.

Algorithmically, the system reads the concept graph structure from either JSON or the book source (as described in Section 3.2) and creates a representation in memory that includes leaf nodes for the specified exercises related to the graph (as described in section 3.3). The system collects XML data from the book about a given student's performance on exercises and populates the leaf nodes with these data. The system then uses a post-order traversal of the concept graph to aggregate actual data in a bottom-up fashion from the lowest levels of the graph to all nodes in the graph. Finally, the system uses a pre-order traversal of the graph to distribute the aggregated information in a top-down fashion, offering estimated knowledge on concepts about which real data has not yet been collected. Currently, these calculations are simple weighted averages. Improved techniques using mathematical modeling and machine learning techniques to produce more accurate results are a matter of current research.

These calculations result in a numerical value for each node, which we then convert into a color code to be presented to the educator. Using Google Charts[4] tools, we display an org chart where each node is labeled with its concept title, has a colored border to represent the node score, and can be clicked to display all related data. Color codes simplify the overwhelming amount of data available to the educator. Such a simplified interface has been shown to allow teachers to identify needed information in a short amount of time [6]. The web interface does allow for teachers to further analyze the source of these color codes, as described in Section 2.

Taking a holistic view of the system, one can now see the manner in which this tool utilizes the textbook system, the data from student use, and the defined Concept Graph to offer the behavior described in the scenario presented in section 2. This system provides educators a powerful tool to peruse the estimated understanding of any given student based on their work within the online textbook for the class, and to drill down into that estimate to understand the source of the estimation.

[2] http://www.metafora-project.org/

[3] http://www.gwtproject.org/

[4] https://developers.google.com/chart/

4. AUTHORING VERSUS AUTOMATION

Throughout section 3 we explained the manner in which the Concept Graph and its connections to individual questions could be created in two different fashions: either automatically or manually. It is worth noting again that an author need not choose only one or the other, but can begin with an automated Concept Graph and edit it to suit. We now discuss this decision in more detail to highlight underlying interesting implications of our system, namely: the contrast of a graph versus a tree structure, and the contrast of hand-crafting a Concept Graph versus using automation.

4.1 Graph Versus Tree Structure

A key difference between a hand-crafted Concept Graph and one that is automatically generated from the book is that the auto-generated graph will always be a tree structure (each node having only one parent), as seen in Figure 4. This is because no question is featured in multiple subsections and no subsection is featured in multiple chapters. In contrast, the nodes in a handcrafted Concept Graph might have multiple parents. For example, in Figure 3, the node for *Boolean Expression* has both *Expressions* and *If Statements* as parent nodes. This difference in structure has potentially profound effects on the resulting calculations, as it can reveal a learner's progress over time. The node for *Boolean Expression* may have a score that fluctuates based on the learner's current work. The learner may not understand boolean expressions at first, but gain confidence when working with if statements. In a handcrafted Concept Graph the progression is recognized in the visualization because many different sections of the text might be related to Boolean Expressions. In an auto-generated Concept Graph, there is only one section of the book that affects this node, making a more static timeline of their performance.

Our automated analysis system was designed to handle any DAG, so calculations for assessment can function regardless of whether the graph is a tree or not. However, a clean and understandable automated display of a DAG is a much more difficult task than automated display of a tree structure. Off-the-shelf free software (in our case Google Charts), offers useful web visualization of tree structures, but we have not found similar software for displaying a DAG.

We have mitigated this display problem by creating a function that converts a DAG into a tree structure. This works by duplicating and incrementing an ID number for any nodes with multiple parents. This tree structure is used only for display purposes, and allows organized visualization of our Concept Graphs (Figure 5).

As can be seen in the figure, this tree is useful, but can easily become large and repetitive, making this solution less than ideal. Better software for DAG visualization is an area of active investigation.

4.2 Improving Content by Authoring

Setting aside the graph vs. tree aspect discussed in Section 4.1, there are still trade-offs to consider with automated graph creation. The convenience of having an automatically generated Concept Graph from the textbook structure is apparent. However,

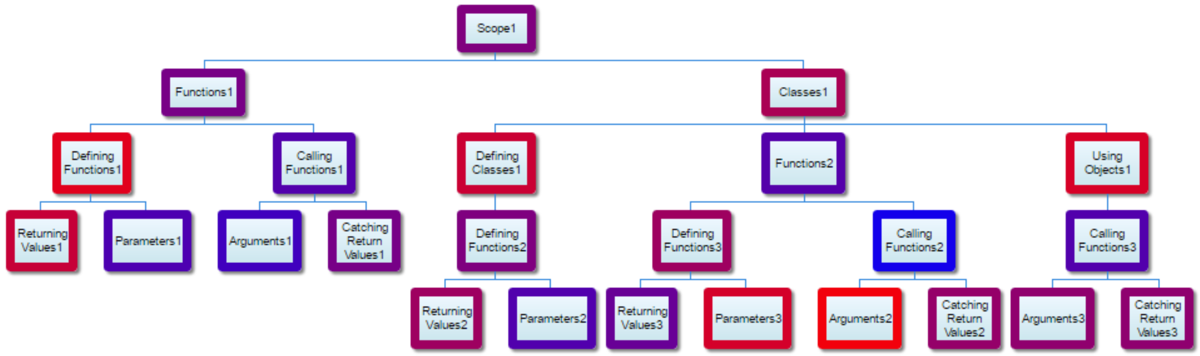

Figure 5. A subsection of our EKB Concept Graph converted to a tree and displayed in our assessment tool.

we have found that hand crafting a Concept Graph has the potential to improve the overall course content. The process of creating a concept graph and linking each exercise in the book helps flesh out the content presented to students and the learning goals for the course. Creating the concept graph can reveal an imbalance of exercises to concepts, even potentially revealing the absence of certain desired concepts from the textbook entirely. In this way, making a concept graph is an exercise in polishing course content and ensuring that the content is driven by desired learning outcomes. We now offer a final scenario to exemplify this potential iterative improvement of course content.

5. Content Improvement Scenario

Imagine again Professor Sinclair, who has been teaching Introduction to Computer Science at her institution for many years. On recent exams, she has noticed that almost all of her students get one question wrong, a question involving dictionaries. While she is aware of her limited time covering this subject, she has always relied on the textbook chapter to fill in gaps for the students. She decides to investigate how she can improve the student understanding of dictionaries.

She decides to look at the class average Concept Graph for last year's class. Since most students got the dictionary question wrong, she assumed there would be a poor score for the *Dictionaries* concept in the Concept Graph. However, there was a positive average score. She is confused as to how this is possible, and therefore decides to compare the question she used on the final with the questions used for the book assessment. She finds that the textbook does not feature any questions that require the student to initialize and populate a dictionary. In contrast, the question on the final asks students for precisely this task. Professor Sinclair now realizes that she has been testing students on something that she had never had them practice. With this specific knowledge she is able to adjust the course content, Concept Graph, and exercises in the textbook for future learners. This theoretical improvement can then be tested in subsequent versions of the course.

This scenario describes a realistic use of our system to aid the educator in refining course content, rather than aiding an individual student. Our system can provide average student data across an entire course in this Concept Graph form, allowing for assessment on a macro-level. This approach can potentially aid in improving the course itself, and thereby improving all students' classroom experience.

6. ELearning Theory

While we consider the rationale behind our system intuitive, it is important to note that we ground our work in ELearning educational theory. Specifically, we refer to the work of educational theorist Robert Gagné and his nine events of ELearning [7]. Our learners are more likely to be successful because we have molded our approach to follow proven principles. We briefly describe the manner in which our system follows these nine events in Table 1.

Table 1. Table captions should be placed above the table

Event	Our System
Gaining attention	The textbook has engaging videos, live code windows, and interactive exercises.
Stimulating recall of prior knowledge	Viewing the concept graph shows the learner what concepts they have already successfully completed.
Presenting information	The textbook itself is the format for presenting content.
Providing guidance	Our future work includes having the textbook suggest exercises and chapters to review based on performance.
Elicit performance	The exercise questions and practice problems prompt the learner to engage.
Providing feedback	Each question gives feedback and explanations based on the learner's selection.
Assessing performance	The system calculates representations of their understanding of different concepts based on their performance and provides visualization in the form of a concept graph that is color coded to reflect level of understanding.
Enhancing retention and transfer	The assessment tool prompts the instructor to make adjustments to the course based on class-wide misunderstandings and the assessment prompts the learner to change their path based on performance.

7. CONCLUSIONS AND FUTURE WORK

Our system utilizes an online, interactive textbook to offer high-level assessment of student understanding. The specific examples given demonstrate the ways in which this system can aid educators in assisting individual students and improving the overall course content. The system is developed to the point where it is useful for the scenarios described above, and we look forward to putting it in the hands of real educators for use with their courses in the coming year.

However, we also see this work as the foundation of a much larger system that can provide further support for Computer Science education. Future directions include increasing the system's ability to understand different types of exercises, providing automated intervention, and creating dynamic collaborative groups based on students' current understanding. We explain each of these briefly, to give the reader a concept of the overall potential of this system.

A clear next step for the project is to expand the sources of information about student performance. Our current system is limited in the type of exercises from which it can glean information. The first version of the system relies mainly on multiple choice and other easily graded question types. However, the textbook also has interactive code windows and programming exercises that are currently hand graded by the instructor. We are aware of the body of research in automated assessment of code snippets and full programs e.g., [8]. Ideally, we plan to integrate this type software with our system via additional XML messages. Receiving assessment on these more open-ended tasks has the potential to drastically improve our estimates of a student's conceptual and procedural understanding.

Beyond collecting more data to improve estimates, our system also has the potential to provide automated adaptation and/or feedback based on these estimates. This would bring our system fully into the realm of ITS. As described above, the first version of our system relies on the instructor to provide intervention. A future goal is to automate certain types of intervention, easing the load on the educator and helping students when an educator is not readily available. The system could directly interact with students, offering suggestions of content to review and exercises to practice. The Concept Graph already contains the necessary mapping to provide these suggestions. The system identifies problem areas for a student (labeled in orange or red on their Concept Graph). The next step is to traverse the graph to reach appropriate leaf nodes, which represent content that the student should review. The greater task at hand is to create a user interface that integrates with the online textbook to present these suggestions in a useful and intuitive manner. In a similar fashion, we could consider macro-adaptation, where the book's content is altered in order to present only the information for which the user is most prepared. A large body of research in such prior work is available to leverage e.g., [9].

As a final direction of planned future work, we also see potential for our system in the realm of Computer Supported Collaborative Learning (CSCL). Particularly, we recognize the importance and challenge of group formation [10], and we see the potential to offer interesting results in the subfield of dynamic group formation. Specifically, we plan to use the information available from the Concept Graphs of different students in order to pair students that could work productively together [11]. We can also use the specific portion of the Concept Graph that prompted the pairing to suggest exercises that would be productive for the pair. This grouping concept is an active area of research for our team, and we plan to pilot test pairings within the year.

8. ACKNOWLEDGMENTS
<Anonymous>

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Carrie Lindeman

Uptown Func You Up

Functions are where it is at. They are basically little minions who do tasks for you so that you don't have to **#blessed** . Think about it like when you convince your little sibling to do your chores for you. You don't care how they do it, you just care that it gets done. Functions have a very simple workflow of input, calculation, and output. For example, the input for the function *makeBrotherVacuum()* might be a pack of 

and the output is an only moderately cleaner living room floor.

Functions are here to make your life easier. If while you are writing your code you find yourself hitting **crtl-C** and **crtl-V** more than a few times then it is time to bring the func.

In this lesson we will cover what you need to know in order to use functions and how to actually create them yourself. Specifically we are going to work in the Python language, not to be confused with the **parseltongue** language. **Yer a coder, Harry!**

What we are going to learn:

1. **Calling Functions** - Okay, so how do I make these function things happen?
2. **Passing Parameters** - These function need input? In where? In what?
3. **Catching Returns** - "If you fall I will catch you I'll be waiting, Time after time!" ♪
4. **Defining Functions** - Excuse me, I thought the point of functions was that I did LESS work! Now I have to write my own?

☎ Calling Functions

Lucky for you, calling functions is easier than calling to make your own dentist appointment. In fact, you've called a function before, like, a lot. So you know that magical spell that makes things print?  Well that is a function! You know what the input is and what to expect when you type it but **Oprah** knows you have no idea how it works.

```
print("Hey, I just met you")
print("And this is craaaaazy")
print("But here's my number")
print("Calling Functions")
```

Where you call a function is very important. The thing a function is supposed to do isn't going to happen until the line where the function is called. You know you've spied a function call when it ends with an open and close parenthesis. These parenthesis aren't always like your gym teacher's heart, empty.

Passing Parameters

You've actually already done this too. You're surprisingly good at this. Whenever you type something between the parentheses of a function call you are passing it a parameter. You can pass a function a literal or a variable. For example, the function *fridayNight()* takes two parameters. The code below passes a String variable, *tv*, and the String literal "chill". This code is totally valid (assuming they are watching something good, like OitNB).

```
tv = "Netflix"

fridayNight(tv, "chill")
```

Carrie Lindeman

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Think of parameters like pockets on a pair of particularly *fashionable* cargo shorts. There is a set number of pockets and each pocket has a purpose. You have to pass the right number of items so that the function works.

<u>Catching Returns</u>

So far all of the functions we have looked at have *done* something, but what about functions that *return* something. Using what we know about assignment, we can assign a returned value to a variable.

Yes, catching this return value might be the only exercise you get all day, and yes, you do deserve a varsity letter.

In the code below you will see a function that takes one parameter, a number representing your age. Depending on your age this function either returns the String "Yes" or "No". If we didn't catch these values then they would just go spinning into the dark void of computer's memory. But we are better than that. We assigned the returned value to the variable answer.

```
def canRentCar(age):
    if(age >= 21):
        return "Yes"
    else:
        return "No"

myAge = 17
answer = canRentCar(myAge)

print("I am " + str(myAge) + " years old. Can I rent a car? " + answer)
```

```
=============
I am 17 years old. Can I rent a car? No
>>>
```

Copy this program and getting it working. Remember that indentation matters.

Defining Functions

Easier than defining the relationship.

So far you are pretty pumped about functions but it is time to get real. If functions are going to be helpful at all, we have to be able to make our own. The syntax starts with a definition statement.

```
def example():
```

After the key term "def" you name your function. Try to come up with more meaningful function names than you come up with for your Pokémon on Pokémon Go. In the parenthesis put in comma separated variables for your parameters. These variables are used within the function for your calculations. Whatever values get passed in the parameters when this function is called will be assigned to these variables. Easy as Py-thon… sry.

```
def example(val1, val2):
```

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Write the meat of your program, whatever calculations you want done, (or brother vacuuming) make it happen!

```
val3 = val1 + val2
```

If you want this function to return a value you make a return statement.

```
return val3
```

You did it! You made a function! If when you run this function you get 5, then you even made a function right!

```
def example(val1, val2):
    val3 = val1 + val2
    return val3

print(example(2,3))
```

Let's up our game.

Code's the Reason for the Teardrops on my Keyboard 

Whether you love her, you hate her, or you are Kanye West, you have to admit that Taylor Swift is an extremely tall pop icon. And honestly, who can't get behind Taylor's alter ego, T-Swizzle. We are going to write a program that takes user input of a first name and a last name and prints the T-Swizzle version of the name.

Follow these instructions to make the T-Swizzle function.

1. Define a function with 2 parameters.
    a. Parameter1: first name
    b. Parameter2: last name
2. Write the calculations.
    a. Create a new string that takes the first letter of the first and last name and add "izzle" to the end.
    b. Example: Bob Dylan becomes "B-Dizzle"
3. Write a return statement.
    a. Return the "izzle"-ed
4. Call the function
    a. Call and catch the return of your function
    b. Print the caught value
5. Consider yourself to have swag

** If you are feeling fancy try and take user input for the first and last name!

Carrie Lindeman

Uptown Func You Up

Assignment Solution for Python 2.7

```
'''
TSwizzle - User creates a new Taylor Swift inspired name.
Date: 9/02/2016
Author: Carrie Lindeman
'''


#input: string first name, string last name
#calculation: creates new TSwizzle name
#output: string new name

def TSwizzle(fname, lname):
    name = fname[0] + "-" + lname[0] + "izzle"
    return name

firstName = raw_input("First name: ")
lastName = raw_input("Last name: ")

swizzleName = TSwizzle(firstName, lastName)

print(swizzleName)
```