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PROJECT TITLE:	Neuroscience Education Advocacy
DATE:	9/28/2017
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Project Summary

The purpose of this 20/20 grant was to fund materials for games made by pour students to teach neuroscience to fifth and eighth grade children.

To provide direction to my students, maintain focus, and work toward a goal, two learning themes were devised: 1) Basic Brain and 2) Functional Brain. A corresponding set of learning objectives was developed for each theme. The objectives for Basic Brain games were awareness of major neuron parts (1a), the quantity of various brain structures (1b), neurons function by chemistry (1c), and learn names and location of cortical lobes (1d). The objectives for Functional Brain were familiarity with neurotransmitter names and general functions (2a), hemispheric asymmetries (2b), sensory and motor pathways (2c), symptoms of neurological diseases (2d), functions and disorders associated with structures (2e), and the changes in gross brain anatomy that occurred through evolution (2f).

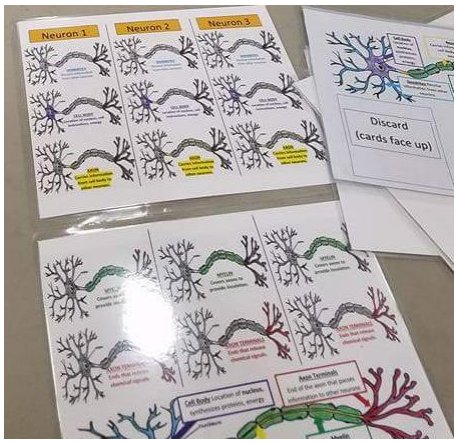
Approximately 438 students from Alder Avenue Middle School and Dr. Joyanne Miller Elementary School participated in the event. Approximately 138 participants were in seventh (n=38 across two classes) or eighth grade at Alder Avenue (n=approximately 100), and the remaining were in fifth grade (n=approximately 300) at Miller Elementary. Alder Avenue students participated during tutorial time periods (akin to study hall) on May 2, 2016 and were brought to a room reserved for Board of Education meetings by their tutorial teachers. Eighth grade students were participating in PAARC testing that week, and so only classes where students finished their testing were able to attend. Miller Elementary students participated during one core period (science or ELA) and were brought to the gym as a class by their teacher during their selected period on May 5th, 2016. Teachers self-selected their classes for participation. At each school, a minimum of two classes participated during a single period, but we hosted three or four classes during approximately one third of the periods. Class sizes varied from five to 27 students. 10 Stockton students participated as a requirement of the course STEM Education: Neuroscience.

Several games were created using craft supplies and game pieces purchased from vendors such as AC Moore, Michael's, local dollar stores, Big Lots, Wal-Mart, Amazon.com, Oriental Trading.com, Staples, ToysRUs, Party City, Ace Hardware, and Home Depot. In addition, two assessment instruments were used, one for the children and one for the faculty at the event. Stockton students were also asked to write a reflection and complete their course evaluations.

Games

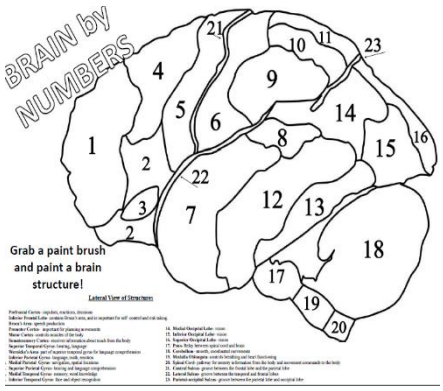
Neuron's Neurites. The goal of this game was to teach the main parts (neurites) of a neuron (dendrites, soma, axon, myelin, and axon terminals) (objective 1a). Each player was given a board that depicted the five parts for three neurons. The boards were constructed from 2 sheets of paper, each laminated, and taped together using clear tape so that they folded. A set of cards was created using card stock, laminated, and cut to 2" x 3". Each card highlighted one neurite, or was "wild", or was "neuron death". Players each received a game board and were dealt five cards. The remaining cards were placed in the center and a discard pile was created by turning over the top card. On their turn, each player either

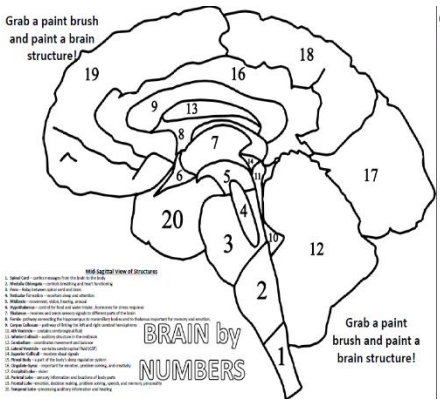
placed one of their cards on one space on the board and then picked up a replacement card, or they picked up a card and discarded one from their hand, or they picked up and used a card from the discard pile. A wild card can be placed anywhere on the board, and a neuron death card meant the loss of one entire neuron. The winner was the first to complete all five parts for three neurons.

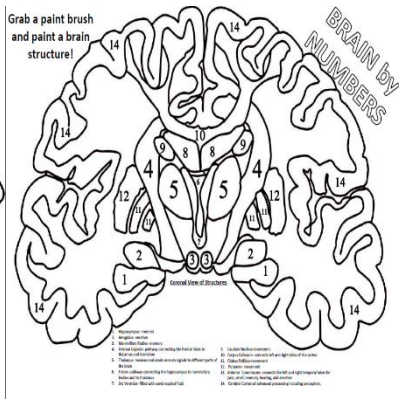


Neuron Factory. The goal was to learn the names of the parts inside the neuron (organelles) and their functions (objective 1a). The board depicted six neurons. Inside each were images of eight organelles (nucleus, ribosomes, cell membrane, cytoskeleton, smooth endoplasmic reticulum, mitochondria, lysosomes, Golgi apparatus). The 36” x 24” board was printed on poster paper. Organelle images were printed on transparency film, cut and glued to the board. Then, the board was laminated. Pieces each had an image of an organelle on one side and its function on the other. Pieces were constructed of cards stock, laminated and cut out. To play, the pieces were spread out in the middle, image side down. Player’s in turn select one piece and place it on the correct organelle on neuron or it is shown to the other players and returned to the same spot. A player could win more quickly if they paid attention and learned the functions of the parts, so they would not have to rely on their memory for the location of a needed piece. The winner is the first to complete their neuron.

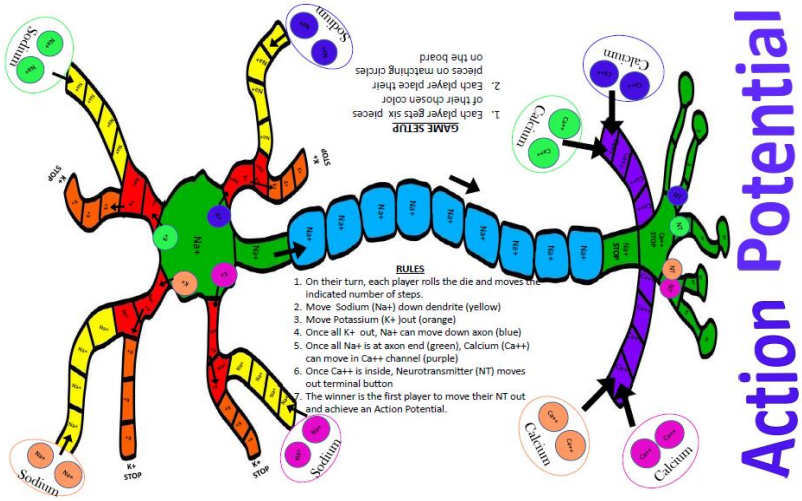
Brain By Numbers. The goal of this activity was to make salient the large variety of structures, functions, and their locations in the brain (objective 1b). Three wall murals, each 48” x 36”, depicted a black and white brain image viewed from lateral, mid-sagittal, and coronal planes. During Spring 2015, each image was traced from a model found using Google images, originally projected onto poster paper. Lines were added to demarcate (sometimes artificially) brain structures. This semester, a student recreated the lines by tracing a pdf of the original tracings using a computer program. All structures were numbered and a key to the name and function of the structures were typed directly onto the mural. The lateral brain displayed 23 structures, the mid-sagittal displayed 20, and the coronal displayed 14.



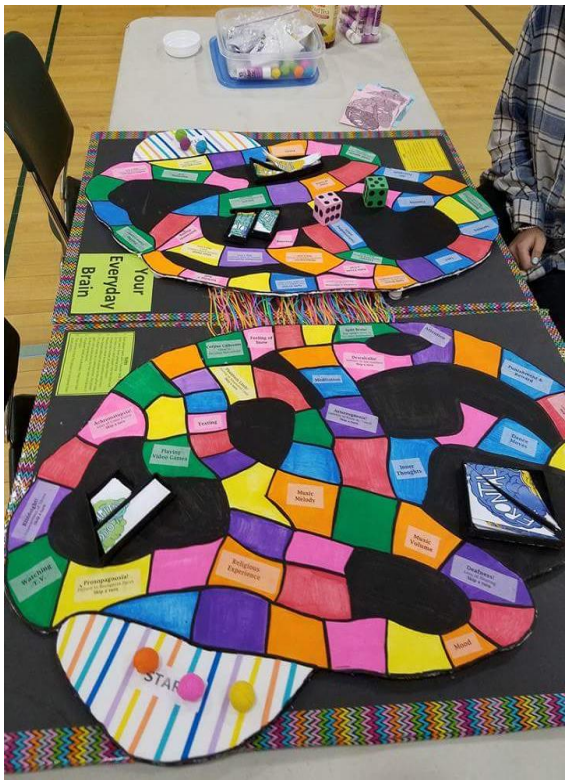




Action Potential. The goal of this game was to familiarize players with the major chemicals (sodium, potassium, calcium, and neurotransmitter), their symbols (Na+, K+, Ca++, NT), and general properties of their involvement in an action potential (objective 1c). The 38" x 24" board depicted a large neuron parsed into spaces, created by a student using a drawing application, printed on poster paper and laminated. Each space was labelled with the chemical symbol that belongs there. The board is set up so that transparent color bingo markers (six per player) occupy all the start spaces (circles) for the different chemicals. Starting at the dendrites, each player rolls the die and must move their Na+ markers into the cell and K+ markers outside the cell along the labelled pathways. Once the K+ is out, the Na+ pieces move down the axon until they reach the axon terminals. Then, Ca++ markers move into the cell, and once in, the NT markers move out. The winner is the first player to get their neurotransmitter out of the cell.



Your Everyday Brain. The goals for this game were to learn about the mundane functions associated with each lobe (frontal, parietal, temporal, occipital) and a few disorders that disrupt those functions (objectives 1d and 2e). This game board was hand crafted using foam board, lanyard string, sticker labels, wood craft sticks, Velcro, paint, tape, and paper. The board depicted two halves of the brain with a pathway throughout for moving game pieces. To add dimension, the brain board was cut and affixed using Velcro to another foam board. To attach the two sides without making the board too large, a flexible/foldable corpus callosum was constructed from multicolored lanyard strings. The spaces were labelled using printed clear mailing labels and indicated a function or a disorder for its proximal lobe. There were black regions within each lobe that held a container constructed from craft wood sticks and painted black. Each container had two sides, each for one of two colored lobe puzzle pieces. Containers were affixed to the board with Velcro. Each player received a playing piece (brain eraser), a board with a greyscale image of a brain puzzle template printed on colored card stock, and a glue stick. Players rolled a die and moved their piece in any direction they chose. If they landed on a function, they picked up a puzzle piece for that lobe and glued it to their board. If they landed on a disorder, they lost a turn. Players were able to cross the corpus collosum as they wished, unless they landed on a split brain space and could not cross over at that spot.



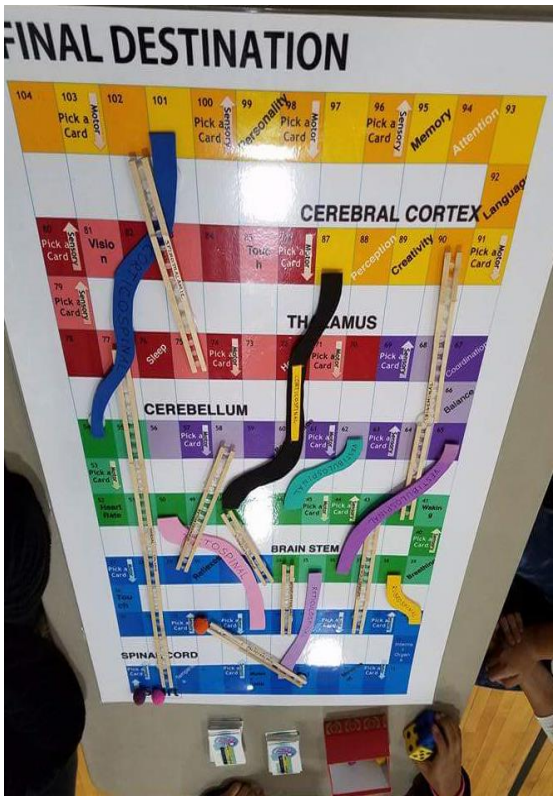
Chemicals in Action. The goal was to familiarize players with the neurotransmitters that are associated with common behaviors of hunger, sleeping, exercise, stress, and learning (objective 2a). The board was constructed from a sheet of corrugated plastic depicting a brain showing the four lobes. Ten holes were cut at haphazard locations in the brain and plastic container rims were glued in place inside the holes. Each hole had a pocket constructed from the mesh of a laundry bag. Each hole also had a single

neurotransmitter label. Each of the five behaviors was represented by two 8.5 x 11 laminated papers affixed to the board with Velcro. The text on the papers consisted of the behavior, a relevant image, a list of five associated neurotransmitters, an image of relevant brain regions, and a set of "fun facts" about the influence of the neurotransmitters on different aspects of the behavior. Each behavior was also made into a small (4 x 6) card for players. Brain shaped stress toys were purchased and the name of a neurotransmitter was hand written on each one and they were placed into two plastic buckets. In teams or individually, players were given a behavior and they had to select the correct neurotransmitters from the bucket and throw them into the correct holes. The winner is the player or team that threw all of their neurotransmitters into the correct holes.

Chemical Brain-O. The goals of this game were to make salient that there are chemicals called neurotransmitters distributed throughout the brain, the names of commonly known neurotransmitters (serotonin, dopamine, acetylcholine, and norepinephrine), that neurotransmitters in normal and imbalanced quantities affect behavior, and to also familiarize players with the terms excitation and inhibition (objective 2a). The cards were made from colored card stock, and the colors were unrelated to the text. This is an Uno-type game. Each player is dealt seven cards, and attempts to match one of the qualities shown on top of the discard pile to one in their hand. In this game, players could match along one of three qualities: neurotransmitter name, amount (too much, too little, normal), and effect on behavior. Inhibition cards could be discarded onto the pile with the effect of limiting subsequent players to only matching the neurotransmitter name until a player discards an excitation card and selects the neurotransmitter and action of their choice. The winner is the first player to discard all their cards.

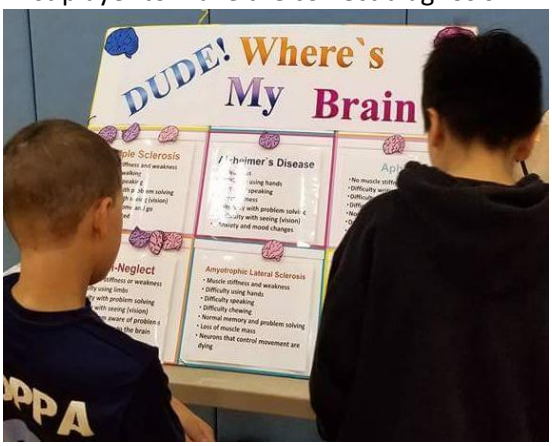
Hemisphere Bingo. The goal of this game was to highlight the different and similar functions of the left and right cerebral hemispheres (objective 2b). Nine 8.5" x 11" game boards were constructed using foam board, each affixed with an image from Google images. Functions were printed on round sticker labels and each board had eight (four left and four right hemisphere) function stickers. Each board was unique in the combination of functions. Function stickers were also affixed to red (right hemisphere) and blue (left hemisphere) poker chips and divided into nine bags corresponding to each board. These poker chips were used by players as bingo markers. Function stickers were also affixed to white poker chips used by the caller. A hamster/gerbil ball was used by the caller to stir and select chips. An actual bingo wheel was not used because the balls that fit them are too small to print words. Similar to typical bingo, the caller selected and read aloud one function at a time and players with that function placed the marker on the board. The winner was the first to fill their board.

Final Destination. The goals for this game were to convey that sensory information ascends toward the brain and that motor information descends from the brain, to associate names of tracks with either sensory or motor function, and highlight the hierarchy of major regions (spinal cord, brain stem, cerebellum, thalamus, cortex) (objective 2c). This game is similar in concept to Chutes and Ladders. The 20" x 36" board was printed on poster paper and laminated. The spaces were colored by nervous system regions. Each space had one of eight functions: blank, labelled with a function, pick a sensory or motor card, or begin/end ladders and slides. Ladders were constructed of wood craft sticks and slides were constructed from craft foam sheets. Players rolled a die and moved their piece (brain eraser). If they landed on the top of a motor tract (slide), they moved their piece to the end of the slide. If they landed at the bottom of a sensory tract (ladder), they moved up to the end of the ladder. If they landed on a pick a card space, the card required the player to locate and go to a tract by name (e.g., corticospinal) or region (e.g., thalamus). The winner was the first player to reach the cortex or final destination.



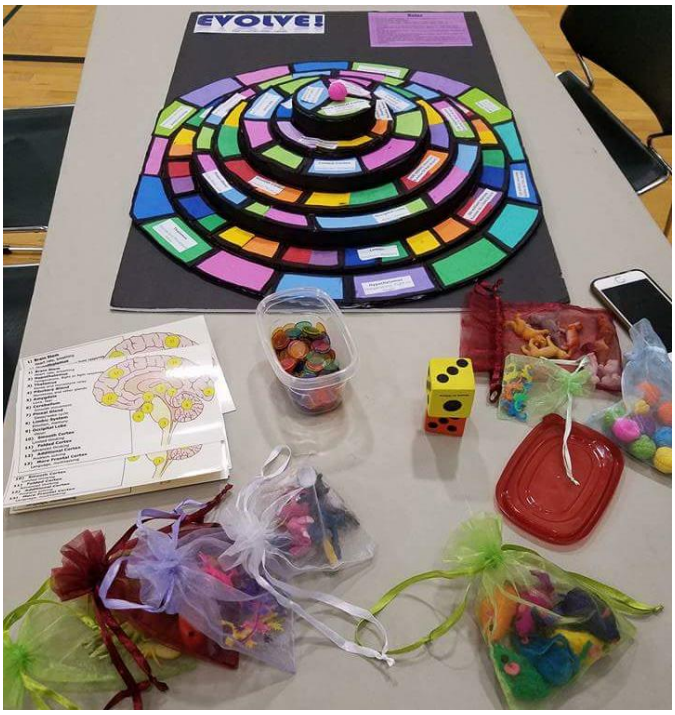
Dude, Where's My Brain? The goal of this game was to engage critical thinking skills to enhance understanding or create awareness of neurological disorders and mimic the neurologist's process of ruling out incorrect and determining correct diagnoses (objective 2d). In this game, players imagine themselves as a doctor who must make a diagnosis based on the symptoms reported by a patient during an office visit. Players each receive one case, portraying one of six neurological disorders (Multiple Sclerosis, Amyotrophic Lateral Sclerosis, Parkinson's Disease, Alzheimer's Disease, Hemi-Neglect, and Aphasia). The cases were printed on colored paper in Calibri bold size 16 font, approximately 7" x 5", and laminated. The case text consisted of the name and age of patient and a bulleted list of symptoms. At the bottom and centered was the script, "Dude, where are MOST of your brains? What is the diagnosis, doctor?". In addition, each player received one set of colored brain pieces (blue, yellow, pink,

purple, or red), each handmade from foam sheets approximately 3” x 2”, and affixed with a Velcro dot on the back. A 38” x 28” foam board displayed the names of each disorder and the associated symptoms, and each disorder had a Velcro strip across the top for placing the player’s brain pieces. To win, players read through each symptom and place one of their brains on the Velcro strip on the board for each of the disorders with that same symptom. In the end, the disorder that has the highest number of their Velcro brains is the diagnosis. The winner is the first player to make the correct diagnosis.



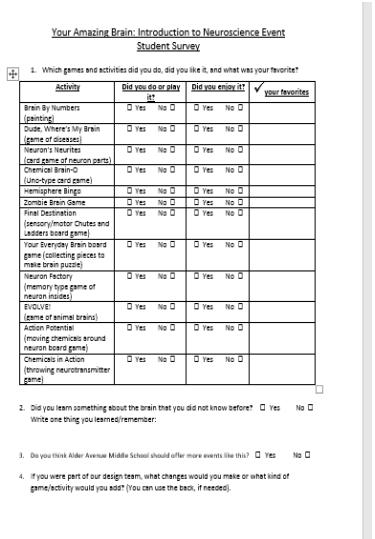
Zombie Brain Game. The goal of this game was to familiarize players with names of major structures and their functions (objective 2e). In this game, there were three types of3” x 5” cards, each constructed from card stock, laminated and cut. Infection card faces stated a single structure that was infected with a picture, the resulting behavioral affliction, and an image of a cartoon zombie related to the affliction. All images were found on Google images. The cure card faces stated that a single structure was cured, with a picture of that structure, and resulting behavioral gain. The star card faces enabled players to steal cures, donate cures, or go directly to the safety house when cured. The 36” x 24” board was printed on poster paper and laminated. It depicted a brain with a pathway for spaces. Spaces were blank, “cure”, infection, or “star”. Players were dealt three infection cards, making them a unique zombie. On their turn, players rolled a die and moved their zombie figurine (playing piece) the indicated number of spaces. If they land on a cure, infection, or star spaces, they pick a card from one of the three piles. If they select a cure card for one of their infections, they turn over the infection and it is out of play. If they choose an infection card, it adds to the number of infections they already have. The goal is to be cured of all Zombie infections and become human. The winner is the first to do so and make it to the safety house without being re-infected.

EVOLVE! The goal of this game was to teach comparative brain differences and evolutionary enhancements between insects, fish, lizards, birds, rats, cats, monkeys, and humans (objective 2f). Because we did not want to depict evolution as linear and we could not depict a tree very well as a game board, we chose to create a game board that looked more like a wedding cake. Levels were created using polystyrene circles in graduated sizes, glued atop one another. Each level represented an animal. Spaces were created from foam sheets and glued onto the layers. Spaces depicted major brain structures for the animal that are also present in animals at higher, but not lower levels. Each level also contained one space that was a neuron quantity and another space that directed the player to evolve to a different animal. Spaces were labelled with white sticker mailing labels. Players each received a game board constructed from card stock and depicting a mid-sagittal view with yellow, numbered dots for placement of a bingo marker. The game board also stated the structure name and basic function. To play, each player received an insect as a playing piece and start at the lowest level. The object of the game is to pick up enough additional brain pieces and number of neurons to evolve to a new animal. For each brain structure they pass or land on, they mark it on their board. Once they have all the brain structures and neurons for the next animal, they evolve by moving up a level and trading their lesser animal for the new animal. The winner is the first to evolve a human brain.



Assessments

Children. This assessment consisted of four questions, printed on one side of an 8.5 x 11 sheet. The first question was presented in table form. The first column named the game and gave a brief description, the second column asked them to indicate yes or no indicate to, “Did you do or play it?” The third column asked, “Did you enjoy it?”, and the response choice was yes or no. The third column asked them to check mark their favorites. The second question asked, “Did you learn something about the brain that you did not know before?”, and the response choice was yes or no. A second part of this questions was, “Write one thing you learned/remember.” The third question asked, “Do you think Alder Avenue Middle School should offer more events like this?”, and the response choice was yes or no. The fourth question asked, “If you were part of our design team, what changes would you make or what kind of game/activity would you add? (You can use the back, if needed).” The response was open-ended.



Your Amazing Brain: Introduction to Neuroscience Event
Student Survey

1. Which games and activities did you do, did you like it, and what was your favorite?

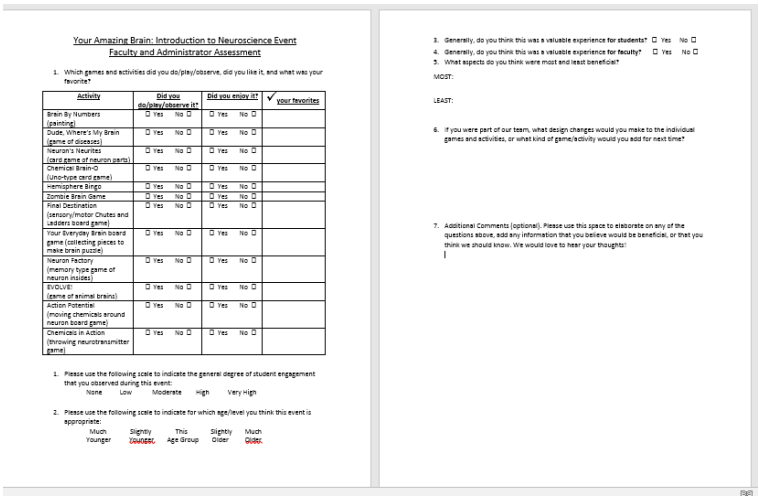
Activity	Did you do or play it?	Did you enjoy it?	✓ your favorites
Brain By Numbers (painting)	☐ Yes ☐ No	☐ Yes ☐ No	
Dude, Where's My Brain (game of diseases)	☐ Yes ☐ No	☐ Yes ☐ No	
Neuron's Neurites (card game of neuron parts)	☐ Yes ☐ No	☐ Yes ☐ No	
Chemical Brain-O (Uno-type card game)	☐ Yes ☐ No	☐ Yes ☐ No	
Hemisphere Bingo	☐ Yes ☐ No	☐ Yes ☐ No	
Zombie Brain Game	☐ Yes ☐ No	☐ Yes ☐ No	
Final Destination (sensory/motor Chutes and Ladders board game)	☐ Yes ☐ No	☐ Yes ☐ No	
Your Everyday Brain board game (collecting pieces to make brain puzzle)	☐ Yes ☐ No	☐ Yes ☐ No	
Neuron Factory (memory type game of neuron insides)	☐ Yes ☐ No	☐ Yes ☐ No	
EVOLVE! (game of animal brains)	☐ Yes ☐ No	☐ Yes ☐ No	
Action Potential (moving chemicals around neuron board game)	☐ Yes ☐ No	☐ Yes ☐ No	
Chemicals in Action (throwing neurotransmitter game)	☐ Yes ☐ No	☐ Yes ☐ No	

2. Did you learn something about the brain that you did not know before? ☐ Yes ☐ No
Write one thing you learned/remember:

3. Do you think Alder Avenue Middle School should offer more events like this? ☐ Yes ☐ No

4. If you were part of our design team, what changes would you make or what kind of game/activity would you add? (You can use the back, if needed).

Faculty. This assessment was slightly longer than the student version, and consisted of eight questions. The first question was identical to the first on the student form, except “did you play it” was replaced with “did you play/observe it”. The second item was, “Please use the following scale to indicate the general degree of student engagement that you observed during this event”, and response choices were: none, low, moderate, high, and very high. The third item was, “Please use the following scale to indicate for which age/level you think this event is appropriate”, and the response choices were: much younger, slightly younger, this age group, slightly older, and much older. The fourth question was, “Generally, do you think this was a valuable experience **for students**?” and the response choices were yes or no. The fifth question was, “Generally, do you think this was a valuable experience **for faculty**?” and the response choices were yes or no. The sixth item was, “What aspects do you think were most and least beneficial?” Response was open-ended. The seventh was, “If you were part of our team, what design changes would you make to the individual games and activities, or what kind of game/activity would you add for next time?” and the response was open-ended. The eighth and final item was, “Additional Comments (optional). Please use this space to elaborate on any of the questions above, add any information that you believe would be beneficial, or that you think we should know. We would love to hear your thoughts!”, and the response was open-ended.



Your Amazing Brain: Introduction to Neuroscience Event
Faculty and Administrator Assessment

1. Which games and activities did you do/play/observe, did you like it, and what was your favorite?

Activity	Did you do/play/observe it?	Did you enjoy it?	✓ your favorites
Brain By Numbers (painting)	☐ Yes ☐ No	☐ Yes ☐ No	
Dude, Where's My Brain (game of diseases)	☐ Yes ☐ No	☐ Yes ☐ No	
Neuron's Neurites (card game of neuron parts)	☐ Yes ☐ No	☐ Yes ☐ No	
Chemical Brain-O (Uno-type card game)	☐ Yes ☐ No	☐ Yes ☐ No	
Hemisphere Bingo	☐ Yes ☐ No	☐ Yes ☐ No	
Zombie Brain Game	☐ Yes ☐ No	☐ Yes ☐ No	
Final Destination (sensory/motor Chutes and Ladders board game)	☐ Yes ☐ No	☐ Yes ☐ No	
Your Everyday Brain board game (collecting pieces to make brain puzzle)	☐ Yes ☐ No	☐ Yes ☐ No	
Neuron Factory (memory type game of neuron insides)	☐ Yes ☐ No	☐ Yes ☐ No	
EVOLVE! (game of animal brains)	☐ Yes ☐ No	☐ Yes ☐ No	
Action Potential (moving chemicals around neuron board game)	☐ Yes ☐ No	☐ Yes ☐ No	
Chemicals in Action (throwing neurotransmitter game)	☐ Yes ☐ No	☐ Yes ☐ No	

1. Please use the following scale to indicate the general degree of student engagement that you observed during this event:
None Low Moderate High Very High

2. Please use the following scale to indicate for which age/level you think this event is appropriate:
Much Younger Slightly Younger This Age Group Slightly Older Much Older

3. Generally, do you think this was a valuable experience for students? ☐ Yes ☐ No
4. Generally, do you think this was a valuable experience for faculty? ☐ Yes ☐ No
5. What aspects do you think were most and least beneficial?

MOST:

LEAST:

6. If you were part of our team, what design changes would you make to the individual games and activities, or what kind of game/activity would you add for next time?

7. Additional Comments (optional). Please use this space to elaborate on any of the questions above, add any information that you believe would be beneficial, or that you think we should know. We would love to hear your thoughts!

Stockton Students. Stockton students were asked, “Please write a brief (1-2 paragraphs) reflection of your learning (enjoyment, benefit to your education), recommendations for future (on what worked and what did not, ideas for improvement) and the impact of service learning on your Stockton experience (perceived success of event and potential to pursue service learning opportunities in the future).”, Stockton students also completed a Student Evaluation of Teaching Small Class Form that consisted of seven questions, each of which will be discussed in the results section.

Activities

Game Development

Stockton students enrolled in STEM Education: Neuroscience (PSYC3535) during the Spring 2106 semester met on Tuesdays and Thursdays from 12:30-2:20 throughout the semester to develop and craft the games. During the first meeting of the class, students were presented with two themes (basic brain and functional brain) and learning objectives within each theme discussed in the introduction, above. Students were also required to adhere to three rules for game design. The first rule was that a

novice, defined as someone who has never heard of a neuron, should be able to play and win it and the game should also be fun for an advanced college student. The second rule was that a player must be able to learn the concepts by playing the game, and could acquire expertise through repeated play. The third rule was that they should be playable in under 15 minutes to maximize the number of games the children can play during a single period. These rules automatically excluded any question and answer games (i.e., jeopardy or trivial pursuit types) and also ensured that the games would be interesting if played repeatedly and to all skill levels of student players. These rules also enabled learning advantages to be built into the games. For example, Neuron Factory, Your Everyday Brain, and Dude, Where's My Brain included an accuracy advantage to players who learned while playing the game, whereas Zombie Brain Game and Chemicals in Action included a speed advantage to players who learned during the game. The first three meetings of the semester were used primarily as brainstorming sessions. During these sessions and also as homework, students individually selected a theme and selected (or created) a relevant learning objective, and individually developed rough drafts for game ideas. The professor then selected the three most promising ideas, students self-selected into three groups, and began designing the games. Students also assessed games that were developed during the Spring 2015 semester and three of our current games (Final Destination, Your Everyday Brain, and Dude, Where's My Brain?) are redesigns of previous versions that were problematic during play, contained errors, and/or were poorly crafted. Brain By Numbers was redone for the purpose of converting it into a workable, electronic PowerPoint file. In subsequent sessions, the games designs were discussed, modified, drafted, crafted, tested, redesigned, and finalized. As one game was finished or put on hold, other games were started and went through the same process. Beginning in late March, a weekly list was created of remaining tasks for each game or potential game. These included tasks such as creating titles, creating rules, printing, laminating, cutting cards and pieces, painting and repairing, purchasing game items (e.g., bingo chips, dice, animal and zombie figures). The professor did all purchasing. We had two site visits from the Vice Principal at Alder Avenue Middle School, one in early February and the other in late April. Cards for games, player boards, and card pieces were printed by our print shop and laminated and cut during class time. Game boards were printed and laminated by our graphics department, and were limited to 24" wide (any length). Because of its extra-large size, Brain By Numbers was printed by special request using a poster printer owned by a different department.

Your Amazing Brain events.

For each event, Stockton students arrived at 8:30, spent approximately 15-20 minutes setting up the games. Board and card games were set up on a single table as a "station". Chemicals in Action was set up on the floor against a wall and a line of blue tape on the floor served as the throwing line. Brain by Numbers was taped to a wall, plastic (at Alder) or paper (at Miller) drop cloths were used, and one of each paint color was situated in an open container with a paint brush on an adjacent table. With the exception of Brain by Numbers, each station had one Stockton student or the professor as a proctor. The same games and activities were made available at each school with the exception of Neuron Factory, which was eliminated after two periods at Alder because we felt it was too simplistic. As each class arrived, a brief introduction was given and the students were told to freely select stations that interest them. During the period, all teachers were given one faculty assessment survey and a set of student surveys for their class. It was stressed to the teachers that assessment was part of our funding requirements and it was requested that they return the completed surveys that day to the Assistant Principal (at Alder) or the Principal (at Miller). Teachers gathered their students and left at the conclusion of each period. Stockton students had a 45-minute midday lunch break. Stockton students left Alder at 2 p.m. as scheduled. They left Miller at 2:45 p.m. because the school erroneously scheduled class visits for 2 p.m. and our students agreed to stay longer.

Stockton Student Assessments. On the last class meeting day (one week before the events), students were required to complete the student evaluation of teaching. The surveys were placed on a table and

students were asked to complete them and return to an adjacent envelope. The professor was not present during the completion, and one of the students sealed the envelope and returned all the surveys to the Dean's office. After the last event, Stockton Students were asked to write a brief reflection and send it by email to Professor Shobe. Completion of the reflection was not stressed as a mandatory requirement for the course to avoid coerced responses.

Results

It was not possible for us to precisely determine the total number of participants because classes sometimes overlapped (a few teachers stayed at least partially for more than one period) or arrived at slightly different times. As such, the total number of participants was calculated as the difference between the number of assessments that were brought and the number of assessments that remained at the end of the day. During the session, each teacher was asked how many students they brought and were subsequently given the same number of assessments. Some teachers gave us an approximate number (e.g., "I think 22 or 23.") and they were provided with enough surveys for the higher number. It is also likely that errors in counting were made, but by a negligible amount. 438 student surveys were distributed, and 244 (56%) were returned. Of the returned surveys, 169 (approximately 56%) were fifth graders, 38 (approximately 100%) were seventh graders, and 37 (approximately 37%) were eighth graders. Twenty faculty surveys were distributed at Alder Avenue and 12 (60%) were returned. Twelve faculty surveys were distributed at Miller elementary and six (50%) were returned. Several Miller teachers brought a morning class and then an afternoon class but were only given one survey.

The remaining report is based solely on the returned surveys. Given a population size of 438 players and a sample size of 244 respondents, the total margin of error for 95% confidence is 4.18%. The margin of error with 95% confidence among fifth graders (169 respondents of approximately 300) 4.99%, among seventh graders (38 respondents of 38) is 0%, and among eighth graders (37 respondents of approximately 100) is 12.85%.

Student Respondents

Did you play the game? Did You like it? Check mark your favorites.

This is the first question asked on the assessment about each of the games. This also directly tests the rule that the games must be playable by a novice and be interesting to variety of grade levels. The following tables show the number of respondents who played each game, the number who enjoyed the game, and the number who also indicated the game as one of their favorites. As can be seen from these tables, every game was enjoyed by most of the children in all grade levels who played them, and each earned "favorite" status among a large portion of players. As such, I am confident in having met this objective.

Fifth Grade Statistics by Game	Number (%) of respondents played	Number (%) of respondents enjoyed; No Response (NR)	Number (%) of players indicated "favorite"
Brain By Numbers (painting)	66	56 (85); NR=0	18 (32)
Dude, Where's My Brain (game of disease diagnoses)	52	41 (79); NR=0	18 (44)
Neuron's Neurites (card game of neuron parts)	52	49 (94); NR=0	27 (55)

Chemical Brain-O (Uno-type card game)	39	30(77); NR=2 (5%)	14 (47)
Hemisphere Bingo	52	46(88); NR=0	19 (41)
Zombie Brain Game	40	35(88); NR=3 (7.5%)	16 (46)
Final Destination (sensory/motor Chutes and Ladders board game)	29	26(90); NR=0	13 (50)
Your Everyday Brain board game (collecting pieces to make brain puzzle)	30	27(90); NR=0	14(52)
Neuron Factory (memory type game of neuron insides)	30	24 (80); NR=1(3%)	6(25)
EVOLVE! (game of animal brains)	37	36(97); NR= 1(2.7%)	23(64)
Action Potential (moving chemicals around neuron board game)	28	26(93); NR=0	8(31)
Chemicals in Action (throwing neurotransmitter game)	88	84(95); NR=0	43(51)

Seventh Grade Statistics by Game	**Number (%) of respondents played**	**Number (%) of respondents enjoyed; No Rating (NR)**	**Number (%) of players indicated "favorite"**
Brain By Numbers (painting)	2	2 (100); NR=0	2 (100)
Dude, Where's My Brain (game of disease diagnoses)	8	8 (100); NR=0	2 (25)
Neuron's Neurites (card game of neuron parts)	7	5 (71); NR=0	2 (40)
Chemical Brain-O (Uno-type card game)	17	14 (82); NR=1 (5.8%)	8 (57)
Hemisphere Bingo	14	14 (100); NR=0	6 (43)
Zombie Brain Game	13	12 (92); NR=1 (7.6%)	6 (50)
Final Destination (sensory/motor Chutes and Ladders board game)	8	8 (100); NR=0	3 (38)

Your Everyday Brain board game (collecting pieces to make brain puzzle)	8	7 (88); NR=0	3 (43)
Neuron Factory (memory type game of neuron insides)	1	1 (100); NR=0	0
EVOLVE! (game of animal brains)	7	6 (86); NR= 0	4 (67)
Action Potential (moving chemicals around neuron board game)	4	4 (100); NR=0	1 (25)
Chemicals in Action (throwing neurotransmitter game)	21	18(86); NR=2(9.5%)	43(51)

Eighth Grade Statistics by Game	**Number (%) of respondents played**	**Number (%) of respondents enjoyed; No Rating (NR)**	**Number (%) of players indicated "favorite"**
Brain By Numbers (painting)	17	15 (88); NR=2 (11.8%)	5(33)
Dude, Where's My Brain (game of disease diagnoses)	13	12(92); NR=0	6(50)
Neuron's Neurites (card game of neuron parts)	9	9 (100); NR=0	2 (22)
Chemical Brain-O (Uno-type card game)	11	11(100); NR=0	5 (45)
Hemisphere Bingo	12	12 (100); NR=0	4 (33)
Zombie Brain Game	8	8 (100); NR=0	4 (50)
Final Destination (sensory/motor Chutes and Ladders board game)	11	11(100); NR=0	5 (45)
Your Everyday Brain board game (collecting pieces to make brain puzzle)	9	6 (67); NR=2(22%)	0
Neuron Factory (memory type game of neuron insides)	4	2 (50); NR=1 (25%)	1 (50)
EVOLVE! (game of animal brains)	14	12 (86); NR= 2 (14%)	7 (58)
Action Potential (moving chemicals around neuron board game)	10	8 (80); NR=2 (20%)	5 (63)
Chemicals in Action (throwing neurotransmitter game)	26	22(88); NR=3(11.5%)	14(64)

Multiple regression analysis (forward) was used to test if the games played by respondents predicted their sum enjoyment. The results, across grade levels, indicated that all the games together explained 83.3% of the variance (R^2=.833, F (12, 241) =95.08, p<.001). However, four games predicted a relatively large amount of the variance for enjoyment. Dude, Where's My Brain explained 21.4% (R^2=.214, F (1, 241)=65.37, p<.001, β=1.4), followed by Neurons Neurites (R^2=.351, F (2, 241)=64.5, p<.001, β=.96)., Chemicals in Action (R^2=.44, F (3, 241)=62.5, p<.001, β=.95), Hemisphere Bingo (R^2=.52, F (4, 241=63.5, p<.001, β=.91). The remaining games were statistically significant predictors, but added negligible amounts to the variance: Brain By Numbers (R^2=.59, F (5, 241)=69.2, p<.001)., Chemical BrainO (R^2=.64, F (6, 241)=68.2, p<.001).), Action Potential (R^2=.67, F (7, 241)=67.6, p<.001), Zombie Brain Game R^2=.70 , F (8, 241)=66.6, p<.001), Evolve (R^2=.73, F (9, 241)=69.2, p<.001)., Your Everyday Brain (R^2=.77, F (10,

241)=78.9, p<.001)., Final Destination (R^2=.82, F (11, 241)=97.5, p<.001)., and Neuron Factory (R^2=.83, F (12, 241)=95.1, p<.001).

Of particular concern to our class was for participants to play multiple games to increase exposure to a variety of neuroscience topics. As such, one of our goals was to make the games and activities playable in under 15 minutes. As can be seen from the table below, participants played a mean of 3.32 games. In those instances, where participants only played one game, it was Zombie Brain Game, Your Everyday Brain, or Evolve. These participants either had an abbreviated period (arriving late or leaving early) or the game lasted longer than expected, as board games are inclined to do. It was known ahead of time that these three games had the greatest potential to run overtime. Nonetheless, we are confident that we achieved the objective of students playing multiple games, but will aim to reduce the playing time of at least two of our longest games.

Grade Level	Total Players	Number of Games Played Per Respondent	Number of Respondents who only played one game
Fifth Graders	543	M=3.20 (SD=1.44), Me=3, Mo=3	26 (10 Zombie Brain game; 8 Your Everyday Brain; 8 Evolve)
Seventh Graders	110	M=2.87 (SD=1.40), Me=3, Mo=3	9 (3 Zombie Brain Game & 6 Your Everyday Brain)
Eighth Graders	144	M=3.89 (SD=1.88), Me=3, Mo=2	1 (Zombie Brain Game)

The number of games played was significantly correlated with enjoyment

Should Alder Avenue Middle School offer more events like this?

This question was included on the assessment for Alder Avenue students to determine if the children found the event interesting and enjoyable. A typographical error in the question required this same question to be discarded for Miller elementary students. These numbers indicate that overall, the Alder Avenue students perceived value in the event and desire more of these kinds of events.

Grade	Yes	No	Blank
7th Graders	36 (95%)	1	1
8th Graders	36 (97%)	0	1

Did you learn anything you did not know before?

The following table indicates the number (and %) of Yes, No, and blank responses for each grade level. A larger than expected percentage of fifth and eighth graders answered 'no' to this question. Unfortunately, after reviewing the responses it appeared as though the fifth grade students who were unable or unwilling to specifically name something they remembered simply answered 'no'. In retrospect, the question is too vague to enable unqualified interpretation of yes, no, or blank responses.

Grade	Yes	No	Blank
5th Graders	117 (70%)	42 (25%)	10 (6%)
7th Graders	36 (95%)	1	1
8th Graders	28 (77%)	8 (21%)	1

Write one thing that you learned or remember.

Of the students who indicated that they did learn something, 79 (68%) fifth graders, 30 (79%) seventh graders and 21 (75%) eighth graders responded, and the remainder left it blank. Of the students who wrote something, the responses fell into one of several categories, listed in the table below with frequencies (%). Three (two fifth grade, one seventh, and one eighth grade) responses were indecipherable.

Category	5th graders	7th graders	8th graders
General Brain Parts: General statements such as, "I learned about different brain parts" or "I learned that different brain parts do different things."	20 (25)	13 (42)	7(33)
Specific Brain Parts: Named a specific structure, such as, "the temporal lobe is used for music" or "the amygdala is important for emotion."	9 (11)	3 (10)	1(5)
Specific Function: General location for a specific function, such as, "vision is at the back of the brain" or "hearing is on both sides of the brain"	10 (13)	2 (6)	0
General Disease: General statement, such as, "there are many different diseases in the brain" or "lots of diseases have the same symptoms".	7 (9)	2 (6)	3(14)
General Chemical: General neurotransmitter statements, such as, "there are chemicals in the brain" or "chemicals in the brain control behavior".	3 (4)	1 (3)	2(10)
Specific Chemical: Named a specific neurotransmitter, such "serotonin is involved with depression" or "about GABA".	4 (5)	0	4(19)
Neuron: Anything to do with the quantity ("there are 86 billion neurons in the human brain"), or general statements ("neurons are brain cells" or "I learned about neuron parts").	16 (20)	1(3)	0
Hemispheres: Contralaterality or a function of a specific hemisphere, such as, "the left side of the brain controls the right side of the body" or "the left hemisphere is used for math"	7 (9)	8 (26)	3(14)

The following table indicates the frequency and percentage of students in each grade whose responses indicate having met one of the ten learning objectives.

Grade 5	Freq	%
Parts of Neurons	9	12.0
Quantity of Structures	8	10.7
Neuron Chemistry	4	5.3
Names/Location of Lobes	4	5.3
Neurotransmitters	4	5.3
Hemispheres	19	25.3
Sensory/Motor Paths	0	0
Diseases	7	9.3
Function to Structure	18	24.0

Comparative Brain	2	2.7
Total	75	100.0

Grade 7	Freq	%
Parts of Neurons	0	0
Quantity of Structures	11	36.7
Neuron Chemistry	3	10.0
Names/Location of Lobes	2	6.7
Neurotransmitters	1	3.3
Hemispheres	8	26.7
Sensory/Motor Paths	0	0
Diseases	1	3.3
Function to Structure	4	13.3
Comparative Brain	0	0
Total	30	100.0

Grade 8	Freq	%
Parts of Neurons	0	0
Quantity of Structures	0	0
Neuron Chemistry	2	9.5
Names/Location of Lobes	1	4.8
Neurotransmitters	4	19.0
Hemispheres	3	14.3
Sensory/Motor Paths	0	0
Diseases	3	14.3
Function to Structure	3	14.3
Comparative Brain	0	0
Total	21	100.0

To determine if the learning objectives were dependent on the games designed to meet them, correlational analyses were calculated for the nominal variables of Played the Game (Yes, No) x Met Learning Objective (Yes, No). While there are several correlational statistics that can be used, I chose the Fisher's Exact test because it is similar to the chi square, but intended for analyses with an expected low n per cell. The results have been compiled in the table below.

Below is the data for the frequency (and %) of children who played the games and whose responses indicate at least one of the learning objectives.

Theme 1: Basic Brain Objectives and Games	% "yes" play and "yes" LO	% "no" play and "yes" LO	% "Yes" play and "no" LO	% "no" play and "no" LO	Fisher's Exact test p
Parts of Neurons • Neuron's Neurites	100	0	19	82	<.001
Parts of Neurons • Neuron factory	0	100	11	89	=.36 (NS)
Quantity of brain structures • Brain by Numbers					
Neurons function by chemistry • Action Potential					
Names and locations of cortical lobes • Your Everyday Brain					

Theme 2: Functional Brain	Existing	New
Neurotransmitter names and general functions • Chemical Brain-O • Chemicals In Action		
Hemispheric Asymmetries • Hemisphere Bingo		
Structure to function • Your Everyday Brain • Zombie Brain Game		
Sensory and Motor pathways • Final Destination		
Neurological Diseases • Dude, Where's My Brain		
Comparative Brain • Evolve		

FINANCES: Based on your proposal, please outline below how the award has been spent.		
	Amount	**Notes/Comments**
Beginning Budget Balance as of:	**$**	
Salary Expenditures		
• Stipends	$	
• Full-time staff salaries	$	
• Full-time faculty salaries	$	
• TES salaries	$	
• Fringe Benefits	$	
Total Salary and Fringe Expenditures	$ 0	
Non-Salary Expenditures *(supplies, travel, etc.)*		
• Year 1 Supplies	$ 743.29	
• Year 2 Supplies	$ 671.69	
•	$	
•	$	
•	$	
•	$	
Total Non-Salary Expenditures	$ 1414.98	
Total Salary + Non-Salary Expenditures	**$ 1414.98**	
Ending Budget Balance as of:	**$**	

YEAR 1 Expenses

19.11	AC Moore
19.26	AC Moore
50.32	AC Moore
29.81	AC Moore
47.93	AC Moore
40.16	AC Moore
39.02	AC Moore
221.27	Amazon.com
59.63	Amazon.com
14.98	Amazon.com
45.55	Carolina Bioligical
8.52	Ollies
28.99	Oriental Trading
9.95	Party City
20	Staples
30	Target
9.59	ToysRUs
49.2	Walmart
YEAR 1 Total	743.29

YEAR 2Expenses

63.63	AC Moore
15.44	AC Moore
21.38	Ace Hardware
20.67	Amazon.com
12.22	Amazon.com
42.62	Amazon.com
17.25	Amazon.com
12.86	Amazon.com
100.69	Amazon.com
5.99	Amazon.com
45.8	Amazon.com
21.4	Dollar Tree
27.3	Home Depot
12.82	Home Depot
40.57	Michaels
74.98	Oriental Trading
2.25	Party City
30.54	Staples
32.08	Staples
26.57	Walmart
44.63	Walmart
YEAR 2 TOTAL	671.69