BRAIN BUSTERS: Final Report

Project Title: Two Birds: Brain Busters (formerly Mythconceptions)

Team Members: Benjamin Howe, Gerson Abesamis, Lisa Schnoll, Stephanie Sasse

Link to latest iteration: http://space-monteluce.com/brainbusters_v2/

OVERVIEW

PROBLEM SUMMARY: What's the issue?

Neuroscientific findings are often highly relevant to other fields, particularly those that directly involve human behavior (e.g. school sciences, business, marketing). In hopes of capitalizing on this overlap, many non-scientists and organizations have attempted to apply research to problems within their domain (Pasquinelli, 2012). However, the foundational understanding of core concepts, the use of context in understanding results, and the use of terminology often differs across disciplines, allowing erroneous interpretations to slip through and quickly gain traction (Christodoulou & Gaab, 2009).

The consequences can be persistent and expensive, at worst resulting in unintended harm and at best taking valuable resources away from more appropriate applications or efforts. An example of the latter was evident in 1998, when Georgia state administrators requested over $100,000 in order to distribute Mozart to children, in hopes of improving cognitive performance (Pasquinelli, 2012).

Equally startling is the resilience and prevalence of these myths in the general population. A 2004 study found that 80% of people polled were familiar with this so-called "Mozart Effect" (Pasquinelli. 2012). By comparison, a 1996 National Science Foundation Survey found that only 48% of people polled knew that earliest humans had not lived alongside dinosaurs.

This excitement over neuroscience may play a role in the rushed communication of findings by the media (Racine, Waldman, Rosenberg, Illes, 2010). Flawed representations of research findings by the media are consequential, particularly when individuals lack the basic reasoning and STEM literacy skills to become critical media consumers.

The proliferation and inflexibility of these myths, even in light of new evidence, is likely rooted in the combination of pseudoscientific treatment by the media, public and institutional craving for brain-based solutions to societal problems, a lack of media and STEM literacy resulting in

unquestioned acceptance of manipulated findings, and the issue of confirmation bias (Pasquinelli, 2012).

Many neuromyths relate to the way STEM is taught in schools. The focus is often on static facts and there is a lack of attention given to teaching the skills necessary to integrate, update, and consume additional concepts in the future. If students are not taught the skills for critical consumption and evaluation of STEM material, they may mature into individuals that are unable to maintain and adapt their knowledge as evidence within the fields change. This may also lead to an increased susceptibility to attach to misrepresentations of research.

As a result, our project will target the misunderstanding of how students perceive, internalize, and synthesize STEM knowledge by correcting potentially harmful neuromyths and training teachers to be critical consumers of new research. This lack of appropriate preparation leads to adult STEM illiteracy, which enables the continued acceptance of neuromyths and STEM assumptions. The goal of our project is, in essence, to help end this self-perpetuating cycle.

PROJECT SUMMARY: How does it work?

The "Two Birds" logo represents an umbrella company we imagined housing a number of interdisciplinary training efforts. The specific program developed for this course targeted the issues of neuromyths and scientific literacy in teacher training and education.

We have developed a program model that will guide the user through a dual educational experience. Each module will be designed to couple the confrontation of a prevalent neuromyth with a skill building lesson to foster increased neuroscientific literacy in the user beyond the boundaries of the program. We also incorporated an application activity into the design concept, giving teachers the opportunity to put their new skills to test in a simulated classroom environment, those this feature did not make it into our latest prototype. Our first mocked-up module is focused on the "Left Brain/Right Brain" myth, which is debunked using activities that teach about common "information filters" as the delivery device.

In an attempt to break the mold that professional development has to be "boring" or "stale", the modules are highly interactive and carefully designed. Though the myth and scientific literacy skill will change for each module, there are a few consistent basics to our current model:

> Phase one of the learning module allows the user to confront their own misunderstanding of the myth through gamified case studies contextualized using educational narratives.
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> The learning module then directs the user to understanding the emergence of the myth, as well as the more scientific alternative, though a narrative. The current module presents this feature as a time-line, but will vary depending on the myth. Drawing on Universal Design for Learning principles, beginning in this phase we have created "hover" over words that pop up with definitions to aid the user in understanding more complex subject matter.
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> Next, the user is introduced to an activity that features the scientific literacy skill of interest. The current module highlights the social filters that information tends to pass through prior to our interacting with neuroscientific findings. This part of the learning module will be included when confronting each "myth" because media and scientific

literacy is critical to consuming this type information in the future, which is a major goal of the program.

The user will then get a chance to apply their new knowledge through a game and self-checks that are brief and fun.

The next phase of each module will give suggestions for how to apply their new knowledge to their educational practices, including an interactive game. We want to scaffold a system where an educator can pick one part of an existing lesson plan that might be misinformed by an existing myth, find their own research, and make a change to a lesson plan. This part of the program will be collaborative with open sharing if the user chooses to share their information through our site.

Finally, the user will be provided with long-term resources that they will be able to draw on in the future. This is essentially an intervention for pop-science myths that are potentially harmful to educational goals.

The user will then engage with a total of 8-10 modules highlighting the most prevalent and potentially damaging neuromyths in education. The goal is for each module to take ~20-30 minutes, so users are encouraged to complete them at their own pace and will have an initial dashboard that allows them to keep track of their progress and return as they see fit.

DESCRIPTION OF TARGET AUDIENCE

Our target audience is adult educators (formal and informal), administrators, and educational policy makers. With the number of alleged "brain-based" products stealing time, attention, and resources from more practical and consequential interventions in education, we feel it is important to make the program accessible to many decision makers involved in the system.

DESCRIPTION OF CONTEXT

At the beginning of our venture we expected this project to take the form of a professional development program for educators. The "Two Birds: Brain Busters" program would be a program that teachers at either the school, city or district level would do together with administrators over a 2 day period with follow up activities weekly. This program would also ideally fit into professional development times for information educators as well.

As we began testing our program and asking educators about using it, the feedback we received challenged this model of delivery. While teachers and administrators were interested, they were not sure if the time would be allotted unless the program was accredited and they ended the program with a certification.

Recently we have been re-imagining the usage of a program like this to be integrated into already existing professional development conferences or series of workshops as a supplement. Because this program is web-based we would want to keep this open source and available for any and all users even if not at a conference.

Many neuroscientists we have been in contact with have also expressed interest in making this program available as a link from their own lab web pages. In this way, our audience may expand to include consumers of neuroscience outside of the educational sector.

Additionally, we are interested in identifying potential space for this program in the Mind, Brain, and Education concentration at HGSE. We see this as a valuable tool for those across specialties at HGSE, but believe the MBE program may provide us with additional insights on what the next iteration should look like. Once a working mock up is complete, we will likely pitch it to MBE students for feedback.

RISKS, QUESTIONS & CONCERNS

Our group is facing three key concerns. The first would have to be designing this experience to be as appealing as possible. Professional development programs need "consumer buy-in" for it to be successful. We addressed this by first, making an effort in creating a personality that was likable in terms of visuals and text, second, keeping the content concise and simple, and third, maintaining the credibility of the information.

The second issue to consider is the best way to balance the needs of the educators with the integrity of the science we're attempting to present. Identifying and effectively striking that balance between speaking the language of the laymen, and maintaining the nuance of the scientific message is very difficult, as we've been learning first hand. One strategy we've employed on this front is to be in constant contact with a few educators and neuroscientists as crucial sounding boards at each level of development.

Finally, we're attempting to identify how far we should push development, and who we should be in contact with for distribution that is as wide-reaching as possible. Should we seek potential accreditation so that teachers can earn professional development hours? Should we build a strong relationship with a few key professional development programs or just attempt to flood cyberspace with a working link? We've definitely found ourselves asking some implementation and limitations questions.

PROJECT COMPONENTS

Brain Busters is a website composed of a variety of modules on debunking neuroscience myths. For this term, we are in the process of finishing one module: *The Tale of Two Hemispheres.* Each module has three parts, a straightforward confrontation of the myth, a brief history of how the myth developed, and how the myth can be used as a lesson for information literacy and critical analysis of text. Games and videos are incorporated, and would be used a bit differently depending on the topic. So far, with our first module, we have 2 games (only one is working) and video explanations scattered within the website. The goal is to have a total of ten separate modules, each containing 2-3 activities, a resource page, and multimedia.

USAGE SCENARIOS

USAGE SCENARIO 1: Teacher

Brandi is a 24 year-old recently certified teacher who has just finished two years serving a low SES classroom through Teach for America. She earned a BA in Creative Writing and a Certificate in Cognitive Learning during undergrad and has been working in her new job at Hemmingway High, a traditional suburban high school in the Midwest, for three months and has already run into problems with the other teachers and administration. Brandi is very interested in staying up to date with the latest literature in education research, but is disheartened by the lack of influence and control over curriculum that she has. She feels frustrated with the stubbornness

of many of her fellow teachers, who she believes are not open to employing the latest research techniques. Fellow teachers, especially those who have been at Hemmingway for years, have in turn expressed frustration with her interest in disrupting the status quo. She is a big believer that cognitive research can inform education, but feels powerless in her role.

Luckily, Brandi was recently given the chance by her school administrators to attend the annual Two Birds' Brain Busters conference in Boston, Massachusetts. Brandi is excited to attend this two-day professional development conference because she believes she can incorporate the latest research in neuroscience and education to help improve learning for her students back at Hemmingway High. While some of her colleagues may feel no need to change their years of proven instruction, Brandi believes if she can bring back the latest research, implement it in her classroom effectively, and have her students improve and outperform her other colleagues' students, then maybe her colleagues will be more open to change in their curriculum.

At the Brain Busters conference Brandi and many other educators start off by logging into an interactive web-based system after a nice complimentary breakfast and meet and greet with her fellow peers. After Brandi creates her user profile, chooses a display of her results (board game, data, or checklist), and completes a survey on her current understanding, she begins phase one of the program, the learning modules.

In the learning modules part of the professional development program Brandi logs into a web-based application that has her confront neuromyths such as right/left brain hemispheric dominance. Brandi begins with a game that presents case studies of individuals and is asked to determine which part of the brain is playing in their strength, such as Darren Cohen who recently completed a book report and excelled at the structured written book report part but struggled with a creative diorama to share with the class. Brandi quickly recalls signing up for creative writing in college because she was always told she was right-brained since she was very creative and remembered completing websites that told her which part of her brain was stronger and what careers she should pursue. This was a no brainer for Brandi and she clicks that Darren Cohen must be left-brained because he is very analytical and methodical. The web-based system then prompts Brandi of being close but to try again. Brandi then realizes through trial and error that both hemispheres are involved in the case of Darren Cohen. When Brandi gets the answer correct a window pops up explaining why both hemispheres of the brain are involved in Darren Cohen's case. Brandi then completes similar case studies and eventually finds the pattern that people are neither right nor left brain, but use both hemispheres for all tasks, thus confronting and debunking the myth. Next Brandi is presented with a timeline that allows her to see how the myth developed in 1796 with Phrenology and became widely used in prominent writers such as Daniel pink in 2006. Lastly, Brandi is shown how information is processed through different filters from the university where the science is discovered to the blog that explains a phenomenon to the common person and how that information is altered and evolved into a myth through these varies filters. Brandi is then given the chance through a game like atmosphere to drag and drop different quotes from the real world and put her own filter model together to check her understanding in this process. This makes Brandi as well as other users more conscious of the sources they get their information from and if something sounds too good to be true in the media, they know how to track the information back to the original source to get the true findings and conclusions.

After completing learning modules similar to the one described above, Brandi enters phase two of the program where she is given researched-based activities that she can try on her own in her classroom and self and peer assessments. This is where the professional development program leaves the conference and this web-based system is taken back to the school at Hemingway High.

The goal in phase two is to start out with an existing lesson plan and change one small element based on current research. The teacher then gets to see how incorporating current research into classroom practices can influence and improve student's learning. The idea behind phase two is Brandi is slowly taught a process of how to effectively incorporate research by critically evaluating its sources and credibility to be used to effectively improving student's learning. Brandi tries this process over the next few months at Hemingway High and is now incorporating current research in her classroom and her students are outperforming the other teacher's students and outdated curriculums.

Lastly Brandi is given sustainability tools in phase three that include additional online resources such as research articles, lesson plans, courses, forums, and e-penpals. This allows her to have sources to contact and use as she adapts her teaching and lesson plans. The main goal of attending the two day Brain Busters conferences was that Brandi met peers and experts in the current research face to face. This allowed her to exchange emails and phone numbers and create contacts that she can bounce ideas off of as she tries to change the way she teaches.

After about a year Brandi has reached Two Birds goals of changing her classroom practice, changing her student's learning outcomes by implementing new research and changing curricula, and she has also changed other teachers' attitudes and perceptions by seeing how effective the Two Birds methodology is. The stubborn teachers and administrators have started taking notice to Brandi's improved student performance and Brandi is now passing on her knowledge to others to help change the lives and learning of other students at Hemingway High. Theoretically if Brandi and others follow the Two Birds philosophy and methodology we can slowly change the way educators across the country and world critically evaluate and think about current research and implement it in their classroom effectively.

USAGE SCENARIO 2: School Administrator

Dr. Edward Smith is a 60 year-old principal of Jefferson High, a suburban, middle-class, high-performing public school located in New England. He has 25 years of classroom experience teaching social studies and economics, and is now on his 8th year serving as Principal of the said school. As a teacher, he pushed his students to their full potential by encouraging them to achieve high scores, as well as highlighting college placement as the end goal. Praised by the school district because of his focus on efficiency and results-driven leadership, his policies of teacher assessment and development are based on quantitative standards and evaluation tools. He values knowledge and content above anything else–he believes that mastery of the subject matter is the key to high teacher quality. He defines great teacher as someone who has great lecture skills and has command over the classroom.

Recently, Dr. Smith was scourging the web for ways to improve his school and came across the annual Two Birds' Brain Busters conference in Boston, Massachusetts. As an intellectual, he noticed the conference was hosted by top notch researchers and individuals in the field of education and neuroscience and decided to give it a try to find new innovative ways to improve his school.

At the Brain Busters conference Dr. Smith and many other educators start off by logging into an interactive web-based system after a nice complimentary breakfast and meet and greet with his fellow peers. Afterwards Dr. Smith creates his user profile, chooses a type of style of learning (board game, data, or checklist), completes a survey on his current understanding, and he begins phase one of the program, the learning modules.

In the learning modules part of the professional development program Dr. Smith logs into a web-based application that confronts him with neuromyths such as right/left brain hemispheric dominance. It has been a while since Dr. Smith has been in schooling, but since he is a well trained intellectual he thinks he should have no problem with the program. Dr. Smith begins with a game that presents case studies of individuals and is asked to determine which part of the brain is playing in their strength, such as Sarah Jackson who loves her Spanish language classes and excels at learning new vocabulary and comprehension but struggles with writing and grammatical structure. He recalls learning in his undergrad 40 years ago about how Roger Sperry won a Nobel Prize for his work and the news popularized that the brain has left/right hemispheric preferences for certain tasks. Drawing upon his past knowledge Dr. Smith concludes and clicks that Sarah must be right brain since she is clearly creative but struggles with analytical and methodical skills. The web-based system then prompts Dr. Smith of being close but to try again. Dr. Smith puzzled by his incorrect results then realizes through trial and error that both hemispheres are involved in the case of Sarah Jackson.

When Dr. Smith gets the answer correct a window pops up explaining why both hemispheres of the brain are involved in Sarah Jackson's case. Dr. Smith then completes similar case studies and eventually finds the pattern that people are neither right nor left brain, but use both hemispheres for all tasks, thus confronting and debunking the myth. Next Dr. Smith is presented with a timeline that allows him to see how the myth developed in 1796 with Phrenology and became widely used in prominent writers such as Daniel pink in 2006. Lastly, Dr. Smith is shown how information is processed through different filters from the university where the science is discovered to the blog that explains a phenomenon to the common person and how that information is altered and evolved into a myth through these various filters. Dr. Smith is then given the chance through a game like atmosphere to drag and drop different quotes from the real world and put his own filter model together to check his understanding in this process. This makes Dr. Smith as well as other users more conscious of the sources they get their information from and if something sounds too good to be true in the media, they know how to track the information back to the original source to get the true findings and conclusions.

After completing learning modules similar to the one described above, Dr. Smith enters phase two of the program where he is given researched-based activities that he can try on his own in the classroom and self and peer assessments. This is where the professional development program leaves the conference and this web-based system is taken back to the school at Jefferson High. However, since Dr. Smith is no longer teaching in the school at the moment, he decides to hold a staff development meeting among his teachers and walks them through the Brain Buster's program with several licenses he bought online for the teachers to use on their own. Being a motivated and forward thinking individual, Dr. Smith challenges the teachers to use the program and slowly incorporate it into the classroom. He promises a nice dinner to Ruth's Chris Steakhouse to any of the teacher's that can change their pedagogy and achieve new results in academic achievement.

At the conference Dr. Smith was given sustainability tools in phase three that include additional online resources such as research articles, lesson plans, courses, forums, and e-penpals. He passes these tools on to the teachers allowing them to have sources to contact and use as they adapt their teaching and lesson plans. After about a year Dr. Smith has reached Two Birds goals of changing classroom practice, changing student's learning outcomes by implementing new research and changing curricula, and has also changed other teachers' attitudes and perceptions by seeing how effective the Two Birds methodology is. Dr. Smith's teachers are actively incorporating new research into the classroom effectively and achieving new levels of academic achievement never before seen by his students. Dr. Smith's teachers have been so successful that

school board members are starting to take notice and looking to Dr. Smith for advice on how to help other schools. In the future, Dr. Smith now has plans to get the school board to help implement the Two Birds' program into other schools and let other schools and teachers use Jefferson High as a model to strive for high academic learning and achievement.

SUMMARY OF RESEARCH & FEEDBACK

Tell me the story of your project effort. How did the research influence and guide your design? What was helpful? What wasn't? How did you gather feedback on your design and prototype? How did the feedback direct and redirect your efforts?

Research

Our research focused on two key themes. The first, was a surveying on the current state of neuroscience and neuromyth pervasion, application, and attempted correction in education. On this front, we found several valuables sources (e.g. Pasquinelli, 2012; Christodoulou & Gaab, 2009; Geake, 2008; Goswami, 2006; Lindell, 2011; Racine, 2010). Our second focus was more specifically on educator's interaction with neuroscience, including their understanding of common neuromyths (e.g. Dekker et al., 2010; Hook & Farrah, 2012). This question was further informed by our own surveys.

The research helped us to establish a more firm understanding of the need, the gaps, and the current problems in translation between science and educators. It made us realize the role of such phenomena as expert credibility (Klucharev, et al., 2008) and confirmation bias (Fragale & Heath, 2004), and in turn, we decided not only to teach on these cognitive biases, but also to have knowledge of them guide our design by forcing teachers to initially confront misunderstandings, thus minimizing the risk of their integrating corrective information into incorrect paradigms.

Process

We started the whole process of production by mapping out our goals for the project. We identified the problem we wanted to address, and began researching the attempts that had already been made to address it (quickly realizing they were few and far between). Once we decided on a problem space, we began creating a preliminary model, and choosing the content we felt was most valuable to work on in the class. We agreed on the "left-right brain dominance" myth for this project, as we feel it is one of the most pervasive misconceptions, which would make this perfect as the first myth to test among users.

This was followed by creating a more refined architecture of the section, deciding on the sequence of pages, and ending up with a very solid site map. Because we had limited time, content writing had to happen simultaneously with design mockups and programming.

The website was made from scratch using HTML, CSS and jQuery. A few ready-made scripts were modified for the specific functionalities, such as the left-right slider and the drag-drop interaction in the game. Some graphics were grabbed from photos on the internet and enhanced on Adobe Photoshop/Illustrator, while others were original designs from our team members.

Design

Because our target audience is composed mainly of adult educators, we wanted the website to be credible, yet engaging. To achieve that, our design centered on being clean and professional-

looking through the use of white space, grid-layouts, and a consistent color scheme. The treatment for the typography (dynamic mix of contemporary serif, slab-serif, and sans-serif fonts) and some graphic elements (such as the recurring diagonal pattern and the black and white illustrations) allowed the website to be tastefully interesting, while still exercising some restraint from overshadowing the content. The green-blue-gray-beige palette is also gender-neutral, without being too monotonous.

User Survey

The group performed an informal survey to obtain feedback from potential users. We were able to contact eight respondents, each with different experiences and backgrounds (formal to informal learning environments, zero to 20 years of experience in education, science to music, etc.) The results highly informed our first steps in designing the experience for our professional development platform. We learned several important things:

1. They had diverse preferences in the types of media they want to learn from (some loved reading, others preferred games)
2. The value of a professional development program highly depends on how it can be realistically applied to their teaching practice
3. No one dismissed the importance of neuroscience to education, but they had varied degrees of knowledge on the topic
4. They appreciate collaboration; they cited group exercises and discussions as the most appealing and useful components of any PD program
5. They think that changing teacher attitudes are tricky, especially concerning systemic changes (e.g. standardized tests), policies that take up their teaching time, plans that involve unfamiliar subjects (e.g. technology), and other policies which did not involve feedback from the teachers

Feedback.

We gathered feedback from our classmates, who generally had positive feedback about our prototype. The aesthetics, they said, were informative but appealing and pretty. A lot of people also loved the modern day filters section of our project, which they believe are highly useful in teaching information literacy skills not just for educators, but also to professionals and students. One concern that was pointed out was the user experience, which was highly linear in nature. A classmate suggested adding navigation features and progress bars, which can help in the wayfinding process of the user whenever interacting with the website. Another colleague commented on how to maintain the content of the modules current, as science is highly dynamic and changes quickly.

Additionally, we have been in contact with the Affective Developmental Neuroscience lab members, including Dr. Leah Somerville, who have been helpful in acting as guides for the neuroscience portion of our content. We received extremely positive and constructive feedback from these individuals, as well as members of Mind, Brain, and Education, all of whom have offered their support in the continued development of content, testing, and eventual (hopefully!) distribution of our project.

REFERENCES

Christodolou, J., & Gaab, N. (2009). Using and misusing neuroscience in education-related research. *Cortex, 45*, 555-557. Retrieved from http://amyalexander.wiki.westga.edu/file/view/using+and+misusing+neuroscience.pdf/237919575/using%20and%20misusing20neuroscience.pd

Dekker, S., Lee, N., Howard-Jones, P., Jolles, J. (2012). Neuromyths in education: Prevalence and predictors of misconceptions among teachers. *Frontiers in Psychology, 3*(429), 1-8. doi: 10.3389/fpsyg.2012.00429

Fragale, A. & Heath, C. (2004). Evolving informational credentials: The (mis)attribution of believable facts to credible sources. Personality Social Psychology Bulletin, 30(2), 225-236. doi:10.1177/0146167203259933

Geake, J. (2008). Neuromythologies in education. *Educational Research, 50*(2), 123-133. doi:10.1080/00131880802082518

Goswami, U. (2006). Neuroscience and education: From research to practice? *Nature Reviews Neuroscience, 7*, 406-413. doi: 10.1038/nrn1907

Hook, C., & Farrah, M. (2012). Neuroscience for educators: What are they seeking and what are they finding? *Neuroethics*. doi: 10.1007/s12152-012-9159-3

Klucharev, V., Smidts, A., Fernandez, G. (2008). Brain mechanisms of persuasion: How "expert power" modulates memory and attitudes. SCAN, 3, 353-366. doi: 10.1093/scan/nsn022

Lindell, A. & Kidd, E. (2011). Why right-brain teaching is half-witted: A critique of the misapplication of neuroscience to education. Mind, Brain & Education, 5(3), 121-127.

Pasquinelli, E. (2012). Neuromyths: Why do they exist and persist? *Mind, Brain and Education, 6*(2), 89-96. Retreived from http://onlinelibrary.wiley.com/doi/10.1111/j.1751228X.2012.01141.x/pdf

Racine, E., Waldman, S., Rosenberg, J., Illes, J. (2010). Contemporary neuroscience in the media. *Social Science & Medicine, 71*, 725-733. doi: 10.1016/j.socscimed.2010.05.017