Restaurant Runners
Final Concept Document

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Cognitive Science II
Fall 2010
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Abstract

Math education traditionally consists of direct instructional methods and rarely allows students to construct their own representations and artifacts of the knowledge (McKinney & Frazier, 2008). For students, math can seem decontextualized, existing only in the classroom and serving no purpose in their lives outside of homework and exams (Brown et al., 1989). As a response to this indexicalization of math, we have designed a tool to promote constructional, personal, and collaborative math learning. Restaurant Runners is a virtual world designed for 4th grade students to create and decipher visual representations and sets of data. This paper will first describe the analysis of the goals, users and media. Then it will details the design of Restaurant Runners including its navigation, collaborations, and creation features. We will conclude with the theoretical foundations that inform the design, and an evaluation of the functionality of the program.

I. Program Description

I.a. Goals

Restaurant Runners is a virtual reality restaurant program that enables learners to participate in authentic situations that allow for transfer of abstract mathematical concepts to everyday circumstances. The program encourages skill building for 4th grade students in the areas of creating and comprehending visual representations for sets of authentic data.

By interacting with Restaurant Runners, we expect student users to complete the following learning objectives:

- Gather, collect, and analyze collected or given data
- Generate tables, charts, and graphs (specifically, pie charts, bar graphs, double bar graphs, and line graphs) using given or collected data
• Determine the best visual representation within various contexts
• Understand and explain data shown in a particular representation
• Collaboratively make decisions after analyzing data
• Solve real-world and word problems using higher order thinking skills
• Transfer acquired skills into real-world situations

In addition to skill building, it is our hope that RR will provide a learning environment that enhances the natural skills and abilities of all students; thereby, increasing their mathematical confidence and possibly increase their interest in careers of math application.

1.b. Backgrounds

Traditional schooling methods do not have a history of supplying real-world contexts and authentic examples for learning math skills. Math is often taught in elementary schools as a complex, abstract discipline that exists only in the classroom and cannot be applied to out-of-school contexts (McKinney & Frazier, 2008). Students also encounter math word problems that attempt to situate the knowledge, but never provide more than a few sentences of text to create a real-world environment.

Restaurant Runners is a response to math being taught with such abstract, ineffective methodologies. Restaurant Runners situates the math in a real-world, explorable context, and provides tools for students to create authentic artifacts.

1.c. Audience

Restaurant Runners is geared toward an audience of fourth grade teachers and students, working in groups, whose schools follow New York State’s mathematics standards (found at http://www.ixl.com/math/standards/new-york/fourth). According to the NY state standards,
fourth grade students are expected to collect and organize data, create visual representations of that data, and analyze it to make decisions. Visual representations include pie charts, bar graphs, double bar graphs, and line graphs. Fourth grade is the first year where students need to make a connection between their skills and real-world application. This is a significant jump in expectations for both fourth grade teachers and students, which makes it difficult to create an environment where students can learn this knowledge with ease especially now with both federal and state educational regulations. Because our children belong to a technology-based society, many classrooms need to make a change towards integrating the skills needed for our students to be successful when they enter the world.

Restaurant Runners can be used in a variety of classroom environments, however, the program’s hope is to change those environments where math is taught abstractly and/or focuses mainly on direct instruction rather than application to the outside world. A majority of our students will come from divergent ethnic and socioeconomic backgrounds and, as with most major cities, English language learners. Prior to using RR, students will have a foundation in basic operational skills as well as a knowledge of creating graphs/charts and analyzing data as instructed by their classroom teacher.

We aimed the program towards fourth graders because this is the first year they are expected to fully apply their knowledge to real-world situations. In previous grades, students coming into the fourth grade are expected to strengthen their higher order thinking and critical thinking skills. According to Piaget (1952), they are in the concrete-operational stage which is “a period characterized by a more mature understanding of the world and objects around them” (as cited in Wolock and Buckleitner, 2004, p.5). This thinking allows for scientific exploration and thought as well as taking on various perspectives through concrete experiences.
Our students, regardless of background and skills, have the ability to solve specific problems, in
collaborative groups, through the use of technology.
Secondary users are the fourth grade classroom teachers. A majority of elementary
school teachers do not specialize in mathematics. Many teaching programs emphasize
generalities of each discipline rather than being experts in all subjects. The University of
Chicago (2010) reports that over 90 percent of elementary teachers are female and have the
highest anxiety towards mathematics. (para 5). Because these teachers are unprepared to teach
mathematics, they choose not to explore, on their own, creative and non-traditional methods of
teaching mathematics an ultimately pass their anxiety onto their female students.

However, most teaching programs and professional development instruct new and current
teachers how to use new technologies in their classrooms and ways to incorporate educational
media into their curriculum. Most teachers need programs that will easily fit into their lesson
plans and allow them to facilitate how students are learning rather than developing ideas and
strategies that allow their students to apply their knowledge. RR is an already created platform
that allow teachers to work with their students rather than at their students. It also involves
a “teacher section” that contains tools where educators can construct data and evaluative items of
their own related to the class and program. Even those with anxiety about math can incorporate
an already created program designated towards the standards they are required to teach.

I.d. Media Selection

*Why a Virtual Restaurant Medium?*

Restaurant Runners implements collaboration whereby students work in groups and
with the computer. By incorporating computer supported collaborative learning (CSCL) into
the mathematics curriculum, students are able to transfer the information received during direct
instruction and class activities into authentic real-world contexts (i.e. buying supplies, selling
dishes, making profit, etc.

According to social constructivists and psychologists, “knowledge of the world is seen
to be constructed through experience; the role of education is to guide the learner through
experiences that provide opportunities to construct knowledge about the world” (Goldman, 2002,
p. 404). The technology incorporated is no longer a medium that contains the information, but
partners with students to creates an environment that allows for communication, thinking, and
scaffolding.

In traditional school settings, there is often little to no opportunity for students to step
outside the walls of their classroom to participate and apply their knowledge to real-world
contexts. By incorporating a virtual restaurant platform, students are able to step inside a
world similar to theirs and perform functions they normally would outside of the classroom.
A restaurant setting is chosen because many young children attend places such as fast-food
restaurants where one can buy and sell food. According to the Yale Rudd Center, 84% of
parents with children ages 2 – 11 reported taking their child(ren) to a fast food restaurant within
the last week (Harris et al., 2010, p. x). 4th grade students can relate to the experience of going
to a restaurant, deciding what to order and paying for their meal. In addition, they also build
skills such as problem solving, data analysis and graphing based upon each case presented within
the program.

Each group creates and runs a restaurant, but more importantly, they take the information
gathered or created from an average day to create new information and knowledge, which is
shared and analyzed by everyone in the class. By receiving the same cases such as determining
profit or stockroom storage, students are expected to determine their data, decide which type of
graph best represents the data, use the program to create these graphs and share them with other
users who can access them by visiting their restaurant.

By sharing restaurant and avatar graphs, or artifacts, with each other, students are able
to see how other students represent and analyze their data thus allowing for a layering of these
different viewpoints and interpretations. As each case and experience within the restaurant
business becomes richer and more complex, students continue to layer and build upon their
thinking about these mathematical concepts thereby reforming their understanding and allowing
for deeper cognition.

I.e. Competitive Analysis

Diner Dash (DS/PC) (resource management)

Single player, casual game

Diner Dash is a resource management game in which the player takes on the role of the
waitress is and given various customer types (number in group, time it takes to eat) and table
settings (2,4, and 6). The player must seat the customers, provide menus, take their orders,
deliver the orders, and clean-up/collect tip. All of these tasks are done simultaneously and it is
the player’s responsibility to keep the customers happy by providing timely service. The game
provides an authentic context for which the player interacts with the challenges.
Cake Mania (DS) (resource management, upgrades)

Single player, casual game

Cake Mania is very similar to Diner Dash, only with a specific goal of creating the correct cakes from a series of options within a reasonable time limit. Customers each have a cake they want made, and you have organize your equipment and process to provide the cakes before the customer walks out. As you progress through the levels, upgrades to your production equipment and the types of cake are expanded.
Neopets (Web) (avatar involvement, economy)

Multiplayer interactive, virtual world

Neopets originally developed as an economy simulation for college students. As it became popular, other aspects were added in, such as a pet avatar. The base of the virtual world exists to collect rare items, items in general, and to sell or auction those virtual goods to other players, or buy stocks in the virtual AI-run stores. Communities surrounding interests evolved, as well as a pet avatar, which never dies but becomes sad. Food is provided free daily, making the focus of feeding the pet purely for entertainment. Players can gain in-game money through playing virtual-world themed games which reward points for completion. Virtual pet homes were included but not the most utilized feature, as it did not correlate directly with the economy basis. A continuous narrative was created involving in-game characters based upon the pets available and made up holidays. Players are able to explore various worlds to pick up different themed
items for their stores. The economy was complex enough that players could utilize excel sheets to track sales, profits, and popular items. (Review based on Neopets 2003/2004, before being bought by Viacom).

Restaurant Runners emulates the virtual world interaction with an in-world maintained economy. However, it focuses more on presenting the data collected through interaction than the interaction taking place. While Neopets could be played for hours on end, Restaurant Runners is designed in such a manner that the interaction can fit within a normal 50 minute classroom session. The students do not need to interact outside the allotted time within class to utilize the tool correctly.
**SimFarm (PC)** (resource management, economy)

*Single player, Simulation*

The player owns a farm and is provided a starting budget in which to develop the farm lands and decide what to plant/buy. Animals must be fenced, and two animals have the potential to procreate. Crops are dependent on the game controlled weather and animals can be destructive. It is the player’s goal to create a self-sustaining farm under the various constraints.
Restaurant Runners utilizes simulating the management of a restaurant and observing the results. SimFarm focuses more on maintaining a farm and expanding what resources are available, whereas Restaurant Runners is more about using what is available, balancing the in game economy and interpreting the results, not acting on them necessarily. If a restaurant goes below budget, the teacher can step in and provide the group with more resources, but encourage them to understand the result. SimFarm is more finite with the player requiring loans or starting over.

Animal Crossing (DS) (multiplayer involvement)

Single player, multiplayer option, life simulation

Gameplay occurs in real time, including player interaction. Holidays and night/day are effected by the internal DS clock. The game involves socializing and interacting with other players via the Wifi connection and sharing items.

Students are interacting with their restaurants at the same time during class. However, the sharing of items is only done through purchases, not through sharing supplies. While supplies are
being moved around, they are not by such a collaborative means.

Survey Monkey (PC) (graphing data)

This web service collects data from user created surveys and allows the user to manipulate the data as they see fit. The data is automatically produced from the program into the graph medium the user selects. The graphs (visualizations) can then be exported or shared in a variety of methods.

While the base data is provided to the students in a similar manner through the Register and Avatar representational graphs, the tools to create the graphs differ. Instead of automatic creation of graphs from the data, students are provided a tool in which they can manipulate the interface to demonstrate graphical representation. For example, instead of a bar graph being generated for them, they will have to pull the bar to the height they feel represents the data best.
II. Design

II.a. Tech Specs

Hardware:

Any type of computing platform meeting the following minimum requirements.

- CPU Clock Speed: 433 Mhz
- Display Resolution: 1024(H) x 600(V)
• Peripherals: Keyboard/Mouse/Wireless or Wired Network support

Software:

• Acid2 Compliant Web Browser
• Google Chart Tools
• jQuery Javascript Library
• Language: JAVA (J2SE) / PHP
• Web Server: Tomcat / Apache
• Relational Database: H2 / PostgreSQL
• Document Oriented Database: CouchDB

II.b. Feature Set

Group

• Restaurant Stockroom

The Stockroom provides students with an environment in which to modify inventory to view the results of having other students interact and purchase inventory from their store. This information can then be applied directly in graphs, for a situated learning environment. Inventory is initially setup through students having a set number of items they can add to their store. Once the students enter the restaurant for the first time, the items are assigned monetary value automatically from the backend system. This helps to jumpstart the in-world economy.
Artifactory

Students have the ability to collect and analyze their information from their stockroom in the artifactory. Students can look at other group’s artifactory to compare information and lead to discussion as to the reasoning behind choosing a particular representation.

- **Grapher function** allows students a quick method to produce clean, clear graphical representation to present to the team, class, and/or teacher. It contains a history of the graphs created for reflection and comparison.
• Customization

  ○ Name, Cuisine, Menu

  Personalization of the restaurant experience is key to the student’s experience. This provides them with a direct connection to the information being created and incentive to continue use.

  ○ Look and Feel

  Not only do students create and modify information, they can personalize their store decoration, such as wall paint color. This provides another method for students to become further engaged with the experience.

• Challenge
Teachers provide challenges to the students to focus on what data they should be focusing on representing over the use of the product. These can be weekly assignments for the group, or extra credit questions that may aid the students in obtaining extra resources in their restaurant. Allowing the teacher to customize to their current curriculum is important to connecting the more abstract material being taught to the experience contained within the virtual world.

- **Register**

  The Register serves as a reflection point for students to obtain the data that their store is producing through sales, purchases, and interaction from the other students’ avatars. This data is represented in the graphics of the Artifactory.

- **Townscape**
The Townscape represents the student’s restaurants and is the method for which students can explore what their classmates are doing passively, compared to when shopping for their avatar’s meal. A link to the restaurant’s artifactories are linked from this view for easy access, to make an easy connection between the restaurant environment and the data being displayed.

**Individual**

- **Townscape**

  The Townscape is the access point for students to explore and purchase meals for their avatars. This provides them the ability to enter a restaurant of their choice and view the menu to feed their avatar. The in-game economy is maintained through these interactions.

- **Avatar food choice**

  Students can choose what they want to feed their avatar. They are provided an allowance of funds to spend on feeding, of which the type cuisine is represented in a food choice graph, which students are encouraged to keep balanced. Should one section of cuisine become over saturated, the student will be encouraged to purchase food from other options.
- **Happiness meter**

  The student’s avatar will become unhappy if the student does not maintain their avatars’ hunger level. This happiness will be tracked over time, for students to have accountability for their avatar interaction.

**Teacher**

- **Setup for classroom**

  The teacher is able to set up Restaurant Runners to match her classroom, including the number of students she has and how many students she would like to be in each group. The teacher can also pull cuisines from a Restaurant Runners directory to give the students a manageable selection of restaurants types to choose from. The number of items on a menu can also be determined by the teacher in this stage.
• **Artifactory (Student data)**

  The teacher has access to each group’s Artifactory, where all the graphs and data that the students have collected and created is stored. With this feature, the teacher can check students’ work, compare graphs, and pull different artifacts from her class archive to present as examples.

• **Grapher**

  The teacher has access to the grapher and can use it in a similar way that the students use it, to make visual representations. The teacher can use the grapher to graph students’ data across different restaurant to show a class comparision. The teacher can also use it to create sample graphs to guide the students’ process.

**II.c. Flowchart**

This flowchart is divided into four sections: Set up, Inside the Restaurant, and the Townscape, which includes other restaurants and the teacher’s view. The assembled version of this flowchart can be seen in Appendix C.

*Set Up*
Inside the Restaurant
II.d. User Story

During today’s math session, Ms. Pascale-Parra tells her students that it is a challenge problem day. Since her class has been working on single and double bar graphs, Ms. Pascale-Parra wants to see what types of representations each group will create based on what they have learned so far. Groups are to go into Restaurant Runners, take care of any maintenance for their
avatars, register and stockroom, and then work on challenge #4. Ms. Pascale-Parra also reminds her students to label their graph with “Challenge #4” somewhere in the title so that she can search for them through the teacher part of the program.

Jose, Arpine, and Emma are a returning group to Restaurant Runners. After logging in and selecting their Bengali Restaurant, Jose’s avatar pops a message indicating that he is hungry! Before getting to their challenge problem, the group decides that it’s important for Jose to feed his avatar first. While Jose feeds his avatar, Arpine and Emma will log in to a nearby computer to start looking at their stockroom.

Jose chooses his avatar in the menu and from the circle graph, shown below his avatar’s face, he sees that he has only eaten from three of the five restaurants in the class. 40% of his meals came from the German restaurant, 30% from his own Bengali restaurant, and 30% from the Jewish restaurant. After analyzing his circle graph, Jose determines that he needs to eat a meal from the Soul Food restaurant or the Chinese restaurant. He decides to try Chinese today and heads over to that restaurant under the city mode to look at the menu. Jose selects a spring roll for an appetizer, a spicy beef noodle soup for the main dish, and a green tea to drink. Once the purchase is confirmed, Jose sees his avatar’s face go from a frown to a smile and his circle graph changes to include the Chinese restaurant.
Jose also makes a note that the next time he eats, he will need to order from the Soul Food restaurant. If he doesn’t eat from that restaurant, it will slow his team’s progress as his avatar will be unhappy from not having a balanced diet which will require him to spend more time taking care of his avatar rather than working with his group.

Now that Jose’s avatar is fed, he joins Arpne and Emma to work on the challenge problem. Challenge #4 states:

It's Friday and you are counting how much of each item on your menu you sold this week. Compare how many dishes you had in your stockroom on Monday, with how many you have today. Create a representation to show how many of each dish you sold this week. Which dish sold the most number of items?
In the stockroom, Emma, Arpine, and Jose check the stock log to see how much stock they had on Monday. They find that on Monday they had 20 servings of curry, 15 servings of tikka masala, 10 glasses of lassi, and 10 chicken lollipops. They did not restock all week. Today, Friday, they have 5 servings of curry in stock, 2 servings of tikka masala, 5 glasses of lassi, and 4 lollipops.

Before making their graph to answer challenge #4, Arpine suggests that they should make a chart of the information presented:

<table>
<thead>
<tr>
<th></th>
<th>Curry</th>
<th>Tikka Masala</th>
<th>Lasso</th>
<th>Chicken Lollipops</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td>20</td>
<td>15</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Friday</td>
<td>5</td>
<td>2</td>
<td>5</td>
<td>4</td>
</tr>
</tbody>
</table>

From there, they decide that the best way to show this information is through a double
bar graph. In Restaurant Runners, Emma clicks on the “Artifactory,” at the top of the program, then on “Create Representation,” and finally on “Bar Graph.” Within the “bar graph” mode, Emma uses the drawing tools to move lines, bars, and titles around based on how her group decides the graph should look. They come up with the following representation and save it into their “Artifactory”:

Before completing this challenge, the group needs to use the graph to answer one final question: “What dish sold the most number of items?” Arpine suggests that they look to see which of the red bars is the lowest to figure out the answer since it makes sense that the one with the least number probably sold the most. Emma responds by stating that the red bars show how many items are left by the end of the week, but some dishes had more items on Monday
than others. Jose agrees with Emma and everyone looks at the graph again. After a discussion
of various solutions, Emma suggests that if they look at the space above each red bar up to the
top of the blue bar, the one with the longest gray space is probably the one that sold the most
number of items. Everyone agrees that this is the best solution and they determine that the
Curry dish sold the most number of items because the space between the top of the blue bar and
the top of the red bar is the longest; therefore it represents the most number of dishes sold that
week.
To double-check their work, Jose states that they should find the difference between
Monday and Friday’s dish numbers. Their work shows:
Curry = 20-5 = 15
Tike Masala = 15 – 2 = 13
Lasso = 10-5 = 5
Chicken Lollipops = 10-4 = 6
Based upon their reasoning from the graphs and the calculations above, the group decides
that they have solved the challenge problem correctly. Their final answer is:
“Curry sold the most number of items = 15. The graph shows that Curry has the most
space between the blue (Monday) and red (Friday) bars. We checked our work by
subtracting Friday’s item number from Monday’s item number for each dish. Curry
ended up with the highest number.”
Satisfied and confident, the group submits their answer to Ms. Pascale-Parra via the Challenge
page in Restaurant Runners.
By completing this challenge, Jose, Arpina and Emma had to collaborate to find a
solution to an ill-defined problem. They were given a scenario, but they had to come up with
the data, the method of representation, and the solution on their own. Each team member used Restaurant Runners’ stock log, and each other as means of distributed cognition (Perkins, 1993), working in their own zone of proximal development (Vygotsky, 1978) and helping each other comprehend knowledge just out of their reach.

Ms. Pascale-Parra is able to look at all graphs in Challenge #4 made by her class. On Monday, she brings prints out the graphs and hangs them up in her class. The students are able to compare each other’s highest selling menu items. Ms. Pascale-Parra asked the group to consider which item sold the most out of all the restaurants, and why they think that might be. Does the item have a catchy name? Is it something the students like to eat in their own lives? This way, the students can reflect on their choices and on their restaurant’s menus.

Then, Ms. Pascale-Parra chooses to have her class work together to make a graph that displays the most popular items out of all the restaurants. She sets up Restaurant Runners on the classroom projector and has volunteers create a data set on the whiteboard first, and then a graph online in the program. This graph is shared to each restaurant’s Artifactory. As the students give each other suggestions on how to create the graph, Ms. Pascale-Parra facilitates and adds guiding suggestions when the students get off-track. By helping the students create a visual representation as a large group, Ms. Pascale-Parra is scaffolding them to be able to create accurate and effective graphs in their small groups without her help.

II.e. Theoretical Design

See Theory Paper in Appendix A.

III. Future Directions

The base structure of Restaurant Runners can be applied to a variety of disciplines. Topics such as nutrition, business, and culture could be focused on within the virtual world
rather than graphical representation through minor changes in the setup and player interactions. Should the students be required to keep track of the different ingredients for each meal, the complexity would be increased to include a much stronger resource management and economy focus.

Curriculum could be created for the teachers based upon state standards, for easy integration into their classrooms. Base concepts could be paired with challenge questions that teachers can set up within the program.

Mobile integration of the virtual world would allow students a more frequent interaction with the data created. Students could feed their avatar on a daily meal schedule, and the interaction individually would be more similar to a virtual pet. This would effect the data created by the in-game economy and provide more data for the students to parse. This interaction would most likely be limited by avatar interaction and data viewing, as the group activity of running the restaurant would still be encouraged, along with the creation of representational graphs, to encourage discussion and reflection of decisions.

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V. Appendixes

V. a. Theory Paper

Restaurant Runners Theory Paper

Restaurant Runners (RR), geared specifically towards 4th grade elementary students, is a virtual reality restaurant program that enables learners to participate in authentic situations that allow for transfer of abstract mathematical concepts to everyday circumstances. Grounded in constructivist epistemology, Restaurant Runners aids teachers in eliciting skill-building knowledge of creating and comprehending visual representations, from their students and connecting it to their lives and the lives of others through knowledge construction. Even further within this philosophy, the program incorporates social constructivism as students are not working alone, but with each other, the teacher, and the computer to create charts and graphs in order to analyze data.

Under the umbrella of the constructivist epistemology, there are related learning theories and instructional approaches that support the design of a virtual learning environment. Based on New York City’s 4th grade mathematical standards, Restaurant Runners incorporates a situated learning environment using the virtual world as an anchor to present various cases that students need to solve. The technology is also viewed as a partner within the environment, or person-plus that contains knowledge created which each group member, their teacher, and classmates can reference again. By incorporating a computer supported collaborative learning approach, the program facilitates and scaffolds knowledge building through collaboration.
I. a. Restaurant Runners: Why Math?

Although there have been significant gains in mathematics proficiency among 4th graders in state testing, New York is far from ranking at the top of the national list in math proficiency. The National Assessment of Educational Progress (NAEP), which is “managed by the Department of Education’s National Center for Education Statistics and is currently the ‘gold standard’ of assessments” (Peterson and Lastra-Anadon, 2010, para. 4), announced that New York is ranked 26 out of 51 (including the District of Columbia) in 4th grade mathematics proficiency. 40% of New York State’s 4th grade students scored proficient or above on grade-level proficiency assessments determined by NAEP; the national average is 39%. There are a multitude of reasons that contribute to such low proficiency, however, some believe that one major factor is the teaching techniques used in the classroom, which inhibit skill transfer.

Traditional schooling methods do not have a history of supplying real-world contexts and authentic examples for learning mathematical skills. Math is often taught in elementary schools as a complex, abstract discipline that exists only in the classroom and cannot be applied to out-of-school contexts (McKinney & Frazier, 2008) Conventional math strategies are based in direct instruction and mainly include drill-and-practice where students are expected to repeat and memorize formulas or instructions used to solve equations or problems (McKinney & Frazier, 2008). Each task of a more complex problem is taught in isolation rather than allowing students to discover the concept holistically by developing their own methods of problem solving.

Students also encounter math word problems that attempt to situate knowledge, but never provide more than a few sentences of text to create a real-world environment (McKinney & Frazier, 2008). Our children today participate in a rich and multicultural society that is
constantly re-inventing itself both technically and socially. Because of this, word problems often are not relevant to their own lives, but rather contain circumstances that the publisher believes the average American student would understand.

Mathematical textbooks also neglect the need to acknowledge gender-learning differences in mathematical cognition and gear their lessons and problems towards the male mind rather than create an environment that, as Bryson and de Castell (1995) state, places “greater emphasis on the ways in which differences are produced through social relations and institutional practices, rather than on how to create, reify, and consolidate differences by liberalizing curricular options or increasing the number of legitimated ‘ways of knowing’ from one to two” (as cited in Goldman, 1998, p. 65).

Because elementary teachers are expected to teach all the major disciplines to their students, there are many of them who do not specialize in mathematics. According to the William Harms at the University of Chicago (2010), “more than 90 percent of elementary school teachers in the country are women, and often they get their teaching certificates with little mathematics preparation. Other research shows that elementary education majors have the highest rate of mathematics anxiety of any college major” (Harms, 2010). Due to lack of preparation, many elementary school teachers choose not to explore, on their own, creative and non-traditional methods of teaching mathematics due to their anxiety about the subject. They can pass this anxiety to their students, and specifically female students (Harms, 2010).

Restaurant Runners is a response to math being taught with such abstract, ineffective methodologies. The program situates the math in a real-world, explorable context, and provides tools for students to create authentic artifacts. After direct instruction, teams of students, in groups of 3, apply their knowledge of gathering, graphing and analyzing data through a virtual
world anchor that is situated in a restaurant environment. All teams are given cases related to running a restaurant, which can be transferred to real life situations. By incorporating media technologies, specifically, a virtual world through the medium of a computer, students can construct their learning with the teacher as facilitator of knowledge rather than the main instructor of mathematics education.

Of course, further iterations of the program will include options to branch off to other subjects and topics such as nutrition, foods of the world, or business strategies. Because there is a need for improving mathematics instruction, we conceptualized a virtual restaurant world that focuses on math.

I. b. Restaurant Runners: Why a Virtual Restaurant Medium?

Restaurant Runners implements collaboration whereby students work together in groups and with the computer. By incorporating computer supported collaborative learning (CSCL) into the mathematics curriculum, students are able to transfer the information received during direct instruction and class activities into authentic real-world contexts (i.e. buying supplies, selling dishes, making profit, etc. . .).

According to social constructivists and psychologists, “knowledge of the world is seen to be constructed through experience; the role of education is to guide the learner through experiences that provide opportunities to construct knowledge about the world” (Goldman, 2002, p. 404). The technology incorporated is no longer a medium that contains information, but one that partners with students to create an environment that allows for communication, high level thinking, and scaffolding.

In traditional school settings, there is often little to no opportunity for students to step outside the walls of their classroom to participate and apply their knowledge to real-world
contexts. By incorporating a virtual restaurant platform, students are able to enter a world similar to their own and perform functions they normally would outside of the classroom. A restaurant setting is chosen because many young children attend places such as fast-food restaurants where one can buy and sell food. According to the Yale Rudd Center, 84% of parents with children ages 2 – 11 reported taking their child(ren) to a fast food restaurant within the last week (Harris et al., 2010, p. x). 4th grade students can relate to the experience of going to a restaurant, deciding what to order and paying for their meal. In addition, they also build skills such as problem solving, data analysis and graphing based upon each case presented within the program.

Each group creates and runs a restaurant, but more importantly, they take the information gathered or created from an average day to create new information, which is shared and analyzed by everyone in the class. By receiving the same problems such as determining profit or stockroom storage, students are expected to examine their data, decide which type of graph best represents the data, use the program to create these graphs and share them with other users who can access them by visiting their restaurant.

By sharing restaurant and avatar graphs, or artifacts, with each other, students are able to see how other students represent and analyze their data thus allowing for a layering of these different viewpoints and interpretations. As each case and experience within the restaurant business becomes richer and more complex, students continue to layer and build upon their thinking about these mathematical concepts thereby reforming their understanding and allowing for deeper cognition.

In addition to being a partner in the student’s learning, a virtual environment allows for each student to engage and interact with his/her learning. While paper and pencil are still
important to mathematical instruction and understanding, our children are growing up in an advanced information and technological society, and so they need a medium that speaks to how the world operates today. Through the use of computer technology, all students, are able to take control of their own learning and allow for what Ricki Goldman (1988) refers to as “genderflexing.”

Regardless of gender, students are able to participate and make use of their mathematical skills outside of the realm of math itself. Our concentration is focused specifically on the building and transfer of skills within a specific context. Because students are working in groups and partnering with other students and the teacher rather than engaging in whole class discussions, the teacher’s and fellow student’s gender stereotypes and actions or reactions are reduced resulting in a decrease of gender stereotyping within these major abstract concepts. The focus is placed on working with interesting and engaging materials as opposed to a traditional classroom or neutral material therefore allowing deeper and richer cognition (Goldman, 1988, p. 9).

II. Philosophies

Restaurant Runners is grounded in the constructivist epistemology for it is a tool that guides the learner in constructing knowledge (Reiser & Dempsey, 2007, 54). Restaurant Runners assumes that the learner has some prior knowledge in the domain of graphing data. While the design of Restaurant Runners is based on a constructivist framework, we recognize that the learners may have acquired prior knowledge through other epistemological approaches, such as behaviorist or objectivist frameworks. Here, we will provide a discussion on these different learning philosophies and why we chose Restaurant Runners to be grounded in constructivism.
Behaviorism

The behaviorist learning philosophy assumes that behavior can “be fully understood in terms of environmental cues and results” (Driscoll, 2005, 33). The environmental cues serve as antecedents to behavior, and the results are the consequences. In this model, what goes on in the mind during learning is extraneous information; the learner’s mind is a “black box” and nothing is known about what happens inside it (Driscoll, 2005, 33). Knowing what happens inside the mind during learning is not essential for understanding how behavior is directed by the environment. The psychologist who is most closely linked to behaviorism is B. F. Skinner, a man who proposed a system of rewards and repercussions to shape a learner. Today, Skinner’s philosophy can be seen in the classroom especially in regards to behavior modification (of study habits, for example), classroom management (providing students with rewards for good behavior), and improving performance (Driscoll, 2005, 56-62).

In our case, 4th grade mathematics, the behaviorist paradigm might be enacted in the classroom by means of rewarding students who produce the right answer to a math problem, and punishing those who come up with the wrong answer.

Objectivism

Objectivism is classified as an epistemological orientation (Driscoll, 2005, 12), a design framework (Reiser & Dempsey, 2007, 54), and a philosophical tradition analogous to empiricism (Smith & Ragan, 2005, 22). Objectivism assumes that reality is external and separate from the learner (Driscoll, 2005, 12). The instruction that often accompanies objectivism is teacher directed, goal-predetermined, and contains teacher/school-driven activities and assessment (Reiser & Dempsey, 2007, 54). Mathematics instruction has been typically taught in an
objectivist framework in which the teacher imparts knowledge to the students in an “explain-practice-memorize” teaching paradigm (Newstead, 1998, 55). Because of the popularity of objectivism in math instruction, we anticipate that the prior knowledge in charts and graphs gained by Restaurant Runners learners may have been imparted in a direct instructional method, in which the learners were the recipients of the information. 

*Constructivism*

Behaviorist and objectivist epistemologies assume that there is an external reality that becomes clear to learners through their experience with it. Constructivism, the framework we used for the design of Restaurant Runners, proposes that each learners construct their own reality as they attempt to make sense of their experiences (Perkins, 1991a, 18). The roots of this philosophy lie with Jean Piaget who says “Knowledge is not transmitted: it is constructed” (Smith & Ragan, 2005, p.30). Piaget created a theory of development, which comprises four stages through which learners proceed in a distinct order: assimilation, accommodation, disequilibrium, and equilibration (Smith & Ragan, 2005, 30). This process describes what happens cognitively as a learner acquires new information, and restructures the new knowledge to assimilate and accommodate existing knowledge.

The goals for constructivist instruction include problem-solving, reasoning, critical thinking, and the active and reflective use of knowledge (Perkins, 1991b, 20). The design of Restaurant Runners incorporates all of these goals.

*Problem solving:* Learners uncover a variety of problems in the virtual world where they run a restaurant. They must manage the restaurant’s stockroom so that there are enough ingredients to provide meals for their customers. Learners need to survey the ordering habits of their customers to decide which meals on the menu are most popular, and therefore which ingredients need
to be more heavily stocked. They must keep their avatars healthy and well-fed with a diverse
diet consisting of meals from their classmates’ restaurants. Finally, learners must balance their
restaurant’s budget, bringing in enough profit to keep the stockroom full. The problems that
learners encounter are solved by the learners themselves, with no correct answer provided by the
teacher. The students’ understanding of the problems in the virtual world will be scaffolded by
the program and the teacher, but not directed. Students will build their own representations in
the form of charts and graphs to address the problems they encounter.
Reasoning: All problem-solving activities must be represented by graphs or charts. Students will
apply the knowledge they have gained in this domain to choose the best graphical representation
for the data at hand. Again, this reasoning does not have a correct answer and is generated solely
by the students.

Critical Thinking: Restaurant Runners allows students to explore the workings of a restaurant
including profit and loss, stock of materials, and marketing to consumers. The manipulation of
one element of the restaurant will effect the other elements in this dynamic system. Students
must make choices about how to best run the restaurant by considering the functionality of a
system and the direct and indirect consequences of their actions.

Active and reflective use of knowledge: The virtual environment of Restaurant Runners affords
active decision making and problem-solving. After a team of students chooses which items on
the menu are successful, for example, they must reflect on their choices by representing them
as a graph or chart. The production of these representational artifacts will allow learners to
visualize and reflect on their decisions.

Social Constructivism

To delve deeper into the philosophical foundations of our design, we must move from
constructivism to social constructivism. Lev Vygotsky (1978) was a critic of Piaget. While Piaget focused on meaning construction as an individual process, Vygotsky proposed that it was social, that learning and meaning making are collaborative (Smith and Ragan, 2005, p.30). In Vygotsky’s opinion, “the social world influences development from the beginning of life: independent activity occurs as children internalize culturally mediated higher mental processes they have previously been able to do only with help” (Tudge & Rodoff, 1989, p. 38). Vygotsky stated that learning precedes development, and that much learning takes place in the “zone of proximal development,” a learning space in which the learner cannot solve the problem at hand without assistance from a teacher, more knowledgeable peer, or program (Smith and Ragan, 2005, p.30).

Restaurant Runners is grounded in social constructivism. The program is designed so that learners work in small teams of two to three people and that each learner takes on a separate, but interdependent role. To participate in problem-solving, graphical representational development, and virtual restaurant management, learners must draw on their own and each other’s knowledge, as well as the knowledge distributed in the program itself. The problems posed in Restaurant Runners exist at in the zone of proximal development, encouraging learners to work together, with the program, and with their teachers to create the graphs and charts that represent their team’s Restaurant. The creation of artifacts in Restaurant Runners is a constructivist, social process.

*Why Constructivism?*

We feel that a constructivist philosophy is appropriate to inform the design of Restaurant Runners. Our goal is to create a learning environment that is social, learner-directed, and affords collaboration. These features are all addressed in the constructivist framework (Smith & Ragan, 2005).
Jean Piaget (1952) categorized human thinking into concrete and formal categories, calling formal thinking “higher level thinking” (Papert, 2000, 231). Higher level thinking is abstract, and involves thinking about thinking itself. It can be cultivated by encouraging the learner to reflect on her own decision making and the steps she took to arrive at a solution. Higher level thinking is valued both in constructivist epistemology and in the design of Restaurant Runners. We aim not only for students to come up with functional solutions, but for them to reflect on how and why they arrived at those answers.

In providing tools for students to partake in higher level thinking, Restaurant Runners was informed by Seymour Papert’s (2000) theory of constructionism. Piaget makes a distinction between concrete thinking and formal thinking (higher level thinking). Papert posits that learning with a computer makes formal thinking concrete (231). By the process of actually constructing and having control over a system, students become “epistemologists” and engage in discussions about their own thinking (Papert, 2000, 229). In Restaurant Runners, students are able to produce charts and graphs to represent data they are collecting about their virtual restaurant. This act of actually making artifacts (existing visual representations that can be shared and printed) is an instance of using the computer to take higher level processes and make them concrete.

In addition to focusing on higher level thinking and constructing artifacts, the design of Restaurant Runners is concerned with collaboration. The design of Restaurant Runners affords group work, collaboration, discussion, and higher level thinking among many minds. In a group, multiple perspectives coincide and conflict, spurring discussion. This is the phenomenon of organicism, where many components interact and some appear to be in opposition, but
when examined from a global perspective, they are in cooperation (Feltovich, et al., 1996, 37). In Restaurant Runners students produce a number of graphs and charts to represent the data they collect while running their restaurant. The data represented as well as the manner of representation is decided by the students themselves. The joint decision making process leads students to discuss and challenge each other’s solutions, thereby partaking in formal thinking (Piaget, 1952) in a collaborative manner. Because we value the affordances of a social context for learning, our design is also grounded in social constructivism.

As aforementioned, we anticipate many users of Restaurant Runners to have prior knowledge in data representation, imparted to them by methods based on both objectivist and behaviorist philosophies. We aim for Restaurant Runners to provide students with a space to find personal meaning in mathematical representations. Therefore, we have based our design on constructivist, constructionist and social constructivist frameworks to allow students not to be the recipients of knowledge, but the constructors of it.

III. Theories

The central purpose behind Restaurant Runners is to create a collaborative environment where students interact, share, and engage in constructive learning together. As per Brown, if the process that leads to knowledge creation is both integral and inseparable from learning, it is not unlikely that cognition is distributed in the learner’s surround and among other learners (Brown et al, 1989, p.32 & Pea, 1993). To facilitate this distributive learning process, Restaurant Runners was designed with an integrated ecosystem or surround that tied together all the participants in an interlinked web. The ecosystem is based on the simple notions of supply, demand, and consumption of food. The tasks that are carried out by the students directly impact not only their
well being, but also other students situated in their world. Which restaurant an avatar visits or what a restaurant decides to serve from day to day will change the dynamics of this restaurant world. The choices these students make generate meaningful residue, in the form of graphical artifacts that are the products of shared group activities and discussions.

Distributed Cognition

Knowledge representation, retrieval, and construction are central to the way Restaurant Runners approaches distributive cognition. These “access characteristics” are vital to a distributed system that expects to result in cognition (Perkins, 1993). Since Restaurant Runners is a supplement to daily classroom activities, students engage the platform with some preexisting declarative and procedural knowledge that is based on current teacher lessons and prior math related experience. Additionally, student access to textbooks, notes, past homework are also pertinent forming the knowledge domain. The acquired knowledge is represented in both an analog and a digital form. The group of students will create graphs and other visual representations based on instructor lessons and then subsequently transfer and apply that information to the Restaurant Runners ecosystem in recording various avatar and restaurant characteristics. Since Restaurant Runners is an ecosystem of students and their restaurants, artifacts created by any individual or group will be available for others to see. This helps to create a community of practice that allows novices to learn from experts and generate constructive dialog.

Person-Plus

As a “person-plus” environment, Restaurant Runners also supports knowledge retrieval and construction. As students create graphical representations of the activities in their virtual world, all their artifacts are archived chronologically by the Restaurant Runners software in a
section called the Artifactory. The retrieval of these artifacts is made easy by the software as each group can readily access their own information from their store’s personal Artifactory. Other students in the classroom can also view the current snapshot of the various artifacts through the townscape view, a town-like grid of all the restaurants available by the system. In addition to these seamless data access mechanisms, Restaurant Runners also gives students access to a guided plotting tool. While the students can create visual artifacts outside the bounds of the software with teacher run exercises, the software allows the students to apply that knowledge to their virtual world in managing not only their restaurants, but their avatars as well. In managing this virtual environment, learners naturally engage in reflection as they justify their actions as graphical artifacts. Finally, since each group is able to see a holistic view of the artifacts in the repository, they can chronologically layer and “assemble the pieces of knowledge retrieved into new knowledge structures” that afford them wider perspectives (Perkins, 1993 p. 91).

Emphasizing the collaborative nature of the environment, students are introduced to the Restaurant Runners platform as a team. Their very first task is to establish their collective group identity. From the naming of the restaurant to choosing the cuisines and setting up the restaurant for day to day operations, students are situated and anchored in simulated case study or problem solving situations. The tasks that are carried out by the students directly impact not only their well being, but also other students situated in their world. Which restaurant an avatar visits or how a restaurant is designed and what it serves from day to day will change the dynamics of this restaurant world. In essence, by participating in this virtual world, the students and their groups are motivated by an emergent narrative of their own making. As a result of their interaction with other students and the environment, students can engage in generative learning by solving
complex and interconnected subproblems in a data domain that is meaningful. Finally, since the
settings, characters, and events are deeply connected to the students, the system should afford
better opportunities for transfer of skills.

_Situated Learning_

Since knowledge is a product of the activity, context, and culture in which it is situated,
developed, and used, the Restaurant Runners platform presents students with an environment
that models an authentic activity. By taking on the role of restauranteurs and consumers,
students “gain access to the standpoint that enables practitioners to act meaningfully and
purposefully” (Brown et al., 1989). In trying to facilitate meaningful knowledge acquisition,
Restaurant Runners enables the students to view learning as a process of internalization and not
just information processing. Engaged in an environment that situates the learner in a simulated
business environment, the complexities of managing supply, demand, and consumption in an
interconnected world forces the students to not only define the problem, but also solve them
while involving their personal beliefs, collaborating and negotiating with other students. Through
this iterative process of interaction with group members and the community of restauranteurs,
students are able to construct knowledge and skills that are rich and widely applicable.

_Cognitive Apprenticeship_

Restaurant Runners also utilizes some of the principles outlined by the cognitive
apprenticeship model in order to generate problem solving knowledge that is not inert. Through
this non-didactic teaching process, students learn complex skills by observation, coaching,
and successive approximation and build conceptual models for properly integrating various
disparate skills. In trying to carry out the various tasks dealing with the store, the problems
are attempted both individually and in groups. From managing the stockroom of goods, to
deciding what is on the menu, to maintaining the register, all these tasks on the surface guide the students in deciding how to run their restaurant. However, all the decisions made by the students must be justified. The justification part is carried out by choosing and plotting the appropriate graphical representation for the statistics or data that influenced their decision. The heuristics for carrying out these tasks will be influenced both by the feedback from the group as well as the strategies that are demonstrated by the instructor at the start of class. The entire graphing process is scaffolded and sequenced. It guides the student as the system progressively discloses more information as the student traverses the plot related decision tree. At any point, the student can employ control strategies to manage, direct, and change problem solving methods without disrupting the thought process. While students will implicitly reflect on their decisions as they choose how they want to represent the raw data at hand, the group also collectively diagnoses all the artifacts to make sure they all agree on the proposed solutions generated by their teammates.

CSCL

Restaurant Runners is designed for meaningful learning through mindful engagement and active participation in a virtual world. This virtual space brings together a multitude of complementary learning theories. Restaurant Runners is essentially a type of CSCL (Computer Supported Collaborative Learning) environment that creates a Knowledge Building Community. The community construction is supported both by the overall goal of the software and the Artifactory. The Artifactory is essentially an aggregate view of all the participants in the class and their generated artifact. All the artifacts generated by the various student groups are present for viewing by all the other groups. In order to support learning at the level of the individual and the group, this environment draws upon the principles of Cognitive Flexibility Theory (Spiro, 1990) and Perspectivity (Goldman-Segall, 1995).

Perspectivity
Although the Perspectivity Framework (Goldman-Segall, 1995) is associated primarily with video data, it’s emphasis on collective view points over isolated and individualized point of view is an important consideration for Restaurant Runners. As members of a restaurant team manage the various facets of their endeavor, they may gain insight to either the stockroom or the register or the menu. As all the tasks are completed for the day, the team gains access to a holistic view of the artifacts of their collective effort. At this point, the group reflects on their collective progress and brings in their personal reflections and feedback. The software additionally allows the students to view artifacts that they have created in the past through the Artifactory. Through this historical and aggregate viewpoint, the learners are able to negotiate “meaning of events from multiple points of viewing [which] enables a layering of diversity” and leads to ”a clearer understanding of the complexity involved in knowing what happened in a given time and place” (Goldman, 2007, p. 15-16). Through this exercise, students get a sense of their impact on the group and also see the results of the way insights from group members helped to change their own perspective. Approaching a problem domain from this collective viewpoint places more emphasis in constructing the shared meaning rather than just the end result of an assigned task. By actively participating in critiques and discussions of their own work, the students are capable of creating their own meaning layered with perspectives from their teammates (Goldman-Segall, 1995).

**Cognitive Flexibility**

In addition to providing a window to past artifacts created by the students, the collaborative environment that materializes within the software and outside in the physical space is representative of Cognitive Flexibility Theory (CFT). The RR Artifactory is essentially “a
repository of the discoveries and insights of the group that can be a resource for the same group at a later time” (Feltoch, et. al. 1996, p. 40). CFT programs support the view that individual and group cognition exist in mutual support. In a group, multiple perspectives coincide and conflict, spurring discussion. With these tools at hand, the individual student can learn to “think like a group” by she is challenged and presented with multiple pathways to knowledge.

IV. Theories that do not apply

Conviviality

Restaurant Runners is limited to a single classroom to provide students a sense of community within their classroom and virtual environment. This goes against “Illich’s theory of conviviality: tools should be . . . accessible by all . . .” (Goldman-Segall, 2002, 403). Though observation, students enjoy sharing. Allowing students to walk around the classroom to see how others are using their restaurant creates a closeness that encourages further use of the world. It is not only an informational tool, but a social tool to start discussions amongst students.

CAI

Design of the virtual world steered away from Computer Aided Instruction (CAI) because focus in this medium was typically: “drill-and-practice, feedback through quizzes, and emulated tutor-tutee relationship” (Goldman-Segall, 2002, 395). Teachers are encouraged to treat the artifacts created by the students as discussion points, and provide students overall representation of progress through creating teacher-created graphical representation. This allows the students to explore their own reasoning behind their representation.

Living Systems

We decided not to make Restaurant Runners a living system. The virtual world is set to
the size of the individual class and contains no networked interaction outside of the classroom. Students are also encouraged to work within the system limits, by choosing cuisines that are available to their particular restaurant, and allowing their avatar to eat based upon previous intake. This forms a self-sustaining economic environment where learners can glean information from the existing parameters, but by no means allows the players to contribute new information. This intentionally focuses the students’ attention on data received and creates a balance of in-world economy not affected by outside causes, such as popularity. Restaurant Runners does not apply to the autopoiesis theory of “a system that has within its own boundaries the mechanisms and processes to produce and reproduce itself” (Plass, 2002, p.36) because the teacher controls the options available to students: incentives such as awards for most profit for the week, and what level of cuisines and economy the students are interacting with. If the students were to upload or create their own meals to add to their restaurant and competitively price the items, Restaurant Runners would start to become more of a living system, which would then take away from the goal of creating an environment for students to learn about representational visualizations.

Though Restaurant Runners is by no means a living system, some of the methodology from the design principles of a living system were utilized. We analyzed end-user requirements through use of mathematical standards for 4th grade, and developed instructional interaction design through a virtual world by means of user requirements of anchored instruction in which a restaurant is immersive and relative to the students. We designed instructional information architecture by creating the virtual world to be an interactive, visual method for students to process complex data sets. (Plass, 2002, p.40).

*Deliberate Instruction*
Restaurant runners is encouraged to be used as an integrated method of instruction where the teacher provides previous knowledge of the subject area. This differs from the typical “‘fingertip effect’ [of] simply making a support system available and people will more or less automatically take advantage of the opportunities that it affords” (Perkins, 1993, p.95). The students will view the world as an interactive restaurant simulation, whereas the teachers can take advantage of the information being presented to create further problem solving and graphical representation questions for the students to explore. The use of deliberate instruction (DI), or “primarily of observation and participation” (Cole, 2010, 462), is the typical method of instruction for the topic of graphical analysis. Restaurant Runners will provide a medium for teachers to minimally focus on this method of instruction, and only use DI as short introductory explanation to introduce the usage of the virtual world. By including a short example, students will gain an understanding of usage, but through exploration and trial and error within the context of the virtual world, students will gain a deeper understanding of the material.

*Intelligent Tutoring System*

Restaurant Runners was not designed as an intelligent tutoring system (ITS) because “…ITS implicitly commits to a standard, ‘correct’ body of knowledge and sees the teacher as the final authority and distributor of that knowledge” (Koschmann, 1996, 8) Since Restaurant Runners is not focused on performance results, but instead on an exploration and discussion based environment for students to discover what representational form best fits the data they have created in their personal restaurants and interactions with fellow student’s restaurants through their avatars. Teachers assist the students by providing feedback and discussion to each representational form, “acting as a bridge between subject matter and student”
(Bransford, 2000, 136). However, teachers are not advocating a correct answer for displaying the information. The students create “schema [that] can be built from hypothesis learners create regarding the material” (Spiro, 1990, p.192). Students could be provided with a list of common usages and properties of graphs, but without providing the students with the “executive function [that] involves making choices during complex situation and draws on the knowledge and representational, retrieval, and constructive resources” (Perkins, 1993, 96), later applications of the information will be limited and difficult for the students to associate. Students only focusing on one function at a time results in “reduction bias, or oversimplification of a complex subject” or “overreliance on a single mental representation” (Feltovich, 1996, 30). Through providing group input, and exploration and discussion of representational methods, students will gain multiple mental models representing when specific methods are of best fit for their information. An “...anchored instruction model...generates interest and enables students to identify and define problems and to pay attention to their own perception and comprehension of the problems” (Bransford, 1990, 123).

**Conclusion**

Often in the education system, learning is split between doing and knowing, which prevents meaningful knowledge acquisition (Brown, 1989). Students are not provided an integrated experience to allow scaffolding of the theoretical information they receive, particularly in their younger years. Providing students with the deep understanding of information allows for executive function and access characteristics of “what it is and how easily it can be found during situations that include authentic and extended inquiry” (Perkins, 1993, 93). Students must learn how to apply their knowledge and adapt it to the information they are provided outside of the classroom.
“Gordon Wells stated a classroom should include: collaborative community, purposeful activities, function of participation, productive activities, (and that) personally and socially significant activities must allow for diversity and originality” (Cole, 2010, 466). Restaurant Runners is providing the platform to make this type of integration in the classroom possible. By placing students in groups from the creation of restaurants, to allowing them to decide what is sold in their restaurant and the individual choices of their avatar diet, students are encouraged to make the virtual world their own. Diversity and originality is encouraged through exploration of creating different visual representations of their interactions and data presented within the world. Production is limited to how the students interact in the virtual world, but can transfer to the real world through observation of supply and demand, competition, and maintaining a balance.

The students are really participating in a metagame, which is a “genre of play in which there is an overall structure that lends form, meaning, and cohesion to collection of nested activities or games, all of which have their own identifiable rules and challenges” (Barab, 2005, p.93). Students must, at the surface level, maintain their restaurant stock, feed their avatar, and observe trends. At a deeper level, they must use comparison data and cause and effect to understand the effects their restaurant stock decisions and how their avatar eating habits effect the larger ecosystem. Since students are mostly taught mathematical concepts in abstract forms, the information”...must be organized around those meaning-making and meaning-using processes that connect man to culture” (Bruner, 1990, p.12). Through use of a restaurant setting, which the majority of students are exposed to in their personal lives, students can relate their actions and artifacts back to the culture they live in. The use of the teacher introducing various graphical representations in the normal classroom setting and then allowing the students to
explore in Restaurant Runners affords a “situated action,...the reasoning behind those actions or the connection between saying and doing” (Bruner, 1990, 19). The focus is knowledge centered with an “...emphasis placed on sense-making, building on previous concepts and asking for clarification when information does not fit the original knowledge” (Bransford, 2000, 137). Allowing the students to see how their actions in the world have an effect on later actions, scaffolds the students’ learning to better understand the mathematical concepts at hand. Placing the students in groups from the beginning, provokes the articulation of problem solving strategies and allows the teacher to coach in a more personal manner (Collins, 1989). Taking the focus away from the front of the classroom and instead putting it in front of the students (or even putting the students at the head of the classroom) allows for useful role reversal, where the teacher can recognize any misconceptions the students might have in their explanation of their process. This takes away from the typical authoritative classroom environment and allows for students to aid each other in social and intellectual friendship (Bruckman, 2000, 5). Having the students justify their artifacts to each other encourages them to discover the inherent properties of the material and “layer their viewpoints and interpretations to create emergent patterns and themes” (Goldman-Segall, 2002, p.393).

Through separating actions with in the virtual world of the group restaurant and the individual avatar, the learner constructs different identities within the scope of different relations (Lave, 1991, 53). They must associate the information both as a group effort and individually, as well as interpret the effects of their own influence and decision making. This makes the entire experience much more personal.

Additionally, discussion in groups encourages the method of “Bricolage... an associative method that tends to have the user try one thing, step back and try another method” (Turkle,
1995, p.51). This is very similar to the scientific method, which the students have been or will be exposed to in their academic careers. Students give their own meaning to the information when they are allowed to understand that comprehending the underlying concepts of information is just as important as producing or mastering information.

It is important to remember that “learning takes place both in the surround (immediate physical and social resources as a vehicle of thought) and the residue left by thinking (what is learned is in both the mind and arrangement of the surround) (Perkins, 1993, 90). While students may only use the virtual world in their classroom, the content within the setting can be applied outside of the world. Encouraging higher-level thinking regarding the subject of graphs and cause-and-effect will allow the knowledge to be more similar to long-term memory, rather than ephemeral scratchwork-like thoughts (Perkins, 1993, 104).

Anchored instruction has been shown to lead to “transfer to new analogous problems (similar situations), and partially analogous problems (less but still similar situations)” (CTGV, 1993, 60). In Restaurant Runners, we created a method for students to have experience with problems that may occur in real life, and an environment where they can identify measures to solve problems later in different contexts. The closer the relationship of the information to the individual student, the more likely it will be referenced by the students in future expansions of the topic area, either in the classroom or in authentic situations in their lives.

For Theory Paper references see IV. References.

V.b. Roles and Responsibilities

Table of Contents and Formatting - Katya Hott
Abstract - Katya Hott
Project Description
  Goals - Kathy Yu
  Backgrounds - Katya Hott
  Audience - Kathy Yu
Media selection - Kathy Yu and Jenn Ash
Competitive Analysis - Jennifer Ash

Design
Tech Specs - Alzaber Rubayat
Feature set - Jennifer Ash
Flowchart - Jennifer Ash
User Stories - Kathy Yu and Katya Hott
Wireframs - Alzaber Rubayat

Theoretical Design
   II. Philosophies - Katya Hott
   III. Theories - Alzaber Rubayat
   IV. Theories not implemented and Conclusion - Jennifer Ash

References - Katya Hott

Appendix
   Theory Paper (see Theoretical Design)
   Complete set of Screenshots - Alzaber Rubayat

Presentation - lead creator Kathy Yu, all participated

V.c. Flowchart (assembled)
V.d. Complete set of Screenshots
Welcome Screen
Set Up Group
Set Up Cuisine
Restaurant Runner

Stockroom
Cash Register
Take a look at the pie chart. You have not eaten from each restaurant in your class. You need to eat equally from each restaurant to keep your avatar healthy! Where will you eat today?
Choosing a restaurant from the Townscape
Townscape Fade-in
Townscape showing a specific restaurant
Purchasing Food
Collecting new challenges

Some question about graphing.....

Some other question about graphing.....
Restaurant Runner

Register Sales Graph

Robert

Anita

Jane

Grapher
Personal Artifactory, including all the representations you have created and graphing tools.
Viewing another restaurant’s Artifactory
Teachers can view all groups’ Artifacts