Grounded Theory Analysis of Ubiquitous Learning Environments and STEM Confidence-building among Hispanic Students

by

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A dissertation

submitted in partial fulfillment

of the requirements for the degree of

Doctor of Education in Educational Technology

Boise State University

May 2021

BOISE STATE UNIVERSITY GRADUATE COLLEGE

DEFENSE COMMITTEE AND FINAL READING APPROVALS

of the dissertation submitted by

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Dissertation Title:	A Grounded Theory Analysis of Ubiquitous Learning Environments and STEM Confidence-building Among Hispanic Students
Date of Final Oral Examination:	09 March 2021

The following individuals read and discussed the dissertation submitted by student Torrence G. Temple, and they evaluated the student's presentation and response to questions during the final oral examination. They found that the student passed the final oral examination.

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The final reading approval of the dissertation was granted by Young Baek, PhD, Ed.D., Chair of the Supervisory Committee. The dissertation was approved by the Graduate College.

Dedication

В конце пути я посвящаю это достижение своей жене, вдохновению всей моей жизни и заднице. Пусть наша работа изменит жизнь студентов, а наследие заставит наших детей гордиться.

Acknowledgements

I started this program looking up a very large hill. Standing at the bottom was a man who was not much of a reader because he was dyslexic, not being much of a writer because he was a builder, and crushing hand pain that resisted his every keystroke. Alone, this impossible journey would have bever happened. I acknowledge my guides that helped me ascend this elevation.

I want to thank my committee and meaningful department members. Dr. Baek for your impressively quick responsiveness over the last 4 years. Dr. Yang and Dr. Snelson for the gift of practice through your patience! I valued every bit of our work together. Dr. Lowenthal's intuitive and ever-present hand was my safety net when I had no idea what to do next. Dr. Ross's ear, though busy, always willing to listen to my posturing about the program.

Randall, I think you were the common connecting point for our cohort. Seems everyone was connected to you somehow. I appreciate your willingness to adopt AREA154 and let the students play with it. I also appreciate the opportunity you fostered with EMDTL and the opportunity to impact a place I almost got to visit.

I want to acknowledge the San Jacinto Unified School District and High School that supported my investigation and the hard work of my ARK Agents. They supported my mad vision even when, I'm sure they quite understand what I was doing. Lastly, Thank you, Joanne Gilbreath. For almost 20 years my mentor for being a better professor, enthusiastic coach, and purveyor of opportunities. She told be to do this long ago. I waited, not sure why, but I have a feeling it was all part of the bigger plan, and I love it when a plan comes together.

Abstract

The fastest-growing demographic in the United States is also the one that has the biggest struggle with academic success, particularly in STEM-related subjects. Hispanic students have been at risk in the public school system for decades despite earnest efforts to close the achievement gap. This investigation asserts that one of the most significant challenges may be the way Hispanic psycho-social behaviors are influenced by cultural heritage. Richard Lewis's work on culture suggests that Hispanic (multi-active) behavioral traits are nearly the polar opposite of those cultural-performance values of the peoples that built the public school system. The two cultural paradigms appear to be as mutually insoluble as oil and water. In chemistry, however, substances called emulsifiers can be used to hold these two liquids in a uniform mixture. This investigation develops a grounded theory about a kind of educational emulsifier called ubiquitous learning technology and provides detailed, firsthand insights from participants about how a specially designed ubiquitous learning system affects Hispanic science students' sense of self-efficacy and perceptions of success in STEM-related subjects in a Hispanic community in Southern California.

Keywords: Ubiquitous Learning (uLearning), Multi-Active, Linear-Active, STEM, Hispanic culture, Self-efficacy, Confidence behaviors

Table of Contents

List of Tables

List of Figures

List of Images

List of Abbreviations

AN	Affect Number is the qualitatively assess numeric value of students experiences.
ATN	Agent Training Notebook – tangible note taking artifact for students
CBE	Confidence-building Experiences – a label given to student responses with an Affect Number larger than 3.0
CRE	Confidence-restricting Experiences – a label given to student responses with an Affect Number less than 3.0
SRT	Survival Readiness Test – built-n fast response formative assessments
CAP	Conceptual Application Proof – a topic that requires the developing theory to identify, explain, and predict to establish the theory's viability

Definitions of "educational technology" and accounts of what it is supposed to do vary even among experts. Instructional technologies can bring material closer to the students in a way that enhances their learning experiences. Technology can provide visuals, auditory content, and multimedia, and gives students the potential to experience and process materials in new ways.

Any piece of matter is only a thing until someone finds a way to use it, and in that instant it becomes a tool. Tools function in ways that are congruent with the instruction provided to the user. The user then provides an operational philosophy of sorts, and it is that philosophy of form and function that determines how the tool is applied and which tools should not be used for the same job. Similarly, instructional technology—tools for learning, whether technical or methodological—are applied in specific situations in accordance with the user's training. A teacher in a credentialing program might provide the opportunity to learn to use a specific educational technology. Google Slides, for example, might be demonstrated as a way to present media in a linear and logical format. This tool offers media and educational content in a unilateral manner. Instruction on the use of this technology also demonstrates methods for learning content in a linear format: The content is presented, students observe it, and then they are usually encouraged to produce an artifact to show their understanding: Watch, process, produce, and repeat.

Lessons, units, and class periods all represent individualized, isolated units organized into a linear progression of subjects that also tend to be individually isolated. The system is efficient and logical, and allows an immense amount of instructional content to be conveyed concisely. Richard Lewis, the author of *When Cultures Collide,* provided some insight into the reason the U.S. public school system was designed in this way and suggests further reasons for its tight synchronization with the psycho-social behaviors exhibited by those who grew up under heavy Western European influence.

But what happens when students or their families didn't grow up with this influence? Lewis (2010) produced a way for people to try to understand how different cultures have different default behaviors. Essentially, this is due to environmental conditioning from being raised among people who value a specific set of behaviors, or an operational psychology derived from extensive social interactions with like-minded (culturally similar) people. Lewis (2010) described three polarized regions that could be identified by distinctive behavioral traits. The further a particular country is toward any apex of the triangular continuum, the more likely its people are to employ those behaviors. Countries in the middle of the triangle have blends of opposing behaviors. One assumption underlying this research is that the cultural psycho-social behaviors of multi-active people are mostly incompatible or immiscible with the public school system in the United States. These immiscible behaviors could well be a significant part of the reason Hispanic students drop out faster than any other ethnic group in the U.S.

Numerous technologies have been designed to assist in the educational process. This study assumes that the philosophy behind current educational technology design is tightly intertwined with linear-active expectations. To modify its design, educational technology will need a significant overhaul and must be adapted to deploy technologies that are more suited to multi-active psycho-social behaviors. Such an overhaul has been attempted in a curricular area that multi-active students currently struggle with much more than other students do. Math and other STEM-related high school courses are particularly tricky for Hispanic students, who also express low self-efficacy regarding these subject areas (Saw & Chang, 2018).

This study investigates a group of high school Hispanic students in Southern California who have or will have taken part (within the last two years) in a program that used specialized "ubiquitous learning" (uLearning) technology and design. The uLearning design philosophy for technology appears to synchronize better with multi-active psycho-social behaviors than does curriculum designed of a more traditional methodology. The uLearning approach led to a chemistry curriculum aligned with the Next Generation Science Standards (NGSS) for California Schools and was also heavily influenced by STEM principles. This study develops a grounded theory that may help to advance educational technology design and could help to address the academic struggles that are prevalent among multi-active (Hispanic) students, especially in highly technical subjects like chemistry and other STEM content.

Background

Hispanic students make up at least 20% of the school population in 23 out of the 50 U.S. states. 60% of these students are Mexican, 10% are Puerto-Rican, and 17% are Hispanics from other Central American countries, according to the National Assessment Governing Board (2013). In 1990, the *Equity of Educational Opportunity Study* (EEOS), better known as the *Coleman Report* (1990), indicated that family culture, or background, was the strongest influencer of academic success. Its impact was greater than those of school facilities, teachers' characteristics, or feelings about student peers. The report was among the first to overtly report that minority students, Hispanic students in particular, were among the lowest-achieving academically. The Hispanic achievement gap was validated again and again in research throughout the 2000s (Haile & Nguyen, 2008; Hawley et al., 2007; Mahon, 2006; Morales & Saenz, 2007; Neufeld et al., 2006; Stiefel et al., 2006). The U.S. government included specific mandates in the No Child Left Behind Act of 2001 (NCLB) to develop methods and strategies to address learning gaps for at-risk groups like Hispanic and Latino students. According to the U.S.

Census Bureau (2006), the educational attainment of Hispanics is significantly below that of the country's population as a whole. Only about 75% of Hispanic students complete high school, as compared to about 94% of the total population. Furthermore, about 25% of the total population has a bachelor's degree or a higher, but only 6% of Hispanics do. Whatever methods U.S. schools had been using appeared to be ineffective up through the publication of this report.

In 2018, Saw and Chang published a paper in the *Hispanic Journal of Behavioral Sciences* suggesting that Hispanics not only had lower achievement in STEM courses, they also had a lower sense of expectancy or self-efficacy. In other words, they didn't score well and didn't believe they *could* score well. The reasons diagnosed for these results were psychosocial (Alfaro & Umaña-Taylor, 2015): Teachers could create greater STEM expectancy through more personal interventions and with support from families at home. This conclusion lacked real-life applicability, however, because it considered the matter through a lens that did not reflect the Hispanic cultural mindset regarding the relationship between school and home.

This study will take place at San Jacinto High School in San Jacinto, California. The school's Hispanic student population is nearly quadruple the national average, at 86%. 84% of these students are in the Free and Reduced Lunch Program, according to CBEDS data collected by the San Jacinto School District last year. Preliminary informal conversations with SJHS sophomores enrolled in NGSS chemistry revealed that Hispanic families tend to see school and home as two distinct and separate entities. The tone of the discussion indicated that Hispanic parents are not likely to assist with school because they tend to hold subject area teachers in high regard and to assume they could not properly assist at home. The students also suggested that if parents were notified that their children needed help at home, at best the parents would engage with the student vocally and the student would ensure them that "work had been done." The parents, who rarely had any academic understanding of the students' work, would accept this to mean that the work had been done to a high standard. In actuality, the students might invent answers or get them from others by copying work; Perhaps even more frequently, the work would simply be pushed aside and remain incomplete.

Culture, behavior, and perceptions of confidence

The development of one's behavior incorporates numerous influences. However, few have the influence of one's cultural surroundings (Han, 2015; Lewis, 2012). Han posited that cultural neuroscience findings suggest there are both indirect culture-brain interactions through behavior and direct culture-brain interactions. These culture-behavior-brain (CBB) interactions form a feedback loop that provides a theoretical lens for viewing how human identity is formed. In essence, the brain fits and modifies culture through behavioral influences. Interactions with others in one's culture provide emotionally rewarding or dejecting feedback to the developing mind. The child's pre-frontal cortex is not wired to operate in a functional manner. As this area is one of the few logic control centers that has influence over the HPA axis (the emotional regulatory center), the child's foremost decision-making apparatus are the emotional regulatory systems (Medina, 2005; Han, 2015). The brain remembers and retains behaviors that are rewarded with positive attention and reduces or extinguishes those met with negative emotional feedback (Medina, 2005)

Imagine a child growing up in an environment where family heritage is highly valued. The child sees adults and older siblings participating in family-related traditions such as eating in ways that have been preserved for a long time. The child also witnesses the positive feedback the older siblings receive from esteemed members of the group. As soon as the child displays the same family-valued behaviors, they are rewarded with emotional attention and thus included in collective activities of the group. No longer on the outside, the child adopts other collective behaviors of the group. In a similar way, Lewis (2010) described why cultures tend to develop similar psycho-social behaviors and how certain behavioral traits can permeate a group.

San Jacinto has a rather homogenous Hispanic population, and cultural heritage could have a substantial impact on how students behave at home and on how those behaviors are transferred to school as the students' "behavioral operation system." Many adults in the community either dropped out of high school or finished with very poor marks. Over time, this behavior could have become a part of the general culture of the area. For example, students are frequently observed giving up on homework after putting very little effort into it. This suggests a lack of direction or support regarding both the content and what is expected of the student. This behavior could also be a habit that was reinforced by parents or other family members. A logical question to ask is "Why don't Hispanic students gather that information in class?" But that might best be answered in an unorthodox manner and with tools that are rarely used to describe the psycho-social behaviors of this cultural group.

Lewis (2010) provided some structured insights into the psycho-behavioral behaviors of a variety of cultures and countries. He described three cultural polarities that exemplify certain psycho-behavioral traits. The Lewis cultural model is displayed in Figure 1. Hispanics and Latinos fall squarely into the multi-active set of psycho-social behaviors. Saw and Chang (2018) presented a study in which they noted the success of White and Asian Students.

Figure 1

The Lewis cultural model

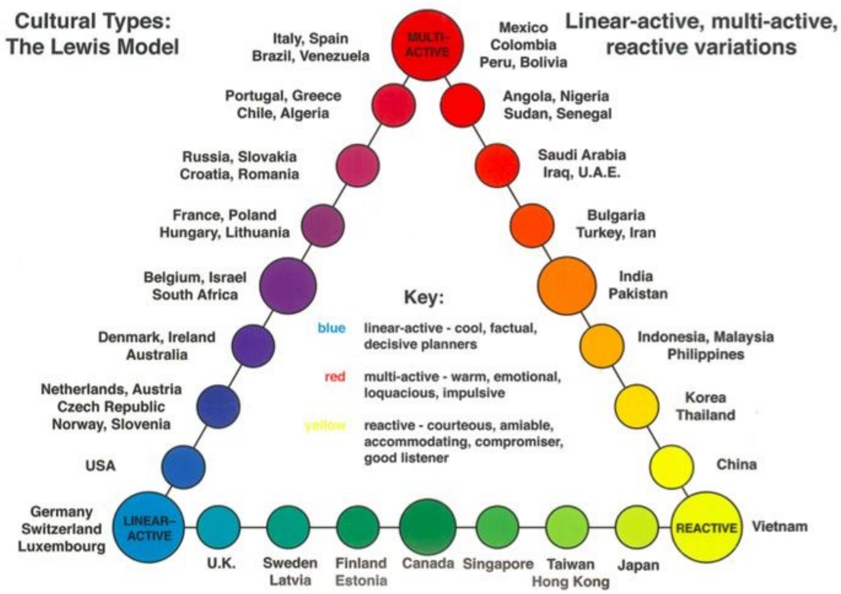
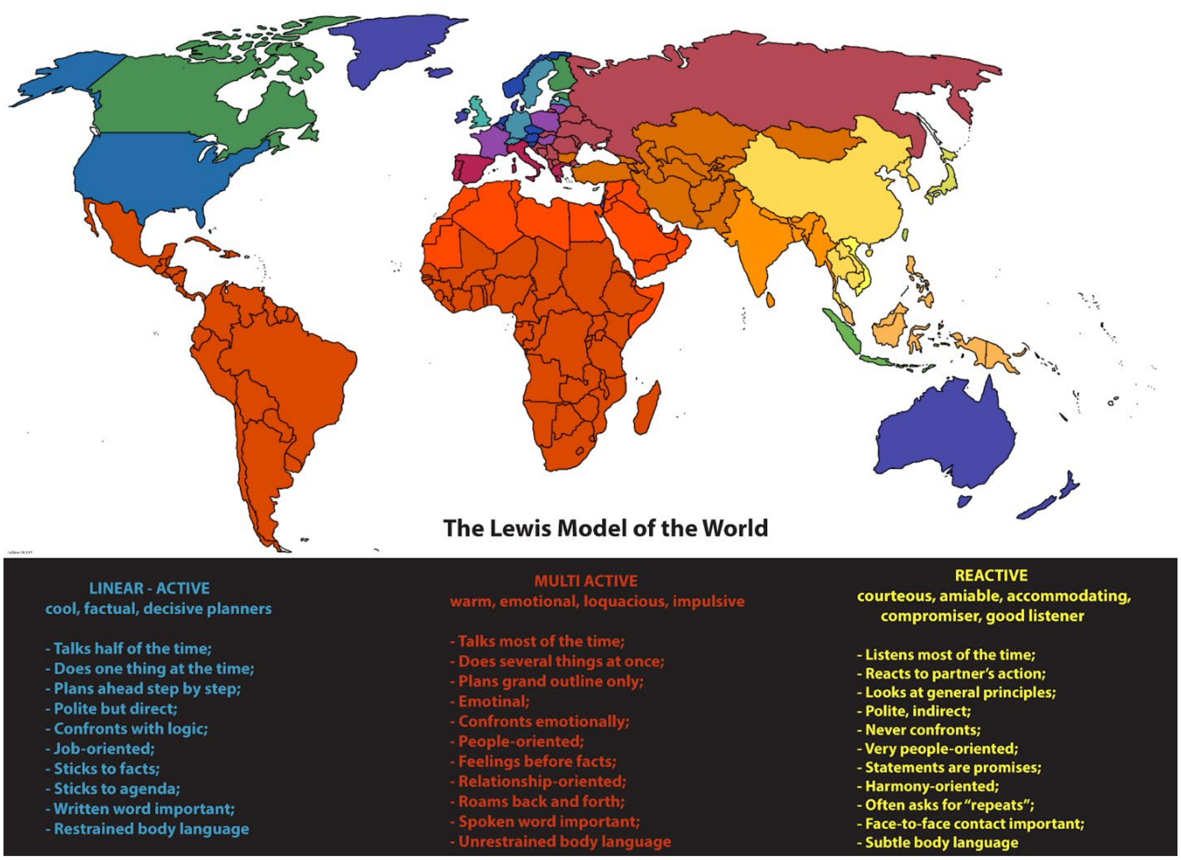


Figure 2:

An alternative display of the Lewis cultural model



The Linear-Active Mindset

The United States occupies the blue section in the lower left-hand corner of the trait spectrum in the Lewis model (Figure 1). Typical behaviors include addressing jobs or tasks one at a time and being logical, job-oriented, and agenda-driven. Writing is essential, and reserved physical expression is preferred. The linear-active trait list strongly resembles the behavioral psychology endorsed by the public school system all over the U.S. Linear-active cultures promote productivity and efficiency: learn to do a job, and then get the job done with as high a quality and as efficiently as possible.

The behavioral traits demonstrated by Hispanic cultures contrast sharply with this. One could argue that the public school system was built around the psycho-behavioral norms of linear-active people, who determine the majority of the cultural, financial, and political norms of the country and generally consist of White people.

The Multi-Active Set of Traits

Multi-active individuals are multitaskers, emotionally motivated, and place relationships before rules. As stated on the cultural behavior spectrum, they don’t habitually accomplish tasks when the timing would be most logical. Instead, they do so when they feel that the time is right to get something accomplished. This is why Hispanic and Latino students tend not to acquire critical information in class that could help them later at home. The concept of putting productivity before the emotional gratification of social interaction runs counter to the inherent cultural traits outlined by Lewis (2010). The pervasive learning paradigm of the U.S. public school system appears tightly aligned with the psycho-behavioral traits of the linear-active classification. If Lewis is correct, then this environment could create obstacles to high-quality educational experiences for multi-active people.

Educational technology researchers and designers have labored over how technology can improve education for as long as technology has been available. But it remains unclear how educational technology could reduce the large achievement gap between Hispanics in the U.S. and almost everyone else. Carr (2013) suggested that part of the problem was simply access to the right technology. Carr's results appear to be congruent with the Lewis Model, in that Hispanic students with access to the technology in this study (a Chromebook) completed more work only on the assignments that required the use of a computer. Hispanic students without access to a Chromebook turned in little work when asked to complete it at home. The students who did work at home had teachers who were accustomed to computer- or internet-mediated work. But according to Carr's research, those teachers were in the minority. In the totality of the Hispanic student's experience, the technology provided little benefit because so few teachers provided technology-mediated instruction. The Hispanic students with Chromebooks did perform better, but all the Hispanic groups scored significantly lower than the control group of non-Hispanic students with Chromebooks.

Hispanic students with Chromebooks who replied to a survey reported that the main reason work went uncompleted was a lack of guidance. They simply didn't know what to do or how to understand the material presented to them. Few mentioned having set schedules for schoolwork. When asked when homework was done, they gave widely varying answers. The lack of consistency implied that work was done whenever there was time to do it, assuming there was any. Research increasingly suggests that a curriculum designed to be better for Hispanic (multi-active) groups should do the following:

- Support social-emotional interaction.

- Provide consistent access at any time and place to educational materials and support.
- Provide content that plays to the multi-active emotional gravitas, in the form of themes or content wrapped around a story-like narrative or containing levels of gamification.
- Provide direct applicability to the real world.
- Allow students flexibility with their schedules.
- Be accessible through a variety of technical platforms (Chromebooks, tablets, smartphones, etc.).

This type of system exists. The concept is referred to as “ubiquitous learning” or uLearning. It includes several distinctions from eLearning (online learning) and mLearning (learning through mobile devices), but it is not limited to computers or mobile devices. uLearning can be accomplished on any device with internet access. It was also designed to favor the inclusion of social-emotional interaction and of curriculums including themes and stories that engage the emotions and stimulated the memory (Huang et al., 2018).

Huang et al. (2018) delineated the functions contained in uLearning platforms**.** Interestingly, their work describes methods for creating uLearning environments on paper, showing that uLearning is less about the technology than about the emphasis on proper design psychology, which can be amplified by various technologies. The literature includes many examples of how this instructional paradigm works, from elementary school students in China and Taiwan to college-aged students from Spain, China, Japan, and Brazil. However, little research has been done on using uLearning with students who have multi-active psycho-behavioral traits.

Purpose

This study investigates how uLearning curriculum design and associated technologies (uLearning systems) affect perceptions of success in Hispanic high school students in an NGSS-designed chemistry course. The students will also be asked to reflect on their experiences in traditional science classes and how the uLearning design changed their sense of success in high school science classes. The study focuses on the specific elements of the uLearning paradigm described in *Ubiquitous Learning Environments and Technologies* (Huang et al., 2018).

Data will be collected qualitatively in a manner that is in line with multi-active psycho-behavioral traits. A uLearning system built specifically for use by multi-active students will be used for science instruction in a traditional U.S. public high school, and students from a variety of academic achievement levels will be selected for interviews to understand how the uLearning system affects the multi-active student. The data analysis will be used to construct a theory about the relationship between perceptions of academic success and uLearning.

The initial observations of the impact of culture on science learning began in 2016, comparing a district in a higher socioeconomically rated city in Riverside County, CA, to the third-poorest city in the county. The two districts are compared in Table 1.

Table 1

Comparison of socioeconomic and ethnicity data between MVUSD and SJUSD

Murrieta Valley Unified SD: Murrieta Mesa High School
Socioeconomic data: Free and reduced lunch, **35.1%** (only Temecula USD was lower, 27.5%)

Murrieta Mesa High School	African American	American Indian or Alaska Native	Asian	Filipino	Hispanic or Latino	Pacific Islander	White	Two or More Races	Not Reported
2,429	6.0%	0.3%	4.1%	3.1%	40.9%	0.4%	38.3%	6.3%	0.6%

San Jacinto Unified SD: San Jacinto High School
Socioeconomic data: Free and reduced lunch,* **75.2%** (ahead of only Hemet USD, 81%, and Corona USD, 78%)

San Jacinto	African	American Indian or	Asian	Filipino	Hispanic or	Pacific	White	Two or More	Not

High School	American	Alaska Native			Latino**	Islander		Races	Reported
2,748	7.5%	1.7%	1.2%	1.2%	74.3%	0.8%	10.2%	3.1%	0.0%

* Data collected by San Jacinto High School put free and reduced lunch participation at 100%.
** Data collected by San Jacinto High School put the Hispanic population at 79.8%.

These schools are separated by just 22 miles by road, but the differences in their socioeconomics and the influence of Hispanic students are substantial. The teachers at both institutions have progressed through California Department of Education–approved teacher preparation programs, so the instructional training for both sites can be assumed to be similar. Anecdotal observations confirm this and also confirm that the curriculum design and behavioral expectations promoted by both districts are closely aligned with the linear-active psycho-social behavior set. The similarity could be due to the philosophical alignment encouraged by the Riverside County Office of Education, which is in turn encouraged to follow the state's educational philosophies, all of which are closely aligned with Lewis' (2012) linear-active behavior set.

The differences between linear-active and multi-active psycho-social behaviors were described earlier and their polar opposition defined. Hispanic students, notably, had low self-efficacy in STEM subjects (Saw and Chang, 2018). One technology design philosophy shows potential for bridging the apparent psycho-social behavioral gap between Hispanic students and the current linear-active pedagogy of current high schools: The idea of uLearning has been around for decades but, according to Huang (2018), has lacked sufficient technological infrastructure to be properly deployed. But on paper, at least, it includes design characteristics that may be more congruent with the multi-active mindset.

According to Huang (2018), uLearning systems should include the following qualities:

- content that can be completed on a schedule that fits the needs of the individual student.
- Anytime, anywhere access to the curriculum.
- Immediate feedback on formative assessments.
- Need-driven availability of curriculum resources, and support instruction available in a predictable place and on demand to explain content outside the classroom.
- Direct applicability to the real world or to theoretical real-world conditions.
- A centrally located curriculum (centralized server or network hub).
- Game elements (gamification) that encourage various forms of engagement.
- Curriculum accessibility through any internet-connected device (device independence).
- Thematically driven or applied narrative.
- Provision for social-emotional interaction.
- Use of student-specific back-end data to address specific user needs.

In 2017, an NGSS chemistry curriculum was deployed that had been designed on the basis of uLearning principles, in response to the low success rate of Hispanic students in San Jacinto High School chemistry classes. This system, *AREA154: Apocalypse Division*, led to a significant drop in student failures, from 48% in 2017 to 9% in 2020. Site administrators noted abnormally high levels of engagement and a drop in the discipline problems generally associated with chemistry classes. Something was working; the question was what, and how? The purpose of this study is to develop a grounded theory of the reasons for the system's apparent success.

Significance

The Hispanic community has been both increasing and struggling with school for decades (Alfaro et al., 2006; Altshuler & Schmautz, 2006; Craft, 2011; Gandara & Contraras, 2009; Harris & Herrington. 2006; Karatino, 2009). The problem has been analyzed deeply and clearly defined. A clear gap also exists between Hispanic and other students in STEM subjects like math, chemistry, physics, and other technical and procedurally rich content areas (Saw & Chang, 2018). Saw and Chang also noted a significant lack of STEM content self-efficacy among these students: they possess little confidence in their ability to do STEM-related work, which might contribute to their lack of success in those subjects. What is missing from research is suggestions for how to address this problem.

Carr (2013) suggested that Hispanics' lack of success in school might be correlated to the availability of technology. The study demonstrated that technology is only helpful when teachers facilitate its use, and only that it helped students complete their work. There was no mention of how well the students did, their improvements over time, or whether the technology enhanced independence and self-efficacy in STEM subjects or any other subjects.

Perhaps the most significant systemic obstacle facing Hispanic students for increasing their sense of self-efficacy in the modern era of progressive education is the system itself. Lewis (2010) presented a cultural model that placed the psycho-social behaviors of cultures from around the world on a triangular continuum. This filter showed how the public school system in the U.S. is tightly aligned with the linear-active behavioral traits, whereas the Hispanic collection of psycho-social characteristics is nearly the polar opposite of this. This opposition may be a part of the reason Hispanic populations are struggling with school; it might be that U.S. public schools are culturally incompatible with them. However, even if cultural disparity is a factor, it does not in itself offer a solution.

If evidence appears of increased self-efficacy and success in STEM courses (in this study, chemistry is the focal subject), it could mean increased Hispanic achievement. Moreover, if the same happens in other subject areas, it could lead to increased achievement and self-efficacy in school and a higher likelihood of progressing further in education. At the least, if the data suggest that uLearning promotes STEM subjects, there will be an increase in technical competency and willingness to engage in more technical professional endeavors. The focus of this study is narrow, but there may be grounds for expansion if the data warrant extension to other subjects or grade levels.

Methodology Rationale

The literature on uLearning environments contains significant gaps regarding multi-active students. The original methodology focused on students' experiences in uLearning environments. The idea of taking a more phenomenological approach can be best understood in light of the conversations between people after novel experiences. When one person experiences a novel event and is questioned by someone who hasn't experienced the same thing, the experiencer might try to describe the experience in a way that helps the other understand the event. The phrase, "Tell me, what was it like?" might be used to ask about such phenomenological data.

However, this investigation focuses on more than the students' experiences. The use of grounded theory should allow for the direct use of students' experiences, insights, enrollment, and GPA data to form a theory about how environments designed with uLearning technology affect STEM-related self-efficacy and perceptions of success among multi-active students. The study uses a uLearning system developed by the principal investigator, and engineered over two years to iron out the interface and eliminate potentially disruptive errors. Some informal observational data were collected about students' experiences with this system, and this feedback provided suggested that a formal investigation of uLearning's potential impact on multi-active learners was warranted.

Assumptions

Factual degradation

The study will call upon the testimony of students who participated in the AREA154: Apocalypse Division program while in their high school career. Some of the students will have experienced the environment more recently than others. As such, the interviews will be conducted while in the classroom that the uLearning system was deployed. The assumption of localization of the interviewee will aide in the recall of different sections of the program that would likely have been forgotten had this step not been taken. The study assumes some degradation of facts learned from the experience. However, it is also assumed that the students will not have forgotten how the experience aided them in their feelings of self-efficacy.

Covid-19

Some of the students that will be asked to participate will have been affected by the COVID-19 school closures. As such, these students did not complete the entire uLearning program in the same manner as other students from prior years. It is assumed that the school closure will have affected the students' sense of self-efficacy. However, just how affected is unknown. The AREA154 program is a uLearning environment, which means it can be accessed and utilized anywhere at any time. The district under study at this time formulated a "no harm done" policy (essentially a grade freeze), and as such, very few students efforted to re-engage in the curriculum if they were satisfied with their current grade. Given these unusual conditions, some students may talk about their uLearning interactions and experiences during the shutdown. The operational assumptions and data will focus on students' interactions with the uLearning system during pre-covid-19 conditions. Additionally, as of February 2021, schools have not yet returned to normal or even semi-normal operations. As such, the availability of interview subjects dropped substantially. The complications incurred by the school closures during the research phase of project will be discussed further in chapter three.

Socioeconomic status and cultural identification

San Jacinto has the third-highest number of students on free and reduced lunches, according to the county of Riverside and the CDE. However, San Jacinto High School has a 100% free and reduced lunch program. The indicators here suggest that all the participants in this study (1) are current students at the high school, (2) have family incomes well below the national average, and (3) self-identify as Hispanic from Mexico or Central America.

Language barriers

This study assumes that the students who experienced the uLearning environment and were selected to participate in the data collection have

- confidence that they understood the curriculum and the program’s expectations.
- The ability to reflect on their past experiences.
- The ability to present their reflections and other observations in English.

These assumptions are made to avoid the possibility that self-efficacy in STEM subjects was affected by participants’ self-efficacy with the language in which the program was delivered.

Accuracy of the Lewis cultural model

The uLearning technology design was selected because of anecdotal evidence of the current model of progressive education in the U.S. and of the psycho-social traits of Hispanic students and their families. Arguments could be made against these claims, but for the sake of the investigation the diagnostic predictions of linear-active and multi-active behavior traits are assumed to be accurate.

U.S. schools are aligned with linear-active behavioral traits

Although no official research has reached this conclusion, anecdotal evidence collected before the study supported the assumption. Science teachers in the same department considered the correlation between the linear-active mindset and the organization psychology of the school system to overwhelmingly support a connection between the two.

The idea of culture and the term "psycho-social behavior"

This study assumes that the culture and behavior sets shared by people from the same country can also be defined as psycho-social behaviors. It is assumed, for the analytic nature of the study, that culture affects people's thoughts, decisions, priorities, and ultimately behavior.

Culture affects success in U.S. public schools

This study assumes that the culture or psycho-social programming a child is exposed to at home has a significant impact on their success as a student. The educational community understands those familial relationships, and the influence of parents is one of the best predictors of success in linear-active (U.S. based) schools. This study also assumes the converse: if a familial culture doesn't support a linear-active school environment, then children's success in that environment will be similarly low.

Ubiquitous learning is a paradigm for technology design

Huang (2018) wrote that uLearning systems could take many shapes and use many forms of technology. Implementations of uLearning can be paper-based, with technology playing only a supporting role. Several fundamental traits are common to all uLearning environments, though. These are listed in the book *Ubiquitous Learning Environments and Technologies*.

uLearning and the limited user base

Most research on this technology design ideology was conducted in China, Taiwan, and Japan, and little of the research into uLearning was conducted with high school-aged students.

Many of studies involved elementary school and college-aged students.

Study Timeline

Date	Actions to be taken	Estimated completion date
[Summer 2020]		
June–July 2020	Complete first draft of dissertation proposal.	Mid-July 2020
July–August 2020	Submit dissertation proposal for approval.	August 2020
[Fall 2020]		
October 2020	• Collect potential participant list. • Submit investigation protocols to IRB for approval for the use of human subjects for research. • Compile permissions letters for parents of participants.	End of September 2020
[Spring 2021]		
January 2021	• Conduct interviews and record and secure data on a password-protected laptop. • Transcribe interview data and import into NVivo for analysis.	End of October 2020
February 2021	• Analyze data and write first draft of chapter four. • Develop conclusions and discussion. • Write first draft of chapter five. • Revise and correct chapters four and five.	End of November 2020
		End of Term Fall 2020

Chapter I Summary

Technology has arguably made education better, but it has unarguably made education more versatile. The tools used for distance learning, 1:1 programs, and learning management systems have radically changed teachers' options. But despite these innovations, Hispanic students continue to fall behind in STEM subjects. Richard Lewis in *When Cultures Collide* (2010) made an interesting observation about this. Though the book was written for business use, it provided insights about culturally influenced sub-conscious or psycho-social behaviors in relation to different countries. Lewis spent 22 years traveling and immersed himself in 26 countries. His work has potential for changing how we view the Hispanic achievement gap in STEM subjects.

The concept of ubiquitous learning developed in the mid-1990s but stalled out, primarily due to a lack of technology to support the complex needs of those who would use the system. As the internet grew, however, networks of all types developed and spread around the world. In 2020, Project Starlink, an Elon Musk project, has nearly globalized high-speed network access. Ubiquitous learning may be making a comeback as the best way to educate students. This educational technology may have real promise for providing multi-active students with the sort of flexibility they need to be self-effective in STEM subjects.

This investigation develops grounded theories about how this technology could enhance the self-effective confidence multi-active students need in STEM subjects. Students of every achievement level will be interviewed. The data must reflect self-efficacy and perceived ability to succeed. The study will try to disconnect students' work ethics and social-emotional factors that prevent them from completing of tasks. Students may feel confident that the uLearning system would have provided a way for them to learn STEM topics, but that they did not earn good grades due to performance-compromising issues outside the scope of this investigation.

Chapter two provides the foundation for the concerns about Hispanic students and explores the development of uLearning as a tool to help multi-active students succeed in a school system designed in a linear-active manner. Additional information is provided about Richard Lewis' work and how his cultural framework plays a pivotal role in revealing Hispanic cultural immiscibility in the U.S. school system.

Literature Review

Introduction: American Schools, European Heritage, and a Major Problem

The development of the modern school system in the United States began with the formal establishment of a centralized system by Horace Mann. Though initially based on the Prussian Model of Common Schools, American public education drew nearly all of its philosophical influence from Western Europe. John Dewey, commonly called the father of progressive education, derived many of his educational influences from German philosophers, including Immanuel Kant and Karl Marx (Cohen, 1979). The fundamental design of the American educational system reflects systemic order, organization, categorization, and behavioral hierarchies that are indicative of a very European psychology. One could argue that the clean lines of the K-12 system enabled the factorial production of American citizens. Furthermore, without Dewey's productivity-based organization of curriculum, it would have been almost impossible to empower a nationwide educational system synchronized to the needs of a growing population.

Dewey began his work as secretary of education in Massachusetts in 1837. In the nineteenth century, the majority of the U.S. was of European descent. The term "ethnic minority" was coined primarily to describe White people from different parts of Europe who would now simply be considered White or "Caucasian." The cultural face of the country today would have been very alien to the people who laid the foundation for the public education system it still uses.

The changing face

The cultural composition of the United States has changed slowly toward greater diversity. In the last fifty years, however, cultural change seems to have been accelerating. In 1972, nearly 80% of public school students were White; by 2005, only 58% were (Gandara &

Contreras, 2009). The country's Hispanic population has grown five times as fast as any other ethnic group in the last ten years (Hansen, 2005). This rapid growth has placed a great deal of stress on the education system, which is struggling to keep pace with a population that seems to face a large number of difficulties integrating into the public schools.

The root of the problem

Completion rates of public education are significantly lower for Hispanics than for the population as a whole. Only about 75% of the Hispanic population in the U.S. completes high school, as compared to about 94% of the total population. This fact could be correlated to evidence that Hispanics have significantly lower household incomes than non-Hispanic Whites. The incomes of Hispanic workers reflect this discrepancy: Hispanics earn significantly less than average for the total population. The median annual salary for Hispanics in 2007 was $37,800, as compared to $52,400 for Whites (United States Census Bureau, 2007), only 57% of Hispanics ages 25 and older have graduated from high school, and only 11% have a bachelor's degree (United States Census Bureau, 2004). Rapidly changing demographics, federal legislation, and misperceptions about language diversity have contributed to the problems educators face in meeting the needs of English language learner (ELL) students (Karathanos, 2009).

Problem Background

Although the Hispanic cultural identity spans dozens of countries all over the Western hemisphere, according to the U.S. Census Bureau (2006) Arizona rates in the top five states for overall Hispanic population gain in the country. Hispanics come to the U.S. from all over the world, but 64% are of Mexican descent. Similar numbers hold for all the states along the U.S.–Mexico border. Many school districts in the Riverside area of Southern California, a center for agriculture, report Hispanic population concentrations far higher than the national average. The

San Jacinto Unified School District in Riverside County has a population consisting of 84% Hispanic students, nearly three times the next largest ethnic group (2019–20 enrolment statistics, cde.ca.gov). Demographics such as socioeconomic status, education levels, language barriers, and other components of student success have been analyzed, but despite the efforts of many researchers, this student population does not appear to be closing its achievement gaps.

Study location

According to San Jacinto Unified School District (SJUSD), when students are informally questioned about why they don't put more effort into school, many report the same thing: their parents don't know enough about the school system to realize that they're doing poorly. Lack of parental monitoring could be due to several factors other than not speaking English well. Students at San Jacinto High School indicated that the reasons for parents' lack of involvement varied from being intimidated by teachers (because of their own limited educational backgrounds), to being too busy with their own lives. Parents may also be unable or unwilling to use the district-provided technology to monitor their children's academic progress. Anecdotal data suggest that Hispanic families, especially parents, see school as school and home as home. This view complicates the idea that students should take schoolwork home and practice it. For Hispanic parents, this idea is culturally incongruent, and it is likely to happen only at the convenience of the student's mother. According to student testimony, this does not happen until well into the evening, when younger members of the family are in bed.

The adults in families that move into the Riverside area tend not to learn English or adapt to what many consider American culture. Hispanic families also do not adjust to the culture of the American school system, according to informal, anecdotal interactions and interviews with students and parents of the San Jacinto area. Further research would be needed to confirm that similar behaviors occur throughout the cities in the area. These social interactions and conversations indicated that many Hispanic students and their families don't realize that more than 75% of future jobs are predicted to require postsecondary education and a greater level of technological fluency than most Hispanic students have demonstrated (Arizona Business and Education Coalition, 2007). Many people see a problem here. With Hispanics making up a growing part of the U.S. population, their academic success seems inseparable from the future success of the country. If they fail, it has catastrophic consequences for the U.S. economy and social stability.

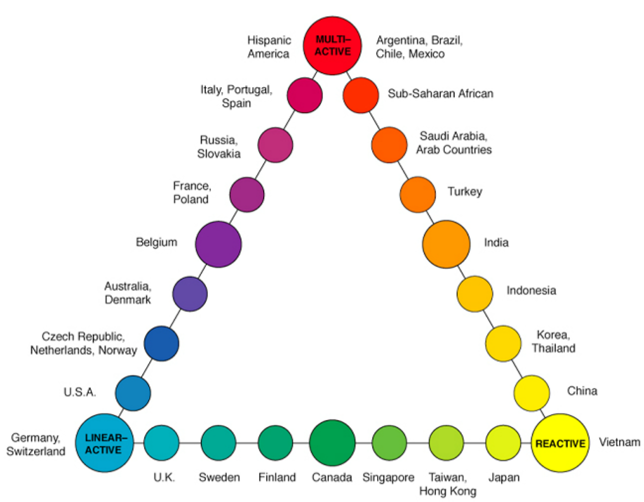
Cultural Foundations and Conceptual Framework

The Lewis cultural model

Lewis' work was partly motivated by his frustration with previous cross-culturalists creating more confusion than clarity when trying to gain insights into foundational characteristics of cultures. After visiting 135 countries and working in more than twenty, Lewis simplified all the world's cultures into three clear polar extremities. Figure 1 presents the Lewis model and assigns countries and their cultural attributes to it on a triangular gradient.

Figure 3:

Lewis's cultural model



Lewis's work, though constantly being revised, presents a model by which people can understand the behavioral tendencies of other cultures. Moreover, and perhaps unintentionally, the diagram may provide key insights into why Hispanic students do so poorly.

The term "polarity" is traditionally used in science to sort entities into two groups. A substance is either positive or negative, polar or non-polar, or organic or inorganic. The idea that something could be polarized in three directions might seem counterintuitive. However, Lewis's model appears to suggest just this.

Most Hispanic people in the U.S. come from Mexico, and their concentration increases substantially in states that border Mexico. The Lewis model suggests that linear-active countries such as Germany, the U.S., Switzerland, and the U.K. are positioned opposite multi-active countries such as Mexico, Colombia, Brazil, and Venezuela. People from linear-active cultures (Lewis, 2010) display task-oriented behaviors and are organized planners who complete actions in a connected series to reach a specific goal. These cultures prefer to stick to factual discourse, are truthful rather than diplomatic, and do not fear confrontation. Linear-active people tend to conceal their feelings and value a certain amount of privacy. They need data to make decisions, and they use accurate decisions to produce results. The linear-active mindset is the mentality of growth, progress, and assessment for the sake of making sound decisions and predicting future courses of action.

People in multi-active cultures depend heavily on open communication and socialization to acquire information. Lewis (2010) described these people as impulsive and placing great importance on feelings to learn about decisions. Multi-active cultures run "off the clock," according to Lewis. They are unhurried, and adhering to self-imposed deadlines appears mostly incompatible with their traditional psychology. Multi-active people are often late paying bills or finishing projects. Relationships with family members and close friends take precedence over other official policies, rules, and other organizational regulations. People of multi-active cultures are accustomed to challenging authority but will accept their place in a social or organizational structure when placed there by an influential, authoritarian “father figure” who emphasizes protecting them. Their interpersonal contracts are traditionally oral so they can avoid relationship-straining regulations in which charisma, rhetoric, and negotiated truth tend to be used to close deals. They are less intellectual and calculating and more engaging and welcoming, and they place great emphasis on compassion and human warmth.

The American educational system is clearly aligned with the lower-left section of Lewis’s triangle. The country’s schools are driven by deadlines, measurable objectives and standards, and assessments of the position and trajectory of everyone in the system. For example, the No Child Left Behind (NCLB) Act made “testing and accountability our national education strategy” (Ravitch, 2010, p. 30). The essence of the act was related to four concepts of public school reform: (a) stronger school accountability; (b) greater flexibility for schools to use federal funds; (c) school choice; and (d) an emphasis on science-based teaching methods (U.S. Department of Education, 2002). Although this strategy may work for many struggling populations in the U.S., every section of this reform initiative runs counter to the cultural mindset of multi-active people. It could be just the opposite of what is needed to encourage their greater engagement in a system that demands behaviors in opposition to their own.

Instructional foundations of the chemistry course

NGSS: Based on experiential phenomena. The state of California recently adopted next generation science standards (NGSS), which let teachers play new roles in developing science curriculums directed toward state-assigned outcomes (Pratt, 2013) intended to narrow the gap between the U.S. and the rest of the world (Christofferson, 2017). Many non-socioeconomically challenged school districts, such as the Murrieta Valley Unified School District, responded by developing science curriculums centered on phenomena such as climate change and the impact of human activity. These topics were delivered to students through standard science pedagogy (Wells et al.,1995). Low-SES school districts with large Hispanic populations suffer from lack of student engagement, which contributes to the most substantial drop high school dropout rate by culture in the U.S. (Marks, 2000).

The ubiquitous learning environment prototype

The AREA154 curriculum was designed to address the engagement problem and recognize the cultural needs of multi-active students. It was tested in-situ over a two-year period as a way to address the traditional pedagogical shortcomings that prompt apathy from the multi-active (Hispanic) demographic at San Jacinto High School. Anecdotal observations and site network data were collected to address problems with system usability, technical and user-interface problems, and network traffic congestion. The focus on usability helped ensure that students' experiences would be focused on the uLearning environment, not technical problems.

The AREA154: Apocalypse Division

This experimental environment meets the criteria for ubiquitous learning put forth by Huang (2018); see Table 2.

Table 2

AREA154: Apocalypse Division and ubiquitous learning qualifying criteria

Characteristics of a Ubiquitous Learning Environment	AREA154: Apocalypse Division Application
A centrally located hub (a	• The server space *area154.net*, hosted by MidPhase Hosting Services.

network server in most cases) centralizes the curriculum.	• Experimental sub-domain: *temple.area154.net.*
Lesson content can be accessed at any time.	• Server and site access are open 24 hours a day. • Site access is monitored using the Simple History WordPress plugin.
Content can be accessed through any network-enabled device	• Because the website is free of district-access parameters, it can be accessed through any network-enabled device. • Experiences with the site may vary as its format changes in response to the type of device and type of network connection.
The user's interactions with the system can be stored and analyzed.	• The organizational aspects of the curriculum are handled by the Sensei WordPress plugin. Sensei is an LMS that presents material to the students after they create accounts. • Data such as quiz scores and course completion information can be accessed through this account. • Sensei also provides student assessment data for comparing sections, students, and classes.
The curriculum is real-world applicable, either theoretically or practically.	• The curriculum was designed to present chemistry and associated STEM subjects as tools for increasing one's odds of surviving an event with world-altering consequences. • The year-long curriculum contains five "case files" that teach students how to save themselves and their families.
Instructions and support for learning new material are immediately available on demand.	• The case files are divided into four pieces of training, which can be accessed via an interactive PDF on the temple.area154.net website after students log in. • The interactive training documents are programmed with "Director Briefing" icons that, when clicked, present a clear instructional video on what to do for each section of the training. • The interactive "media icons" are programmed with links to videos that explain complicated content in different ways or provide screen-captured examples of how to complete procedure-based problems. • Interactive icons called "check it out" link the student to new net-based media or images stored on the area154.net server. • Multiple supports are accessible in this format at the students' whim.
Responses to formative assessments are immediate and provide opportunities for re-learning and re-assessment.	• Formative assessments, referred to as survival readiness tests (SRTs), are presented in sections of ten questions. • Students are presented with their scores immediately upon pressing the "complete" button. • Students can use online materials to re-train and retake the assessment for a better score.
Systems are usually thematically centered, with a central narrative and evidence of interactive gamification.	• The student plays a member of a black-budget special-access program run by the U.S. government known only by an "AREA" designation. AREA154 operates in specialized high schools and trains teenagers, as the most resilient segment of the population, to survive the end of the world. The government calls this "strategic human asset protection." The kids in the program call it the "Apocalypse Division." • Badges and achievements are provided on the basis of user interaction. • The Agent Leader Board displays the twenty students who have the most achievement points. • Achievements can be completed at any time while a case file is active.

	• These are thematically related and provide additional STEM opportunities for students.
The system adapts to the cognitive needs of the student.	• Most of the adaptations to the student's experience come from the system designer. • Many of the students present fairly uniform psycho-social behavior. As such, this system was developed to address the cognitive needs of the students using it. • Most of these changes occurred in the first two years of testing, with smaller adjustments based on observations and feedback from users.

Table 2 outlines the AREA154 uLearning system from a mechanistic standpoint. It describes how the system was inspired by Huang's (2018) inclusive definition of an effective uLearning platform. The inner theme and narrative of the program were derived from two sources: Laborda (2015) and television program *CSI:NY*. Laborda recognized the power of a narrative to present the notion that any content can be learned more effectively if embedded inside a narrative. This is especially true for game-based learning. *CSI:NY* also provided a significant design influence, as the program had researchers working as science consultants on blood suspension chemistry. TV-show consulting is not written research, but the show's design principles are soundly rooted in the psychological principles of cognitive dissonance. The lesson it provided was, "Show something that seems impossible and then slowly reveal science as providing clues to solving the case. At the end, curiosity is fulfilled and the dissonance is relieved."

The AREA154 narrative for learning takes the idea of implausible dissonance and applies it to uLearning. Each case files shows the student ways the Earth could be irreversibly changed in ways that seem impossible to survive. Then, layer by layer, science is used to demonstrate that survival is possible. In the end, the student uses their experiences to prove they can save themselves from doom.

Review of Literature

The shoulders of giants

Von Brocke et al. compared the literature review to a famous remark by Isaac Newton: “If I can see farther, it is because I am standing on the shoulders of giants.” Modalities of instruction have varied over history so that one generation can pass on knowledge to the next. Constructivist learning methods are not new, but the tools that enable constructivist ideologies have evolved, as have the peoples enrolled in the schools that practice these Western educational philosophies.

This investigation began with the discovery of Lewis’ (2010) work on countries’ underlying psycho-social behaviors, which we have superficially called “cultures.” Lewis defined these behaviors as national characteristics. Although they appear to be racist, Lewis claims that they are in fact national norms of behavior. His book was intended for business use, in the hopes that proper education on national behavioral norms could maximize the success of transcultural personnel transfers. His theories about culture include elements of humor. For example, Asian cultures generally do not find Americans and Western Europeans very funny because much of their humor is built on sarcasm. Many of the cultural underpinnings of Asian people comes from the Confucian ideas of truth, kindness, and compassion. As such, harsh, belittling jokes tend to go against the grain for them. Lewis categorized Asians as “reflective” in their national behavioral norms.

Lewis has also published on more culturally specific concepts, like how different cultures address the idea of time (Lewis, 2014). In *Fish Can’t See Water* (Lewis et al., 2013) he claimed that people who grow up in a specific cultural psycho-social mindset are blind to its inherent behavior sets. Germans do not realize that they are naturally procedurally driven and linear thinkers because they grow up and live in Hamburg. They are essentially blind to their own norms and tend only to see those norms when they come into contact with conflicting ones. Even then, they probably observe simply that everyone else is "different" in a negative way without recognizing their own norms. It is from this perspective, this framework, and this realization that Hispanic behavioral patterns and psycho-social traits can be seen to be very different from those that created the U.S. public school system.

Searches about Hispanic educational experience returned hundreds of books and articles, many of which, such as *Hispanic Education in the United States,* reported biographical information and people's experiences of "what it is like to be" a Hispanic person in the U.S. school system (Garcia, 2001). However, this book contains little evidence that the author identified cultural differences inherent to the mingling of cultures as the reason for the perceived inequalities. Lewis (2014) suggested that cultures are prone to not seeing their own psycho-social traits. Garcia (2001) gave a clear example of this in his demands upon the educational system: "Schools must shift their emphasis to the development of broader 'living' processes that will enhance human relationships, critical thinking, and civic responsibility" (p.16). These are clear examples of multi-active cultural norms favoring relationships, emotional warmth, and community.

Garcia (2001) further asserted that the preservation of Hispanic (multi-active) psycho-social behaviors is more important than the academic skills responsible for the long-term success of the student:

> In a nationwide survey of families, researchers found evidence of serious disruptions of family relations occurring when young children learn English in school and lose the use of the home language. This study revealed that while the language minority parents

> recognize the importance of English (for academic success), they do not want it to be at the expense of the home language. Many of the parents expressed concern that their children would lose their native language (culture) and become estranged from their family and their cultural heritage. (p.17)

In other words, multi-active psycho-social tendencies favor non-acculturation. These cultures would fight to maintain their national behavioral norms at the expense of the student's academic success. A study by Gillard et al. (2007) supported Garcia's findings. The authors concluded that providing language support by preparing students to work in their home languages supported the psycho-social traits valued by Hispanic cultures. The same study inferred that individualization of classwork also supported cultural vitality in the home. Those accommodations consisted mostly of changing assignment timelines and due dates to accommodate events at home. More and more, the literature suggests that multi-active psycho-social norms are incompatible with the linear-active design of the public school system in the United States.

Gillard et al. (2007) also provided suggestions for U.S. public school teachers to address the situation: in summary, that the teachers must work to address each student according to the specific set of national norms its family follows. There was very little indication that the needs of all families would be the same, only that in multi-active cultures, the family comes first in whatever form it takes. The article did not explain how to accomplish this task.

The Hispanic educational paradox is well documented, but proposed solutions have often been placed on the shoulders of "technology" in the hopes that it might somehow present an answer. A finite amount of disclosure of this type of financial waste is available. However, after 23 years of anecdotal observation, spending money on technology in the hopes that it will fix something is not just a theory; it is what happens.

Expenditures, priorities, and the catch-22 of the ed code

Wenglinsky (1997) provided insight into how school districts spent money to increase student achievement. Their spending priorities were studied in both high- and low-SES districts with high Hispanic populations. The study reinforced others observations about contemporary spending in school districts. School spending can be broken into two categories: investment in instructional capital, such as more teachers, support staff, and administrators capable of making wise fiscal decisions; and investment in terminal goods, of which the largest category in almost every district was technology. Low on the list of expenses was training in the use of those goods, which cost only about 1% as much (Wenglinsky, 1997). Wenglinsky concluded reducing the student-to-teacher ratio was ultimately the best way to spend money. However, some consideration was given to the possibility that Title I districts (largely Hispanic-populated districts in the U.S. Southwest) experienced more growth among poorer students. In those cases, expenditures included training the current staff on the use of terminal technology. However, when in-house personnel were lacking, that training rarely happened.

Wenglinsky (1997) suggested a practical course of action that had demonstrated improvement in nearly every district that spent money on instructional capital (for example, training in an instructional philosophy). Despite the study's clear directives, its suggestions are fraught with complications that school districts may be powerless to fight.

State budgets control the amount of money that schools get, and that quantity is often tied to assessed property values in the areas the schools serve. Poorer areas may receive far less state funding because their real estate values are depressed. Although federal Title I funding can rectify some of that inequity, that funding is frequently categorical and cannot be spent on anything but terminal goods. California and many other states use property taxes to fund schools, but this money is collected and redistributed evenly on the basis of attendance. Districts can try to reallocate state funds for instructional capital and use federal funds for terminal goods, but this is not simple. Lower-SES districts in California often have a much higher concentration of Hispanics, and as a result these Hispanic communities struggle to find administrators capable of spending on capital assets that can reduce the achievement gap. Most highly qualified tech-savvy administrators are unwilling to work in impoverished areas. The same is true of highly skilled teachers, especially in math, science, and technology (Wenglinsky, 1997; Cochran-Smith, 2016). Discovering, acquiring, and retaining talented instructors can be difficult for any district, but the literature agrees that it is especially difficult in non-affluent areas, where it could make the most difference. One solution that could work appears to be obstructed by social factors and budget constraints. The other choices seem to be very limited.

The argument for terminal goods

The only other option, according to Wenglinsky (2012), is to take the money and spend it on terminal goods. According to Machado and Chung (2015), the majority of principals asked in a survey said that they were in favor of using technology for education and displayed little hesitancy to spend money on it. When asked what they would spend one-time funds on most said they would purchase technology for the staff to use in the classroom or to be shared. By contrast, the respondents indicated that they spent very little on training, and that they spent that with little confidence that it would have any long-term impact. According to Machado and Chung (2015), the lack of influential instructional technology leaders and strong examples of technology use at the sites led to training being either ineffective or lacking follow-up support for instructors. The reason for this was not directly stated, but it could be surmised that ineffective training was due to lack of time on the trainer's part or lack of funding for continued instruction.

Carr (2013) reported that technology only helped Hispanic students when the curriculum was presented using the technology. However, few teachers showed the capacity to prepare lessons this way. This deficit could be explained by Machado and Chung's study.

In combination, these studies support the idea that technology by itself is not the answer, and training is also required. Evidence for this can be observed at the high school where this study will be conducted. In the past three years, the school has acquired federal funding to create a 1:1 device program for providing students with technology to complete school work. Despite efforts to provide technology to Hispanic students, this group experienced the least academic growth. Again, technology was only a gateway to a solution, not the solution itself.

Why does this loop of failure continue?

The literature suggests that the district administrators are aligned with the expenditure of money of terminal goods because current monetary governance mandates that money be spent in a specific way. Additionally, bias was reported toward spending money on training and on new technology design methodologies, even though research did not support this. Machado and Chung (2015) also reported that districts with more Hispanic students are less likely to have strong instructional capital on technology or talented curriculum designers. More affluent districts may rely on the local instructional technology capital without hiring outside specialists. This practice, according to the same study, did not yield promising results either, but it did have the advantage of being less expensive.

Systemic problems that require innovation

Technology offers great potential for resolving a problem that resembles the paradox of the unstoppable force meeting the immovable object. Hispanic cultures value behavioral norms that appear to be incompatible with schools that manifest linear-active educational constructs.

The challenge for Hispanic students goes well beyond technologically restrictive factors. Problems such as generational poverty, cultural ecology, and the highest dropout rate of any ethnic minority (Kayaardi-Hinojosa, 2011) seem to persist through every sort of intervention, including unrestricted access to learning technology.

Low-SES, high-Hispanic population school districts typically do not attract or retain skilled instructors who can create innovations that might contribute to solutions (Wenglinsky, 1997). As a result, they end up using Title I funds to buy technologies that few teachers are adequately trained in using (Machado & Chung, 2015). The foundations of these challenge have been presented, and they are very rocky foundations. This investigation will collect data on a uLearning system design that has had little exposure in school systems in the U.S., possibly none in districts densely populated with students possessing multi-active psycho-social behavior traits. The multi-active enigma is a complicated problem but perhaps not insoluble.

Ubiquitous learning systems: Instructional personalization

Computing technology has expanded the domain of possibilities in ways that the founders of constructivism might never have believed possible. Mark Weisser introduced the idea of ubiquitous learning as providing a world in which computers and associated technologies are so intertwined with students' life experiences that they have difficulty distinguishing between learning objects and parts of everyday life (Weiser, 1991). Jones and Jo (2004) quoted Weiser as saying "The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it" (p.3).

Weiser was a Xerox PARC researcher who coined the term "ubiquitous computing" in the late 1980s. In 1993, he discussed how the relationship between computers and students would one day act occur in a ubiquitous learning space, or "u-space," where the technology fades into the background and simply facilitates the learning experience. He has been credited as the initiator of the modern ubiquitous learning environment. Weiser postulated this type of learning in his *Scientific American* publications, and the internet, wireless communication, and the omnipresence of people-centric, social-sensing, over-sharing, communicative hand-held devices brought it to life (Campbell et al., 2008).

The Fundamentals of Ubiquitous Learning

Kidd and Chen (2011, p. 4) and Cope and Kalantizis (2010, p. 15) described ubiquitous learning as a paradigm that promised support for teaching anything, anywhere, at any time through the use of computers, software, and services. In 2020, that definition has the ring of common sense, but ten years earlier it raised substantial questions about the pragmatic nature of uLearning. In 2010–11, networking, online storage, and high-speed internet access were nowhere near their current levels. The concept of uLearning also included revisions of the ideas of Po-Sheng et al. (2008) and other notable researchers, such as Chen, Chang, Wang, Kao, Hwang, Ogata, Yano, and Yang. The ideas of these influential thinkers were synthesized into a general framework for uLearning. A comprehensive list, probably similar to one derived by Huang (2011) for uLearning's basic framework, was provided by Kidd and Chen (2011).

Key ideas of the uLearning framework include the following:

- *Urgency of learning needs.* A uLearning environment can be used for urgent learning needs. On-demand and just-in-time learning are variants of the uLearning concept.
- *Initiative of knowledge acquisition.* uLearning provides information upon request and promptly, in the context where the learner needs the information.
- *Interactivity of the learning process.* The interface of a uLearning system must facilitate effective communication between students, teachers, and other influencers of

information.

- *Situation of instructional activity.* uLearning involves situated interaction. The learning is embedded in the natural flow of an event or everyday activities, real or virtual.
- *Context awareness.* Students interact with the environment, and that interaction is governed by the context in which natural learning would take place. This includes synthesized contexts like gamification and thematic or story-driven settings (Huang, 2015).
- *Self-regulated learning.* The environment allows students to control their learning progress. In more advanced cases, the system uses this information to adapt to future study (Huang, 2015), a technology that was not available when original list was compiled.
- *Seamless learning.* A uLearning environment allows students to control their own learning processes and progress as they move from place to place.
- *Learning community.* A uLearning system can access networked content and services to enhance the interaction between students and teachers.

This list provides the constructivist basis for authentic experiences and learning opportunities. The experiences, context, meaning, and motivation and the acquisition of the knowledge would be the learners' primary experience, and the technology supporting it would simply play a facilitative role (Hung et al., 2013; Huang & Springer-Verlag, 2016).

uLearning and connectivity

One of the most rapidly expanding technologies to support ubiquitous learning is wireless technology. Expansive, location-dependent connections were actively endorsed as one of the essential underpinnings of uLearning (Barbosa et al., 2008; Dey et al., 2010). Barbosa cited

WiMAX, Wi-Fi, and Bluetooth as crucial elements of connectedness in 2011. That list has since grown to include ubiquitous 5G wireless access that allows algorithms to provide data using the "internet of things." Radio frequency identification (RFID) is a low-power alternative for providing location data to a more extensive network in which positioning data can be used to upload information to users that is relevant to their current locations.

The endeavor to move ubiquitous computing to the worldwide stage has recently seen a huge advance, as the company SpaceX deployed of Project Starlite, which is intended to put 12,000 satellites into orbit to provide high-speed internet to the entire planet (Mosher, 2019). These nodes for data transfer will provide yet-unseen quantities of data. Given the demand to process all this information, the technology and science behind big data processing may play a significant role in the future of ubiquitous learning. Later in this review, the roles of specific technologies will be addressed. The full range of technologies, new and old, will help uLearning realize the benefits that many researchers have reported from experiments.

uLearning, Pedagogy, and Teachers

In today's classroom, uLearning does not use live camera feeds to upload lessons to the cloud for everyone to access (Ogata et al., 2014). Experiments in Taiwan and China have used intricate algorithms and RFID tags to provide lessons in parks and museums, however (Liu et al., 2009). While research has suggested a promising future, constructivist uLearning in classrooms is still confronted by restrictions. Access to technology and pedagogical freedom retard the evolution of uLearning-type systems. Connectedness and big data provide unique opportunities for the personalization of learning. However, the customization that some variants of uLearning thrive on could also pose security risks, as big data can impinge on personal freedoms (Laborda, 2015). In the section "uLearning Analyzed through Pedagogy," below, I give more attention to the current state of ubiquitous learning.

Themes, gamification, and stylized variations of uLearning

Huang (2015) laid out the importance of the classroom experience to ubiquitous learning, dedicating an entire chapter to the design and architecture of thematic storylines in which study takes place. Laborda (2015), reviewing the book, expanded on the idea that storylines are good for subjects like the humanities, but argued that they are essential for science. He went on to describe enrichment that gamification might provide to uLearning. Laborda concluded, “These authors present a good conclusion as they suggest gaming skills in learning should be supported and enriched by adequate stories” (p. 74). In a section examining themes, games, and other variations of ubiquitous learning, Laborda argued that the future of uLearning may be found not in abundant connectedness but in the creative differences in how uLearning stories are told.

uLearning, adding value, and combatting idealism

At the conclusion of this literature review, I summarize ubiquitous learning as it is seen in the educational technology research community. Evaluations of current forms of uLearning are also provided, with some scrutiny and a projection of where uLearning might be heading if wireless technology, big data, and the thematic evolutions of uLearning continue their current trajectories.

Ubiquitous Learning: Varied and Evolving

Definition through literature

Ubiquitous learning is a new paradigm and still far from universal acceptance (Laborda, 2015), but it is valued as an area of research to improve educational strategies using a wide range of established and experimental technologies (Barbosa et al., 2008; Lewis et al., 2010; Ogata & Yano, 2009; El-Bishouty et al., 2010; Rogers et al., 2005; Yin et al., 2004; 2010). The revolution in ubiquitous learning is expanding due to the evolution of wireless networks and cellular networks, and expanding access to the internet. Wong and Looi (2011) recognized this trend. They started to refer to the ability to learn anywhere in or out of the classroom as “seamless learning.” The term “seamless” was meant to refer to the borderless transition between in-class and out-of-class learning (Hung et al., 2013). Before there was technology to accomplish this, the American College Personnel Association (1994) noted the importance of connecting classroom learners to the outside world. Doing so would result in greater academic success. As technology has advanced, the concepts of ubiquitous learning technologies have grown in kind.

The expanded nomenclature of the uLearning paradigm includes “computer supported ubiquitous learning” (CSUL), or “context-aware ubiquitous learning,” which is the more common term. Both of these names refer to technology-enhanced learning environments supported by ubiquitous computing technologies such as mobile devices, RFID tags, and wireless sensor networks (Ogata & Yano, 2004; Wu et al., 2013). Hwang et al. (2012) also included interaction between personal mobile devices through wireless networks based on the interaction with physical objects in the surrounding environment. This interaction would be accomplished through sensing technologies and connections between devices using cellular or hotspot wireless networks. Barbosa et al. (2011) defined the uLearning environment similarly but added the idea that students use the technology collectively to integrate their group into an environment that interacts with or reflects aspects of real life. In this situation, the ideas of location and context-aware learning are also known as “LOCAL.” The system’s goal was to stimulate interaction between students; it was not designed with any sort of mitigating courseware that focused or guided the learning experience.

Huang et al. (2011) provided an extensive list of characteristics that could be used to define uLearning:

- Urgency of learning
- Initiative of knowledge acquisition
- Interactivity of learning
- Situation of instructional activity
- Context-awareness
- Active provision of personalization
- Self-regulation
- Learning community
- Adaptive learning
- Constructivist learning

Most researchers appear to have a similar understanding of the foundations of uLearning. However, some have offered new ways to describe them. For example,

> The ubiquitous learning environment provides an interoperable, pervasive, and seamless learning architecture to connect, integrate, and share three major dimensions of learning resources: learning collaborators, learning contents, and learning services. (Chang & Sheu, 2002; Cheng et al., 2005; Haruo et al., 2003)

This is another:

> Ubiquitous learning is characterized by providing intuitive ways for identifying right collaborators, right contents and right services in the right place at the right time based on learners surrounding context such as where and when the learners are (time and space), what the learning resources and services available for the learners, and who are the learning collaborators that match the learners' needs. (Ogata & Yano, 2004; Zhang et al.,

2005; Takahata et al., 2004).

In summary, the literature defines uLearning in a variety of ways that all hinge on a central theme: uLearning opens the horizons for anytime, anywhere, environmentally specific personalized learning.

Claims, context, and the learner's perspective

Kidd and Chen (2011) claimed that uLearning "can be powerful, personal, current, and situated as learners and instructors can communicate, interact, and learn in real-time." They did not say whether this instructional communication must be face-to-face, but one can infer that as long as instructional communication can take place between the student and the instructional component of the lesson when needed, the real-time criteria can be met from the perspective of the student, who requires the right information to be available to for learning while minimizing time spent waiting for feedback.

Yang (2006) defined "context" from two perspectives, the student's and the learning service's. From the student's perspective, the context is the surrounding environment, which might include web services, discovery and access, the student's profiles and preferences, and the network channels and devices used to connect to the web. From the service's perspective, the context is the surrounding environment affecting delivery of learning services, such as service profiles, networks, protocols for service binding, devices, and platforms. Typical services for ubiquitous learning are devices, network detection, location tracking, calendars, content access, and social activity services (Yang, 2006).

An example of ubiquitous access was presented by King in "Social Media, Story Stream + the University Classroom." This video podcast gives an environmental context for students who create what King called a "living-learning" classroom experience, a heuristic adventure un which they find, sort, analyze, share, discuss, critique, and create. The assignments were built on an ideology that claims students do not live in a passive world where memorization is the key to success. King argued that students were best served in a learning context that uses expository software to help them read, write, and produce works that are published. Critics of the idealized uLearning environment, however, have painted a bleaker picture of it.

In *Ubiquitous Learning Environments and Technologies,* Hwang and Springer-Verlag (2016) discussed the context of the student in the uLearning design process. They emphasized the importance of the student's perspective. One's understanding of the learner's background and prior knowledge significantly influences the structure of the learning context. Arguably this would include geographical and cultural experiences as well, though I found no literature that discussed cultural perspectives in conjunction with uLearning.

In answer to the questions, "What does the learner know about the topic, or about associated topics?" and "What skills are fundamental to understanding the new topic?" temporal elements such as when the student was last taught the material or how much time passed between sessions on related topics or successes by the student could influence the student's motivation or momentum in moving through the material. Although one could add linguistic understanding of the content, I found no resources drawing links between language immersion, ELD students, or other language-related topics and uLearning.

Students have a variety of learning perspective, such as Gardner's eight learning styles, VARK (visual, aural, read/write, kinesthetic), and the Felder Silverman learning style model, which provide standardized answers to the question of how students learn. The FSLSM provides delineations such as sensitive-intuitive, verbal, visual, sequential-global, and active-reflective (Felder & Silverman, 1998).

Beyond the psychological profiles, students' working memories are what Miller (1956) described as the limits that people can keep in short-term memory accurately. The number revealed in that study was 7 +/- 2. Working memory capacity (WMC) plays a key role in uLearning lesson design. The data were collected independently of the learners' style or profile. The methods for collecting those data from students were not divulged. However, the guiding limit is that no more than seven elements should occupy a student's cognitive pathways at any time during uLearning. Additional neurocognitive traits might include profiles generated for memory capacity, inductive reasoning, and associative skills. Hwang and Springer-Verlag (2016) discussed this aspect of the student's perspective when proposing how to make a road map for the integration and deployment of uLearning.

uLearning and applied technologies

Tan et al. (2011) presented a uLearning framework in which five factors had to be in place for the technological aspects to be implemented:

- Timing of the learning: day, year, or point in the curriculum.
- Location of the learning and the student: classroom, park, museum, home, etc.
- Availability of devices or technology at the location.
- The content to be learned.
- The individual characteristics of the student: learning style, previous content exposure, etc.

Tan et al. (2011) described situations that might give further insight into these framework guidelines for uLearning. For example, the timing might matter to a law student who needs access to a legislative body but could be turned away because the uLearning system understands his location, environment, and, most importantly, his timing. If no legislative body is meeting at the time, the system must know that to provide the right content in the context. The right content will give the student proper access to resources around them with which they can learn. Tan's framework does not address how AR and VR would change these frameworks.

Timing and content are crucial, but the devices and their connectivity hardware are the bottleneck of the uLearning framework and determine what the student can and cannot interact with or experience. For example, if a device doesn't support Flash animations (as of 2020, nothing does), the student will be denied the ability to use that learning medium. The synchronization of the device, its access to the network, and its access to the server that provides the content are all interdependent. If any part of this system breaks underperforms, the entire uLearning framework is affected.

The student is the final and perhaps most complex variable in the framework. The technical complexities are numerous and may fall largely outside the control of the instructor. For example, instructors and content designers may have little on the institutional network or the networking variables controlling students' access at home. In addition, the mental, emotional, and preparatory state of the student enters the equation. Putting students in a psychologically better state may not be something the instructor or the content design can do. Authors who have written on the application of uLearning, such as Huang (2016), have identified these external challenges to learning with technology-enriched environments.

However, learning styles may also be influenced by cultural norms. If a pool of learners contains wide diversity in culture, parental involvement, and socioeconomic status, creating a curriculum that fits all the students' cultural priorities may be very difficult. Huang and Springer-Verlag appeared to conclude that the cultural profile of the community can be considered one of the elements of contextual awareness. Questioning students before the learning activities to determine this presents a couple of possible drawbacks, however. The questioning might take up critical education time, and the information gained represents the student only at that particular time, place, and age; those could change the following day (Huang & Springer-Verlag, 2016). Bayesian networks were used to collect data on students as they experienced the content to illuminate points where intervention might be useful (Graf, 2007). Ubiquitous technologies can help teachers make these determinations and analyze students' learning styles and patterns.

uLearning can be static and can happen where learning happens, essentially creating or engineering learning to happen when the student can best relate to the subject. Huang and Springer-Verlag called these contexts "authentic environments." The evolution of technology has led to more powerful and compact devices that can be used in the field and computers powerful enough to create worlds that students can be transported into for maximum collaboration with the learning environment, as in AR and VR systems. Integration between GPS and mobile cellular networks (FCC, 2010) and positioning based on wireless antennas appear to be the beginning of such distributed systems (Hightower et al., 2006). The precision available today allows for practical applications (Vaughan-Nichols, 2009). Moreover, the proliferation of wireless hotspots suggests that in the future, this precision will grow, allowing for sophisticated location-based services (Dey et al., 2010). As of 2020, the date of this literature review, SpaceX had created a global network of 4,425 satellites to provide complete planetary coverage for high-speed internet (Kyle, 2017). The argument could be made that these notions are outdated, considering the advances in global internet access made in the last ten years.

Beyond geographical location, various elements of the student's descriptive context and conditions (e.g., business location, temperature, humidity) could be included and detected, and sensing devices (e.g., RFID, GPS, or an infrared ray system) could be used in context-aware learning activities, or what Huang and Springer-Verlag (2016) called “environmental awareness.” For example, RFID has a broadcast distance measured in feet and is useful for localized applications. GPS is suitable for detecting locations in large areas, as the GPS signal is global and free, and requires only an app to make use of. Moreover, the contexts have an even more daunting task, as researchers have indicated that “timely location” is the most essential and fundamental parameter for context-aware uLearning (Chu & Hwang, 2010; Hwang et al., 2008).

One thing that depends heavily on the success of education on demand is knowledge of which real-life objects are available in the student’s environment. Environments outside the classroom require a broader understanding to make learning possible. This information can either be stored in a database or presented to the student through something like a QR code. This type of uLearning might occur at a museum or an exposition where QR codes or RFID tags interact with cell phones to provide information about the exhibit when the learner wants it. These appear to be ideal applications to be studied in VR or AR, but I found no literature investigating the use of virtual or augmented realities through uLearning principles.

Wong and Looi (2011) presented a similar concept they termed “seamless learning,” in which the student could learn at any time and in any place. They provided multiple ways of learning throughout the typical day. Traditional in-class activities and out-of-class activities appear to blend into each other (Hung et al., 2013). The American College Personnel Association (1994) placed a great deal of importance on linking students’ in-class experiences with their experiences outside class. Applicability to real-world situations and environments has been consistently referred to or implied to be a foundation of uLearning systems.

It should be noted that nearly all uLearning environment and technology studies were done in clinically sealed environments that existed for experimental purposes only. Little uLearning research has been applied primarily to in vivo learning environments.

uLearning presents a variety of problems, and the technology needed to solve them has changed drastically since the inception of the idea in 1993. The premises of uLearning include having the right information at the right time, where it can be applied to the real world in a meaningful way. The delivery of that has required the synthesis of technologies that continue to evolve. The growth of wireless devices in both power and number has created great potential for uLearning. However, the use of mobile devices does not imply that uLearning is either a form mobile learning or a part of the eLearning paradigm. There are commonalities, but these concepts are not the same.

uLearning and big data technologies

Large numbers of people create large quantities of information, whether they are aware of it or not. Comments, "likes," time in sessions, and even the inclusion of meta-data in material consumed online can be used to generate a picture of small pieces of collectible information. When this lake of information is dammed up and processed, striking correlations and predictors can be presented (Huang, 2016).

The graphical evaluation of massive pools of information tools like the structural equation model (SEM) can be used to show the connectedness among variables used in social-science behavioral analysis. SEM analysis can indicate that a causal relationship is in play (MacCallum & Austin, 2000). SEM can also be deployed in a counterfactual manner: an SEM analysis can suggest a significant correlation to something claimed to be true but also present big-data statistical analyses demonstrating the claims to be likely false. SEM can show that there is a non-causal relationship and a causal one. Analytical tools, such as SEM, provide insights into what students know and have proven they know, and into what they claim to know and do not.

More robust versions of SEM may even provide the opportunities for students to converse with an assessment A.I. that can determine that can accurately estimate of the depth of their knowledge through the content of the talk.

Big data analysis presents the learning technology community with the highest anticipated possibilities of uLearning. With new options comes the development of innovative tools that can use learning analytics to enhance what many consider the “holy grail” of content absorption and learning efficiency. Huang and Huang (2015) described the factors of learning efficiency as a complex commingling of learning style, metacognitive scaffolding, peer interaction, self-regulation, coregulation, social networking, and biological stability factors such as emotional and hormonal status at the time. These learner-dependent factors are then factored into the presentation of content and what were noted as “support for learning” elements. These variables included pedagogical effectiveness, peer evaluation, instructional interface, human factor design, instructional design, presence and type of learning props or objects, assessment structures or options, instructional flexibility, and instructional choice. All of these depended on the instruction being human or software mediated, and the connection between the student and the method of content delivery. For example, Mouri et al. (2016) used spatio-temporal data-mining technology used in disaster and weather prediction to build uLearning tools for language instruction. Phrase recognition was developed using the associations among phrases used by participants, such as where and when these phrases were used (via GPS data). For example, thousands of “good mornings” uttered at workplaces in the morning would intuitively be used by the AI as an appropriate phrase for that time of day.

Huang and Huang (2015) also suggested the incorporation of eye-tracking technology, video analysis, activity monitoring, and interaction analysis to increase the content that is presented and assessed per unit time. One might imagine this in the form of a personal A.I. that acts as an instructional trainer and motivator when it realizes the learners' rate of interaction has slowed, or when the learner is no longer facing the screen, or when the eye-tracking algorithm notices that the learner spending a lot of time looking at an image of an airplane taking off. At that point, the A.I. restructures the theme of the content to match the assumption that the learner is interested in aviation. Huang and Huang (2015) stressed the use of both the extensive analysis of volumes of meta-data and the use of much smaller, finer-grained data that the learner presents in the moment of operational cognition within the learning context.

Zimmerman and Bandura (1994) suggested that this type of computational intervention would fall in line with the kind of educational reforms that the U.S. has been pushing for the last fifty years. The notion of a learner as reactive instead of active, and as a recipient of information rather someone seeking and acquiring it, may not have been realistic, though an argument could be made that in 2020, the expected roles are opposite to those of the original prediction. The vast amounts of information available seem to have put the student in the position more of a gatherer than of a hunter.

uLearning Analyzed through Pedagogy

All the literature on uLearning as a pedagogical asset reflects comments by Erickson (2013), in a review of Kidd and Chen's book *Ubiquitous Learning: Strategies for Pedagogy, Course Design, and Technology*. Erickson describes how uLearning has great potential for improving online teaching and learning. The literature is abundant with claims about technologies like those used in uLearning, and about what they can do for students' progress and content absorption. However, one might be remiss to discount one of the more essential elements of any educational technology implementation.

Liu (2007) studied the implementation of wireless network technology and found that innovative technologies alone do not create meaningful learning opportunities. Significant consideration must also be given to design. The technology should support the design of the environment and the activities engaged in there. For that reason, one cannot complete a literature review of uLearning without a careful diagnostic of the uLearning environment's pedagogical design and implementation.

The vision of ambitious instructors

Kidd and Chen (2011) asserted that uLearning can be "powerful, personal, current, and situated, as learners and instructors can communicate, interact, and learn in real-time." Erikson (2013) summarized the message of King's essay "Social Media, Story Stream + the University Classroom." The podcast has become a form of student assignment that offers diverse and mindful content for instructors who want to create something like a "living-learning" classroom experience. The tasks were based on the premise that we no longer live in an isolated, segregated world. Instead, students today exist in a reading and writing world that encourages interaction on a much broader scale. This vision was further illustrated as analogous to blogs, wikis, Google searches, and RSS readers. Ubiquitous learning sides philosophically with constructivist pedagogy. Learning opportunities are learner-centered, as opposed to traditional teacher-centered approaches (Erikson, 2013; Kidd & Chen 2011). In an ideal world, learner-centered instruction would provide many advantages. However, because of the stress and complexity of the real world, research on uLearning and real-life, non-experimental, constructivist implementation is difficult to find.

uLearning is not merely another form of distance learning. Although uLearning could be done at a distance, the one-dimensional nature of traditional distance learning is frequently cited as a source of disengagement. Moreover, the asynchronous nature of the discussions has required students to engage with each other separately, frequently, and in ways that minimally meet course requirements (Erickson, 2013). Advances in mobile education hardware and software are opening more doors to distance learning and transitioning students to the uLearning collective. These technologies address the need for interaction and the fact that learning often takes place independently (Laborda, 2015). Key researchers in this area (Hwang et al., 2008; Ogata et al., 2008; Peng et al., 2008; Yang, 2006) have all described pedagogical enhancements of peer interaction and recommended support for learning in authentic situations, for self-regulated learning, and for the active deployment of personalized services as benefits. The potential of uLearning echoes throughout the literature, yet the focus always falls on its technological potential and less on how the technology is deployed.

Ubiquitous situated reflective learning (USLR)

Situated reflective learning descends from works by Collins (1994) and the self-regulated learning theory developed by Zimmerman and Schunk (1989). This model was designed for situated learning as it applies to uLearning environments. It has five steps, summarized in Table 3.

Table 3:

Steps for Situated Learning

Steps in the Process	Description of the Purpose and Support for Each
Articulation step	
Purpose:	Student thinks about learning and then judges and classifies.
Supporting functions:	Teachers have explanatory functions.

Authentic step

Purpose:	Student discovers connections in knowledge gained from real-life situations.
Supporting function:	Learning annotation, GPS, situated triggers, photography, and sound recording (all aspects of learning to interact with the electronic learning materials).

Evaluation step

Purpose:	Student reflects on the correctness of knowledge discussed with other students.
Supporting function:	Learning annotation, reflective learning, photography, and sound collection with others.

Plan step

Purpose:	Student reflects to confirm errors in concepts and reestablishes a plan to learn correct information.
Supporting function:	Learning annotation and reflection.

Adaptation step

Purpose:	Student confirms the reason for failed learning in order to covert plans into action.
Supporting function:	Learning annotation and reflective learning.

From a philosophical standpoint, uLearning is opposed to a teacher-centered approach and leans heavily toward a constructivist instructional design. Opportunities for uLearning are evaluated on the basis of their potential to support interactive learner-centered instruction (Kidd & Chen, 2011). Researchers in this area all appear to understand that to adopt uLearning, a teacher must embrace an entirely new role as a facilitator and not a sole source of knowledge for students. Moreover, the students will need to learn that uLearning environments are not merely about the acquisition of data, but about how to organize and apply that data in the world they live in (Erikson, 2013). Interestingly, I found no literature discussing temporal applications of such learning activities.

Hwang et al. (2018) conducted a situated uLearning investigation with a quasi-experimental design that involved two fifth-grade classes at an elementary school in Central Taiwan. The students had access to information-processing tools and tablet computers with eBooks containing a unit on fire and rust. One group of 25 students received traditional instruction, and the other group, of 27, used the ubiquitously situated model of content delivery. After the four-week instructional period, a post-test was given. Whereas the control group was provided with oral instruction, the experimental group was provided with uLearning-designed content. The guidance provided to the students used the five-step model presented in Table 4.

Table 4*:*

Five-Step Model

Step	Description
Step 1:	Able to check the textbook and use the knowledge provided by the teacher to evaluate and classify knowledge on rust. *(Articulation step)*
Step 2:	Able to connect knowledge with life contexts, identify which objects will rust, and write down explanations. *(Authentic step)*
Step 3:	Able to think about the casing of fire alarms seen in daily life and what materials in them might rust. Able to reflect on this information with peers to see if their assumptions about fire alarms are correct. *(Evaluation step)*
Step 4:	If students were wrong, they are able to consider which other objects also rust, look for them in daily-life contexts, and record them on reflective learning sheets. *(Plan step)*
Step 5:	Able to review the textbook and the information on rust taught by the teacher to explain incorrect learning and gain more accurate knowledge. *(Adaptation step)*

Experimental studies of the inclusion of situated learning with uLearning-type technologies produced statistically significant results. High-achieving students did a noticeably better job with the situated learning, as their Pearson correlation in four categories was double that of the lower-achieving students. However, both high- and low-achieving students displayed notable gains over the control group. The researchers inferred that the situated instruction provided a time, place, and role for the technology to be used, along with the opportunity to connect in-class learning to real-life observations of familiar objects. Both of these aspects of uLearning have been mentioned frequently in the literature as differentiating uLearning from other learning technologies

Group discussion may be one of the most critical aspects of this instructional paradigm. Gall (1987) discussed the importance of the verbal and non-verbal elements of collaborative work and identified the ideal size of a cooperative group as between five and eight individuals, depending on age and maturity. However, Hwang et al. (2018) were not clear about the grouping of the students in their study. Moreover, Gall's research involved students in their late teens, but the best-sized group would probably be smaller for younger students.

Mindtool for Ubiquitous Knowledge Sharing (MUKS)

Huang et al. (2013) developed another instructional design implementation tool that used uLearning technology to measure students' learning. MUKS is a semi-automated system for helping students complete a sort of matrix grid or a mind map. In essence, the students engage in "authentic activities" involving the identification of butterflies in the wild. The unit was developed around a specific garden in one of the Taiwanese elementary schools. The garden was divided into eleven areas, and the butterflies stayed in their designated areas due to the specific types of plants each needed for nourishment. RFID tags and hand-held PDAs were used to record information about each butterfly and its unique qualities. Both groups were given access to uLearning technology; the experimental group used the MUKS template to organize their work. The researchers noted a tendency toward confusion with the uLearning system among the non-MUKS students. They concluded that a "pure" uLearning environment would often confuse students, and they would stop and need redirection during lessons.

The MUKS instructional approach also included a protocol for structured collaboration, in which students compared their grids (mindtools) with each other. The students in the "pure" uLearning environment were given the opportunity to collaborate but no overt guidance on how to do so. The lack of structure encouraged more off-task behavior and social loafing. The t-scores from the statistical analysis demonstrated that the control group consistently scored lower than the group that used the MUKS construct.

A couple of observations can be made about this experiment. First, the idea of structural guidance seems to undermine the premise of uLearning. If the experiment had been done with older students, it would be hard to even recognize it as uLearning. The ubiquitous use of sensor technology and handheld devices was a complex deployment of uLearning technology, as was the introduction of data to students when they were physically present with the object of study. But other researchers in the field might have difficulty calling this a substantial step toward uLearning; it seems rather like a step back toward more regimented learning if viewed independently of the psychological and behavioral limitations of younger students.

Although students' task freedom might be brought into question, the butterfly experiment does provide an example of legitimate location-accurate context-aware services. The first approach involves filling in a form (digital or paper) and acquiring environmental context directly from students' input. The second acquires context awareness through sensing, recording, and positioning systems such as GPS (large environments), RFID, and sensor networks (small, enclosed environments). The third approach is context extraction, which involves deriving contextual information from students' ontological and phenomenological presentation of their experiences, either in person or through uLearning technology (Huang et al. 2013) such as VR and AR, though there was no specific mention of these tools.

On the other end of the age spectrum, Yang (2006) conducted an investigation in which a uLearning environment was engineered to identify the right learning collaborators, learning contents, and learning services in a university context. The system would use the position, time, date, and profile of the student to provide intuitive data that could be used for learning. It was supposed to match the needs of the student to the real-time availability of those resources. In this situation, context and environmental data provided the most needed information. When the user logged into the network, the server would determine the type of device, the user's profile on that device, and the physical location of the user. Additional information about the user was derived from calendars and personal profile information in a process called context wrapping (Yang, 2006). The network server handled the communication, but each user acted as a node. In this sense, the user functioned as a server. For example, suppose someone asked for the location of a study group. Network users would sort this request on the basis of their knowledge of the world around them and provide feedback to the requester. This open, peer-to-peer format would be ideal for students who are organized, technically savvy, and self-motivated, but elementary and middle school students may not have these traits. This example is one of the purest forms of uLearning environment, one where the learning is governed almost entirely by the user and peers associated with the network.

Yang also identified several problems with the system. One was its ability to validate information. The system had no mechanism for verifying dates, times, locations, or other data transferred between peers. Perhaps more importantly to users, it was not possible to see whether anyone else was online or nearby. Requests would be sent out and go unanswered until the system timed-out and deleted the message. The article reported an anecdote was reported about a man, Albert, who wanted to have a real-time discussion about the New York Yankees. He was unable to search for or identify anyone he knew who was online and could communicate in a system-sponsored chat room. Instead, Albert left a post-it-note-style link to see if anyone was interested in future discussions (Yang, 2006).

Low-tech uLearning adaptations

Searches using the terms “paper-based ubiquitous learning” and “low-tech ubiquitous learning” revealed little. For the first, search engines returned articles on paper and ubiquitous environments in health care, with a note reading, “Your initial search query did not yield any results.” The search on low-tech ubiquitous learning produced the same result.

However, there was one book that covered the problem in some depth. Huang and Huang (2016) dedicated an entire chapter to the idea of low-tech uLearning environments. These systems are built on procedural scaffolding, in which uLearning deployment is much more confining than in typical uLearning environments. This was done to organize student engagement, maximize results, and reduce social loafing (Janssen et al., 2007; Johnson & Johnson, 1989). According to Chen (2011) and Pea (2004), the additional scaffolding provides increased opportunities for collaborative learning and significant increases in learning efficiency. In summary, the paper may be the structural organizer of the learning, but the technology provides the ubiquitousness of the learning environment.

Huang described the application of low-tech or paper-based learning environments as having four layers. These are described in Table 2.4. A visual interpretation is provided in Figure 4 (Huang, 2016).

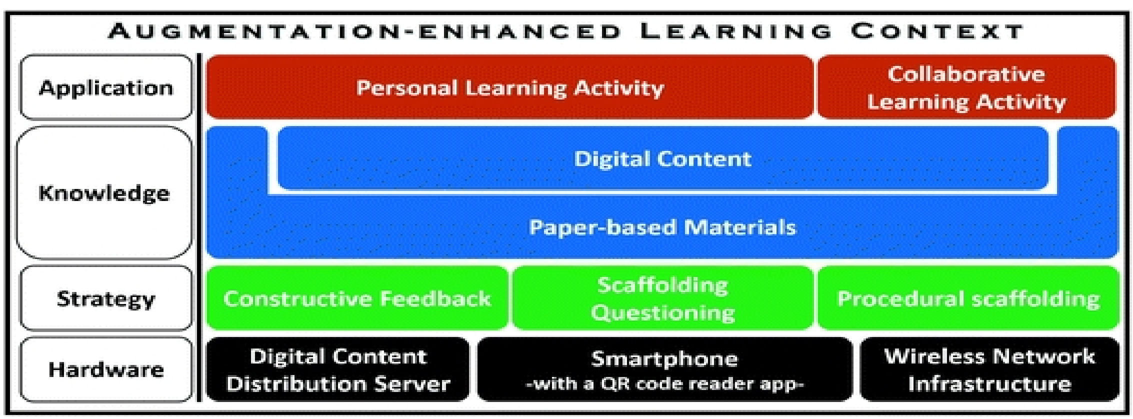
Table 6*:*

Low-Tech uLearning Applications

Step	Associated Actions
Application	The personal learning activity or collaborative activity
Knowledge	The digital content supported by the paper-based materials
Strategy	Constructive feedback, scaffolding, questioning, and procedural scaffolding
Hardware	Digital content servers, student-usable digital tools, connective network technology

Figure 4

Augmentation-Enhanced Learning Context



Learning materials can be placed in front of students through any number of mobile devices. Mobile device flexibility tends to put the burden of distribution on devices such as cell phones, iPads, and others that allow students to acquire content from places other than a desk in a classroom (Daniel et al., 2013; Embong et al., 2012; Koike et al., 2001; Rockinson-Szapkiw et al., 2013). Since these studies were published, many high schools have begun using Chromebooks as tools for acquiring content in order to embrace more ubiquitous pedagogies (Doyle, 2015). These devices not only add value to the content, they augment texts to provide access for students with vision difficulties through zooming features, screen captures, and text-to-speech functions (Chen, 2011; Koike et al., 2001). Digital devices also provided enhanced constructivist pedagogical options when students were online. Quick feedback between the content provider and the student is a cornerstone of heuristic constructivist instructional styles (Vygotsky, 1978; Hannafin et al., 1999; Saye & Brush, 2002).

Ubiquitous learning is a constructivist pedagogy, and through that lens, Huang (2016) suggested that a paper-based uLearning system could be built in several ways.

Possibility 1: Self-learning with constructive feedback. The student accesses the material though whatever digital tool is available, interacts with the content, follows the scaffolding, and then submits the learning product for evaluation. The self-grading parts of the system can be set to allow retakes, and various types of questions can be used to vary the assessments.

Possibility 2: Self-learning with scaffolding questioning. The student is provided with supportive questioning. QR codes, sounds, and information icons provide direction and guidance. Incorrect responses on assessments prompt the student to go back and re-study the section containing the answer. According to Chen et al. (2011), this method was particularly useful for teaching Taiwanese English-language learners.

Possibility 3: Collaborative learning with procedural scaffolding. QR codes on printed material provide logins, and QR codes on paper provide access to digital materials. QR codes are used to initiate team discussions, and after a set decoding process, team members respond to questions. Experimental results suggested that the procedural scaffolding team produced better results than those who worked individually (Huang et al., 2012).

After assessing the commonalities between them, researchers had to contribute to the topic of low-tech versus paper-based uLearning options. A few criteria were clear: the need for carefully planned activities and a process that students could follow was urgent, and informational scaffolding would also play a critical role in the success of the learning activities. Instructional designers must anticipate the informational needs of students before implementing a learning environment, or be able to adjust it quickly enough not to slow the momentum of the learning experience.

uLearning and the Incorporation of Themes

Fundamental to uLearning is the idea that ubiquitous learning environments must reflect the world around the learner. Unique to this idea is the concept of the "world around them." Hwang et al. (2018) studied uLearning that took place in real-life situations. They reported that knowledge is embedded in its situational context as well as in learning activities. Situated learning includes apprenticeships, collaborations, and possibly the virtual representation of those activities and of places where multiple reflective opportunities have proven valuable for enhanced learning.

The study also implied that situated learning has innumerable applications. The situation could include the interactions of students outside the classroom in typical real-world environments, in the classroom, or in simulated outside environments while the student is still in the classroom. When applied to uLearning, situated learning encourages students to think independently as well as they do in real-life situations (Arnseth, 2008). Although real-world applicability is possible without the use of digital resources, Huang (2016) argued that a base minimum of technological applications is still required to supply the ubiquitous access to information. Situated learning implies a location, a context, timing, and other environmental factors, but for practices such as social-emotional learning, situated uLearning is often supported by a theme as well.

Thematic applications

Thematically situated learning takes advantage of a “brain hack” noted by Medina (2011). Under the assumption that knowledge is anything that can be recalled on demand, memory plays a vital role in learning. Emotional responses and intensity also play a crucial role in the neurochemical storage of memories, according to Medina (2011). Researchers have contributed to the understanding of the establishment of thematic uLearning environments. Their criteria include descriptors like the following:

- Active
- Constructive
- Cooperative
- Authentic
- Intentional
- Emotionally guided
- Integrated (Jenssen et al. 1995; Karppinen, 2005; Grabe & Grabe, 2007).

Ubiquitous learning appears to be the primary vehicle for learning when one needs to accomplish two critical objectives: Apply the teaching in a real-life context, and provide essential data when information is demanded. When a narrative or storyline is applied to a hypothetical timeline of events, educational content designers can meet both objectives and also create a structure and pacing (scaffolding) to govern when, where, why, and how content is delivered.

For example, learning about the ecology of the rainforest through a mobile app can meet one of those goals. When coupled with cellular technology, RFID, and other sensor technology, environments like museums, zoos, and nature preserves can provide need-driven connections to relevant information (Chang & Chang, 2006) and their own thematically situated learning experiences. Museums and outside environments are inherently thematic and emotionally relevant vehicles.

Situated or theme-based learning can be enhanced in natural settings like parks or ecological reserves, as Lui et al. (2009) did. In their study, RFID technology was used with a "treasure hunt" theme. The study involved two classes of Taiwanese elementary school students. ANCOVA results for the tests of experimental group ($F = 18.89$, $p < .005$, $d = 2.01$) indicated a significant difference from the control group. Each additional phase, including a problem-solving section and an immersive learning activity, showed that the use of the thematic uLearning helped students to retain and make use of the information they learned.

Moreover, advanced technology was also used to augment the appearance of birds that were not present due to seasonal migration. Rudimentary augmented-reality (AR) technology was used to show where the birds would be and what they would look like. Lui et al.'s (2009) study appears to have been successfully integrated into the situational context and a thematic framework that provided evidence of the efficiency and efficacy of uLearning.

The application in AREA154: Apocalypse Division

The Apocalypse curriculum is an interdisciplinary science curriculum, focused primarily on chemistry, in which students are presented with science contents as tools for surviving end-of-the-world scenarios. The program is encased in "realia," a simulated reality, to enhance emotional engagement and real-world application. Students were asked to take part in a year-long simulation. Supporting information provided to them is available on the site's "Backstory" page, and this how the program is described to the students:

> You are now a member of a black budget special-access program run by the US Govt. As is the case with all covert black sites, they are known only by their "AREA" designation. AREA154 - is the special-access program that operates in and among specialized high schools in the US. The program utilizes teenagers as they represent the most resilient segment of the population and trains them to survive the literal end of the world. The government calls it strategic prevention. The kids in the program call it, "The Apocalypse Division."

The narrative of AREA154 was developed through research into areas of high speculation and interest. These involve theories that have not been proven, but appear to be gaining mainstream acceptance and entering daily discussion. As such, the research helps students bridge the gap between science in the classroom and the events that could happen outside it in the near future. According to Huang (2018), a concept only needs to be conceptualized to be considered personally applicable and valuable in one's world experience.

Gameplay

The gameplay aspect of uLearning is highlighted when one adds a plot sequence and emotionally relevant, context-arranged relationships. A common way to motivate someone to take part a game or contest is to present a "rescue" theme as motivation. Adding team members who either play along or act as non-player characters (NPCs) can help the player progress through the story (Rabin, 2010). This approach can be seen in the 2017 film *Jumanji: Welcome to* *the Jungle*. In it, players of a game learn about jungle life, animals, and the environment on-demand in a way that lets them progress in the storyline. Multiplayer interaction and NPCs provide direction, assistance, and "just-in-time" knowledge relevant to the situation at hand. The inflexible nature and specificity of the NPCs are mocked in the movie to demonstrate the role they play in the story progression. Relational connections provide ways for players to use non-quantifiable motivation factors (not grades, scores, etc.) to continue playing. Interestingly, the same relational and emotional connections include one of the three main aspects of successful instructional dyads (Vygotsky, 1974).

Storyline

A storyline, linear or nonlinear, provides educational content designers with control over story-based events, content for the learner to choose from, choices for interacting with objects, and ways for those choices to interact with the story. Huang and Huang (2015) described the construction of partial ubiquitous knowledge structures that similarly relate objects to specific bits of information in ways that provide feedback relative to the user's position in the game. For example, a scientist NPC might present one set of data to a player early on in the game, but in a different location further along the timeline might provide a very different set of data. In the context of learning, partially ubiquitous knowledge structures could play a significant role in students' experiences in specific learning environments.

Huang and Huang (2015) discussed the generation of ubiquitous learning activities through a series of steps, shown in Table 5.

Table 5:

Steps for uLearning Activities

Step	Actions

Analysis of the learning domain	Determine the relationships between the objects and the characters. Once that is done, the knowledge structure for the environment is used to generate the section attributes.
Roles and themes	Options for the learners and instructor to work within.
Learning activity chain generation	Puts the role and theme into every activity that the activity engine determines is suitable for the situation, theme, or character. The engine then produces the chain of learning activities by comparing the complexity and rarity of learning objects in the environment.
Learning by playing	Users follow the instructions and look for designated learning objects (icons or real-world objects that represent specific content-based data). Players learn by playing heuristically, experiencing the cause-and-effect aspect of being present in that world.
Personal experience updates	Experiences and measured knowledge are kept in a database, so the game's engine is aware of the player's progress and performance. Lu et al. (2011) provided information on the mechanism of autonomous content generation, but it extends beyond the scope of this literature review.
Basic story application	The most basic iteration is in a traditional classroom, but masked as a more sophisticated environment. Context-aware story engines take the ubiquitous knowledge structures and then build a story structure in line with a selected genre and use it to sprinkle thematic elements into and around the generated learning activities.

Citing experiments involving male and female students, Huang (2016) described how engagement can be measured in role-playing educational games that were situational in design:

- Stories influenced users to accept the RPG context.
- Stories made the RPG feel useful but also seemed to reduce the perceived efficiency of the learning process.
- Descriptive statistics showed that males and females both had positive perceptions of the experience effectiveness of the RGP storyline. However, females perceived this at a higher rate. Huang and Huang (2015) mentioned that other researchers of RPG learning reached similar results.
- "Hardcore" gamers (people who played video games more than 20 hours a week) were more positive about the RPG experience than casual gamers.

The inclusion of a complete, progressive storyline was one of the more apparent factors in a successful uLearning experience. Huang (2016) noted that four-phase transitioned learners produced successful uLearning results.

In RPGs, the *teleport phase* is the beginning of the process, when the environment is presented to the player and the game offers them an array of visuals to prepare them for the *transfer phase*. In this second phase, the player takes responsibility for driving the experience. The *training phase* follows, ensuring that the player is properly instructed in the rules of the environment and the control mechanics. *Challenge phases* make up the majority of the experience and provide "bread crumbs" that ultimately make up the *adventure phase*. This last phase is the collection of all of the previous experiences, which eventually lead to a penultimate experience that is usually presented as an ill-structured mystery or an open-ended challenge.

Many educational researchers have emphasized the necessity of "authentic activities" for learning to take place effectively (Collins, 1991; Looi et al., 2010; Price & Rogers, 2004). This neatly sums up the concept of situated learning. It also opens new avenues of expression that can be found in augmented and virtual reality. Huang (2016) made identified science as a subject area in which storylines have been particularly useful.

Situated learning stresses the role of context. According to this approach, learning includes the situation in which it occurs (Brown et al., 1989; Hou, 2011), and within which the content is presented. That could be another location or another type of reality. The literature is not clear on the type of location or the type of reality, virtual or otherwise.

Gaps in the uLearning Research

Clinical, scientific, and quasi-experimental research all show a lack of qualitative publications on uLearning systems that interact with real students during regular educational cycles. Ironically, uLearning is supposed to involve applicability to the real world, yet little of the data on the topic was collected in vivo or in real-world classrooms. The results that researchers reached were applicable only to students in the exact conditions of the observations. An experiment involving fifty Taiwanese fifth-graders in an ecology reserve may allow for some extrapolations, in the hope that everyone will display the same learning behaviors, but that assumption is doubtful.

The great majority of published research on uLearning comes from China, Taiwan, and Japan; it is interesting that little has been done in other countries, or in environments other than elementary schools and universities. Published research also lacks significant coverage in education systems with culturally heterogeneous student populations, or of any of the major cultural groups of the United States. The closest is in one chapter of Cope and Kalantzis (2010), in a section titled “Ubiquitous Learning, Ubiquitous Computing, and Lived Experience.” Curiously, all the lived experiences described are hypothetical extensions of instructional ideologies that John Dewey envisioned for forms of modern education.

Cope and Kalantzis (2010) postulated hypothetical situations that could be developed to be more ubiquitous. Examples of traditional media such as display boards and handouts were used to facilitate their vision of instructional ubiquity, after which the authors conditionally described what the students would experience. These situations appear idealized and do not account for various growing cultural groups in the U.S. school system. In particular, student populations from low socioeconomic status groups, African Americans, and Latinos do not appear to be represented in any research on ubiquitous learning environments.

Unforeseen areas of application and possible research

The concepts of uLearning have great potential. As network access and uLearning-enabled devices become more available, faster, and more intertwined with the educational community, scholars might move toward another surge of uLearning research opportunities. The financial crash of 2008 probably played a role in the reduction of published research, due to loss of funding.

A resurgence in uLearning research due to the covid-19 outbreak of 2020 is also plausible. The outbreak has created new pressure for uLearning technology and instruction that supports learning in the real world and at a distance. Millions of families were forced to scramble for resources to continue their children’s education, and simultaneously, millions of professional teachers, some of whom had never used class websites were asked to formulate online teaching methods. Demand could arise for funding for new pedagogical methods, infrastructure, and mobile technology. Investigations into technologies like VR and AR may also follow. Parents, school districts, and state governing bodies could also push for better preparation. If education needs to accommodate real-world contextualized learning anywhere, at any time, it will probably require a resurgence of investment in uLearning research.

Chapter II Summary

This investigation reveals a fundamental incongruency between Hispanic multi-active behaviors and the expectations of U.S. public schools. The modern, progressive school system advanced by John Dewey would engage students in focused, linear, and productive education. This system, which Dewey's influences Immanuel Kant and Karl Marx would probably have approved of, became the dominant educational framework in 1837 (Cohen, 1979). Because most of the population had linear-active psycho-social behaviors, the educational system was fairly homogenous at that time. As the Hispanic population grew, it presented problem, however.

According to the 2007 census, Hispanics' median annual income was almost $14,000 less than that of Whites of similar socioeconomic status. In addition, only 57% of Hispanics 25 and older had graduated from high school, and only 11% had a bachelor's degree (United States Census Bureau, 2004). Moreover, these numbers have been declining for decades.

Karathanos (2009) brought attention to a potential barrier to learning English. Families oppose their children learning English out of fear that they will no longer be able to communicate or connect with their parents, who probably chose not to learn English for much the same reason. These problems are deeply embedded in their psycho-social mindset and may be one of the biggest obstacles to multi-active students focusing and feeling successful at school.

Teachers of STEM subjects noted this behavior as well. They related how students would do baffling things that undermined their education and made no sense to the college-educated, mostly Anglo American teaching staff. No teacher at the informal pre-data-collection gathering had ever heard of the Lewis cultural framework. However, they all saw the similarities between the traditional school systems and linear-active psychology. Anecdotal evidence suggested that an overwhelming percentage of teachers that also saw the psycho-social immiscibility. They also had no ideas about how to make the situation better other than giving students more time on assignments.

The lack of applicable methodology may be a result of state-mandated spending. Winglisky (2012) pointed out that districts may legally have no choice on how to spend Title I money, which is supposed to offset the financial discrepancies created by property tax–based funding. Winglisky pointed out that little money was spent on training, and it was not spent on expert instructors but on staff who had some expertise in the area.

Ubiquitous learning was a pipe dream even fifteen years ago. However, developments in network and mobile device technology have opened the door for it, and it has been tested successfully in several countries. This study places considerable importance on cultural frameworks and the role they play in academic success. It would be a mistake not to address any culturally influenced behaviors that might affect the outcomes of the studies. Most research in this area has been done in China, Japan, and Taiwan; Hwang et al. (2018) is a representative instance.

Hwang's research team studied two grade-five classes ($N_{C1} = 25$, $N_{C2} = 27$) from an elementary school in Taiwan. The socio-economic status of the schools, the type of school (public or private), and the cultural diversity were not mentioned. According to the National Immigration Agency and the Ministry of the Interior (Demographics of Taiwan, 2020), less than 2% of Taiwan's population is American, so a strong possibility exists that there were no American students in the study population.

Although the statistics of the study were sound, the t-squared and regression analysis made a strong case for uLearning methods, though this cannot be extrapolated to Hispanic-American students. If Lewis (2010) was right, then the cultural differences between Hispanic multi-active students and Asian “reflective” students make the results of any research done in Asia almost irrelevant because of the different psycho-social behaviors of the student populations. Reflective learners simply see education differently and therefore behave and interact with the system differently from multi-active students. As such, a uLearning system would need to be built with the participant’s cultural psycho-social traits in mind and then tested with students for years to evaluate its impact before any conclusions could be drawn about its effectiveness for multi-active students.

The uLearning system AREA154: Apocalypse Division was based on longstanding lore of black sites, secret bases, and special-access programs the U.S. government keeps secret. Whether this lore is accurate is irrelevant to the validity of the students’ perceptions. The curriculum includes five “case files” involving STEM-based tools that would help a person survive a world-altering event like the eruption of the Yellowstone super volcano. More details about how this system aligns with uLearning specifications are provided in the next chapter.

Methods

The analysis of psycho-social behaviors associated with culture provides insights into the sorts of pre-programmed behaviors students bring to the classroom. The public school system in the U.S., described as linear-active by Lewis (2010), is psycho-socially incompatible with the multi-active behavior Lewis attributes to Hispanic cultures. However, there appears to be an educational technology design framework that better matches the behavior of multi-active students. The uLearning framework has many design attributes that appear to better match the fundamental cultural behaviors of Hispanic students. The concept ubiquitous design was applied to a uLearning system called *AREA154: Apocalypse Division* constructed by the principal researcher of this study.

The *AREA154: Apocalypse Division* curriculum delivery system was designed to align with the core design ideas of uLearning as presented by Huang (2018). The science curriculum itself followed the California NGSS guidelines, so that the science was presented in relation to observed natural phenomena. The core content delivery system and the curriculum were developed for ease of content delivery and anywhere-anytime access, and to establish proper network traffic bandwidth. The system was implemented with the permission of the San Jacinto Unified School District and San Jacinto High School in an effort to develop educational technology frameworks that improve the learning experiences of the school's students.

Problem Statement

According to the United States Census and the California Department of Education, Hispanic populations in U.S. public schools struggle academically more than any other minority group (Haile & Nguyen, 2008; Hawley et al., 2007; Mahon, 2006; Morales & Saenz, 2007; Neufeld et al., 2006; Stiefel et al., 2006). The U.S. Government included specific mandates in the

No Child Left Behind Act of 2001 (NCLB; United States Census Bureau, 2006). Lewis (2010) presented the results of a 26-year study that offered a way to categorize the collective behavioral traits of peoples from different countries. This model provided insights into the psycho-social incompatibility of U.S. schools and Hispanic people. The goal of this study is to investigate the effect of uLearning design principles on students who demonstrate multi-active cultural behavior traits in order to devise a working theory governing the success of the program.

Need a working theory

The difficulties confronting Hispanic students in U.S. schools are well documented. Saw and Chang (2018) also observed significant self-doubt among these students in STEM areas. Both of these facts suggest that Hispanic students more likely than others to disengage from STEM topics. Despite efforts to close it, the Hispanic achievement gap continues to widen. This study uses an educational technology design framework that, according to the literature, has not been used to address this problem specifically. Ubiquitous learning design strategies use special applications of technology to improve students' experiences with STEM subjects and to discuss the psycho-social needs of Hispanic multi-active students. The theory being developed should identify, explain, and predict foundational concepts such as these:

Conceptual Application Proof (CAP) - 1 : Students at a variety of different achievement levels demonstrate the ability to experience confidence-building events and these events provide evidence of improved STEM area self-confidence. The theory must be able explain and predict situations where succuss is and is not experienced.

Conceptual Application Proof (CAP) - 2: The AREA154: Apocalypse Division program has identifiable elements of uLearning included and demonstrates these criteria as contributors in student confidence-building experiences.

Conceptual Application Proof (CAP) - 3: The students benefiting from the program were classified as Multi-Active through a variety of assessment tools.

Conceptual Application Proof (CAP) - 4: In their own words, uLearning participants indicated the experience provided confidence-building experiences resulting in an increased level of self-confidence in STEM subjects.

Analysis of assumptions: Cultural psycho-social behavior

The population of San Jacinto High school, according to the school's CBED data, is 88% Hispanic. From 2005 and 2015, before the implementation of the test curriculum, the students averaged a 67% failure rate in math and a 56% failure rate in chemistry and biology. During two years of anecdotal observation, the vast majority of the student population displayed easily detectable behaviors that were closely aligned with the Lewis cultural theory's description of multi-active people. These included the following traits:

- Lively
- Tend to work on many things at once
- Prioritize activities according to thrill or emotional impact.
- Act impulsively
- Use emotions to make decisions, rather than using task-oriented logic*
- Warm, friendly, talkative
- Engage in emotionally driven confrontations
- Unconstrained in body language

*Research (Diamond, 2000; 2002; Fuster, 2002; Barkley, 1997) has indicated that most students of high school age are heavily influenced by emotions when making decisions, as the prefrontal cortex is not fully developed. However, anecdotes suggest that this trait persists in multi-active parents.

Analysis of assumptions: uLearning for multi-active students

uLearning has undergone many adaptations and been defined in many ways. In chapter 2, I tried to demonstrate its full range of applications and the range of technologies that could be used to carry it out. The idea of uLearning could be refined to include elements like anytime, anywhere access to on-demand information, and to focus on the students' specific needs at the moment. It could also include a central point of access, thematic and narrative applications that support emotional engagement, and the use of individual user data to tailor education to the needs of the student. Table 6 describes the feature and behavioral alignments to show how the uLearning design framework meets the needs of the multi-active students.

Table 6

Multi-active feature-behavior alignment for the AREA154: Apocalypse Division uLearning system

Multi-Active Behavior	Self-efficacy-supporting features of the AREA154 uLearning content-delivery system
Work in a nonlinear fashion and tend to jump from task to task.	Site curriculum is provided through interactive PDFs that can be completed in any order.
Plan actions in accordance with their emotional relevance.	The narrative of the curriculum centers on training the students as agents of a government program that teaches them how to save themselves and their families during a world-altering emergency. It engages motivating feelings of self-preservation and preservation of loved ones.
Act impulsively	In case students are distracted during class time, the content is fully accessible all the time. Because impulsive behaviors lead to lack of studying, the system also allows the student to retake assessments after a poor grade.
Place more emphasis on relationships and family	The system provides PDFs that include videos to help students recall the steps for accessing science content they have forgotten or

than on school or jobs.	missed during standard instructional time. If calculations or other technical processes are involved, videos are also provided to give students on-the-fly help with problems and complicated concepts.
Highly communicative	The uLearning system has a messaging system that allows students to post questions on pages that pose problems. Ideally, other students will help them solve the problems. There is a secure message system for communicating directly with the teacher. Each day, the site provides students with reminders, guides to which challenges to take and how to pace the work, and alerts about future assessments. Backend site tools allow access to students' usage data (time and duration of access to the site, and what they did there) and academic performance data for each assessment case file.

Table 6 describes features that suggest uLearning would work fluidly with the psycho-social behaviors native to Hispanic (multi-active) students. This study presumes that multi-active behaviors in a linear-active learning environment are counterproductive. Table 6 illustrates the components of the AREA 154 uLearning system that are designed to bridge the gap between the two psycho-social extremes and foster a successful academic experience for multi-active students in the traditional school system. Additional information on the AREA154: Apocalypse Division program can be found in Appendix A.

The uLearning environment was launched in a beta form in 2017–18. Over the following two years, students provided data through conversation and performance feedback, which focused on the functionality of the interface and the quality of the students' experiences. These phenomenological data were informally collected and used to improve the AREA154 system and help the curriculum designer understand the users' experiences. After students were better acquainted with the lived experience data, an experience more aligned with their learning and interactivity goals could be implemented. Although I want to continue learning about the experiences of the students, the focus of the data collection will shift from curricular and technological functionality to uLearning and psycho-socially multi-active student populations.

Research Methodology: Contrast with Applicable Methods

Analysis of assumptions: Phenomenology vs. Grounded Theory

Essential experiential data on uLearning and the specialized uLearning system could be acquired through the use of a phenomenological lens or one based on grounded theory. Comparison of the two lenses led to the development of Table 7The organizational structure of the comparison is described below.

Table 7

Comparative analysis of phenomenology and grounded theory.

Criterion	Phenomenology	Grounded Theory
Example research question	What is the meaning of . . . ? What is the structure of . . . ? What is the essence of . . . ? What are the intangible assets of an experience that leads to the understanding of . . . ? (Patton, 2002)	What theory can be derived from fieldwork on . . . ? What theory can be used to build or enhance our understanding of . . . ? What theory can be derived from the lived experiences of . . . ? (Patton, 2002)
Findings will yield . . .	Deep reflective data that present an understanding of the shared experience of a person or group of people. (Morse & Richards, 2002)	An evidence-based theory that advances knowledge in a particular field. (Morse & Richards, 2002)
Data generation	In-depth interviews focused on utterances or body language that communicate data about facts and feelings. These interviews are long and unstructured. The interviewer and the subject work together to reach a common understanding. Multiple individuals may participate in the data pool. (Tesch, 1990; Creswell, 2017)	Interviews, in-situ observations, and secondary sources on the condition under investigation. The data produces and continually shapes the theory. The data pool can include multiple individuals who took part in a central action. (Baker et al., 1992; Creswell, 2017)

Data analysis	Study-specific meaningful units are generated to reflect the typical experience. (Leedy & Ormrod, 2005)	Codes are used in a prescribed method to organize data into categories and generate relationships. Data are interrelated with the evolving theory and the categories developed from the data.
Literature review	Little literature review before the study, so as to not to bias the researcher about the phenomenon. (Suddaby, 2006)	Standard review of professional research with a focus on relevant prior studies and methodologies. (Moustakes, 1994)
Researcher background	Can have personal experience in the phenomenon under investigation, as the experiences of others can broaden one's own understandings of a thing. (Fendt & Sachs, 2008)	Experience in the field can be advantageous but should not influence the interview subjects. The experience should help one develop questions for critical data gathering. (Leedy & Ormrod, 2005)

Research Method: GT with Focus on Users' Lived Experience

The original plan for this investigation was to study multi-active (Hispanic) students' experiences with the novel technology-curriculum synthesis uLearning. To keep true to that vision, some aspects of the phenomenological approach would need to be conserved. The details gathered in the interviews need to manifest more in-depth conversational style. Multi-active people are more congruent with unstructured conversations (Lewis, 2012). As such, a loosely structured interview may provide a more vibrant and deeper analysis of their learning experiences, though conversations can still be directed to specific topics.

If the goal of the investigation is to develop a theory about how multi-active students interact with uLearning environments, a grounded theory lens should guide the methodology, as it is ideally suited to investigating relationships, developing meanings, identifying motivations, and capturing a wide range of facts about the environment and experiences of that reality (Prigol & Behrens, 2019). GT also promotes the use of axiology and axial coding, which includes the subjects' central belief systems. The exposition of fundamental beliefs can be helpful for identifying motivations and revealing new connections between behaviors or interactions (Creswell, 2017).

The GT framework presented by Charmaz (2009) describes the role of the researcher as a theoretical constructivist. The emphasis is on the construction of meaning between individuals and the research environment. The research will be conducted through an iterative exchange between the data, the organization of the data, and the cross-checking of the resulting concepts with continued observations. In this sense, GT is exploratory, and the researcher must be familiar with the environment, if not part of it (Charmaz, 2009; Creswell, 2017). These conditions are ideal, as the participants will have occupied the same physical space during the students' experiences with the uLearning environment (Area154: Apocalypse Division). Charmaz makes the case that the researcher can refine, intensify, and make sense of collected data, which are amalgamations of subject data and the researcher's observations of that data (Morin, 2000). The process sounds complex, but Prigol and Behrend (2019) made a case for the use of GT in education because of this: education is also complicated and full of systemic, instructional, cultural, psychological, and technological difficulties.

Grounded theory, like many qualitative lenses, has difficulty answering the question, "Are there enough data?" The question of saturation varies between study and tends to asked at the point when the researcher feels that the data are becoming redundant (Charmaz, 2009; Creswell, 2017). To achieve redundancy, I will aim to recruit fifteen subjects for this study, from a range of achievement levels. During the school year, this would be about 10% of the student population. Traditionally, GT studies have not used a lot of subjects; the number tends to depend on the depth of the study (Wu & Beaunae, 2014). Fifteen was a little more than used by most of the GT-theory dissertations that were used as references for this work; their populations ranged from two to eleven. However, because I wanted students whose grades ranged from F to A, fifteen appeared to be a reasonable place to start. If the evidence shows any large variations or the opportunity arises, more students will be asked to participate in the interviews.

Research Design: Methodological Challenges

Disclosure

The curriculum designer and technical lead for *AREA154: Apocalypse Division* is also the researcher for this investigation. Concerns about bias toward a positive interpretation of students' experiences should thus be addressed. First, the developer of *AREA154: Apocalypse Division* was not compensated for that work, nor for the use of the curriculum by the school. The developer is also not emotionally attached to the program apart from being dedicated to its constant improvement. In other words, the researcher's only emotional bias is toward improving the system. Negative experiences reported by students will offer as much value or more to this as positive ones. *AREA 154: Apocalypse Division* provides students with highly differentiated learning experiences, so an investigation into it should include all participants' reactions.

Questioning

The study will begin by asking students big-picture questions like "Can you please describe experiences within the program that had an impact on you?" As the students discuss their experiences, more particular questions will be asked to reveal evidence of multi-active behaviors and connections to the uLearning framework. The items will not be limited to this list. Following Lewis' list of multi-active behavior traits, an in-depth flowing conversation will be required for students to access past events and articulate their responses.

Categorical questioning

These questions will help me acquire information about each of the focus areas. The first step will be to establish the strength of the interviewee's adherence to Lewis' cultural behavior theories. The second will be to see how the uLearning experience fits into that cultural identity.

Questions for multi-active cultural behaviors

- [CAP4] How would you describes your work habits at home?
- [CAP 4] What are your primary methods of communicating and gathering knowledge?
- [CAP 4] How do you address conflicts between peers or between your parents?
- [CAP 4] How would you describe conversational patterns in your home, between orderly and chaotic?
- [CAP 4] How would you describe your personal priorities between family and schoolwork?
- [CAP 4] How much physical body language do you use when communicating with family members?
- [CAP 4] How well do you deal with changes in plans?
- [CAP 4] How important is it for you to include a family member's feelings when telling them something troubling?
- [CAP 4] How important is your reputation with your family in comparison to your reputation with the general public?
- [CAP 4] How frequently do your family members include people they know from work in their social circles?

Interview questions for developing confidence in STEM uLearning

- [CAP 3] How would you describe your confidence in STEM subjects before enrolling in the AREA154 program?
- [CAP 3] How would you describe your confidence while enrolled in the AREA154 program?
- [CAP 3] What areas (case files or specific trainings) did you feel the most or the least confident in?
- [CAP 3] What sorts of behaviors do you exhibit in any class where you feel confident about your success?
- [CAP 3] In what parts of the AREA154 program do you recall exhibiting those same behaviors?
- Please provide details about your experiences with each of these elements of the AREA154 system [CAP 3]:
    - The centralization of the content on one website.
    - The presentation of daily class activities on the front page of the site.

  - Content (lessons and units) organized as “case files” and “trainings.”
  - The interactive “HyperDoc”-style PDF documents.
  - On the PDF: the briefing icon (provide video instructions for each section).
  - On the PDF: media icons (provide additional task-based instruction).
  - On the PDF: the comic book-inspired design (content presented in panels).
  - On the PDF: use of full-color documents for communication.
  - On the SRTs: instant feedback.
  - On the SRTs: ability to retake formative assessments.
  - On the ATN: as a dedicated place for classwork (notebooks for only AREA154 use).
  - On the ATN: for signature feedback.
  - On the ATN: as a learning tool.
  - Flexible deadlines, both online and in class.
  - The AREA154 Top Agent Leaderboard (gamification element).
  - Achievement points and ranking among peers (gamification element).
  - The “Examulation” summative assessment simulation.
  - The AREA154 thematic approach.

Interview questions for data about students’ behaviors outside the classroom

- [CAP 2][CAP 1] Describe your experiences trying to work at home on your own.
- [CAP 2][CAP 1] What types of devices did you use to access the site besides the school-provided Chromebook?
- [CAP 2][CAP 1] How did your confidence in doing the work change when you were no longer at school?
- [CAP 2][CAP 1] From what locations outside of school did you attempt to engage in site-related work?
- [CAP 2][CAP 1] How did the site and the program design help or hinder you in working outside the classroom?
- [CAP 2][CAP 1] How frequently did you talk about your experiences in the AREA154 program to your family at home?

Interview questions for opinions on the thematic elements

- [CAP 2][CAP 1] How did you feel about the thematic approach to teaching STEM topics?
- [CAP 2][CAP 1] Did you feel that the intensity of the “apocalypse” theme interfered with your ability to learn?
- [CAP 2][CAP 1] What case file had the biggest impact on you personally?
- [CAP 2][CAP 1] Did you feel empowered in any way by the real-life applications of the survival chemistry?

- [CAP 2][CAP 1] In an actual event, do you think your parents might turn to you for input?
- [CAP 2][CAP 1] How would you describe any impact the AREA154 experience had on your perceptions of the world around you?

Interview questions for perceptions of experiences

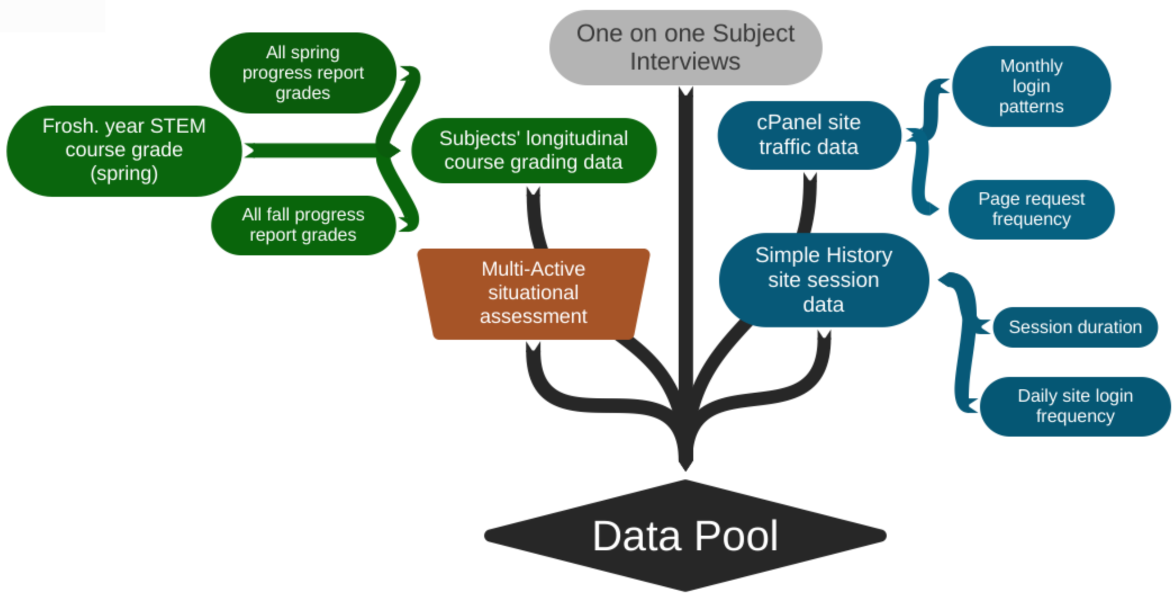
- [CAP 2][CAP 1] How would you describe yourself academically in comparison to the rest of your family?
- [CAP 2][CAP 1] What was your experience like of being in a STEM classroom after being in the AREA154 system?
- [CAP 2][CAP 1] How would you describe your grade in AREA154 in comparison to those you earned in other STEM classes?
- [CAP 2][CAP 1] How would you describe how much you learned in the AREA154 program in comparison to other STEM classes?
- [CAP 2][CAP 1] Did the AREA154 program influence your potential career choices?
- [CAP 2][CAP 1] How would you describe your overall STEM confidence at the end of the program in comparison to where it was at the beginning of the year?
- [CAP 2][CAP 1] Did your experience in the AREA154 program influence your choice of a STEM course for the following year?
- [CAP 2][CAP 1] Based on your experience and your observations of the program, do you feel the course could be adequately taught by a teacher other than the one who was your instructor?
- [CAP 2]CAP 1] What sorts of professional or personal traits would an instructor need to teach the program successfully?

Contributions to the data pool

Interviews guided by specific questions represent the axis for the data in the study. Data acquired from other sources, including the Aeries student data base system, cPanel site traffic data, and WordPress backend apps that track user logins and session duration comprise elements of the data pool that cross-check and support the data acquired from the subjects. Below, Figure 5 illustrates the contributing factors to the pool of investigative data.

Figure 5

Flow chart diagram demonstrating the data pooling procedure



Coding lenses for grounded theory

During the coding process, the influence of the researcher's epistemological approach reveals the reasons for the multiple types of GT (Charmaz, 2006; Greckhamer & Koroljunberg, 2005). According to Glaser and Strauss (1967), proper coding includes constant comparison among acquired data at three levels: open, axial, and selective. Few "official" or foundational practices were consistently used among selective GT instruction texts, however (Wu & Beaunae, 2012; Charmaz, 2006; Greckhamer & Koroljunberg, 2005; Glaser & Strauss, 1967; Strauss & Corbin, 1998; Charmaz & Belgrave, 2012; Thornberg & Chamaz, 2014; Grbich, 2007). Themes arose that centered on categorical reflection, revision of theories, demonstration of reflective processes, presentation of themes and categories as ongoing reflective processes, and tendencies toward axial coding due to the nature of data being compared to a central theme. The introduction of data in a narrative format was suggested but not consistently practiced. A hallmark of GT-type investigations is large amounts of information (Wu & Beaunae, 2012). To help the reader digest this, the use of themed stages or narratives was suggested. Interestingly, the use of themes is also a highly advised design characteristic for uLearning systems. As such, the findings will be analyzed and presented in similar ways.

Procedural challenges

Many of the students in the sample pool are Hispanic and English language learners. Consideration must be taken to encourage these students to speak as accurately as possible. If a participant has difficulty expressing a particular concept or experience, they will be encouraged to speak in Spanish if this will ease the communication and lead to more accurate and precise feedback. The researcher has access to multiple adult translators who work with the student population and can provide translations.

Covid-19 school closures also created a number of difficulties in acquiring participants for the interview process. The main problem was getting their attention outside of school. Teachers have access to students' cell phones, but it appears that students do not read emails from school as consistently as adults do. Several of the subjects also would not or could not participate via the prescribed Zoom interview protocol. These decisions probably strongly influenced by the stay-at-home situation caused by the pandemic. In normal session, the same participants could have been gathered at school by the primary researcher, and the interviews would have taken place on campus.

Analysis

The results of the interviews will follow a structured method presented by Stevick-Colaizzi-Keen (Derakhshan & Singh, 2011) and will form the backbone of the analysis. This method was endorsed by Creswell and Poth (2017) as practical and useful. It can be summarized as follows:

Analysis Phase I: Program user's (subject's) experiences

- Describe personal experiences with the phenomenon under study by the researcher. This provides a presentation of the users' experiences and data collected through the subject's interactions with the technology.

- Develop a list of significant statements made by subjects.
- Group the statements into broader units of information.
- Write a textual description of *what* the participants experienced with the phenomenon.
- Write a structural description of *how* the experience happened.
- Write a composite (both textual and structural) description of the phenomenon.

Analysis Phase II: User profile; analysis of subjects' psycho-social profile

- Use interviews with subjects to collect data that will be coded using the principles of Lewis' multi-active behavioral classification.
- Develop a list of significant statements made by subjects.
- Group the statements into broader units of information.
- Write a textual description of *what* the participants of the study experienced with the phenomenon.
- Write a structural description of *how* the experience happened.
- Write a composite (both textual and structural) description of the phenomenon, including the structural and textual descriptions written in Phase I. At this point, congruent evidence is strengthened and contradictory evidence is reduced in influence.

Analysis Phase III: The uLearning System Profile

- Use interviews with subjects to collect data that will be coded using the principles in Huang's (2018) description of the key features of a uLearning platform.
- Develop a list of significant statements made by subjects.
- Group the statements into broader units of information.
- Write a textual description of *what* the participants of the study experienced with the phenomenon.
- Write a structural description of *how* the experience happened.
- Write a composite (both textual and structural) description of the phenomenon that includes the structural and textual descriptions written in Phases I and II. Congruent evidence is strengthened, and contradictory evidence is reduced in influence.

Analysis Phase IV: Non-categorical influences on subjects' perceptions

- Use interviews with subjects to collect data that will be open coded across categories in the study that did not connect to either the multi-active behaviors or the uLearning list of characteristics.
- Develop a list of significant statements made by subjects.
- Group the statements into broader units of information.
- Write a textual description of *what* the participants of the study experienced with the

phenomenon.

- Write a structural description of *how* the experience happened.
- Write a composite (textual and structural) description of the phenomenon that includes the structural and textual descriptions from Phases I, II and III. Congruent evidence is strengthened, and contradictory evidence is reduced in influence.

Analysis Phase V: Articulation of the theory

- Visual articulation of the theory. The complexity warrants the need to present the evolved theory where all the influencing factors can be seen at once.

A constructivist spiraling analysis

Grounded theory provides an effect research methodology for identifying the cause of an event. The application of grounded theory can stem from both positivist or constructivist ideologies. Whereas positivists assert that culture and other large, indomitable forces are responsible for the nature of the individual, constructivists put the power of change in the individual. This study takes a constructivist point of view and thus uses prolonged data analysis to clarify the multiple realities of the subjects (Charmaz, 2005). Charmaz (2005) also argued that spiraling and reflexive data analysis reduces the possibility of researchers imposing biases on the data. These practices increase the rigor of the analysis in this study, as the primary researcher was heavily involved as both the subjects' instructor and the developer of the educational technology used.

Description of participants' regional community

This study will take place in the community of San Jacinto in Riverside, California. The demographics of the area are described in detail in Chapter 1, but for quick review, they are outlined here (census.gov):

Population:	46,375
Median age:	36.2 years
School-age population:	29.7% of total population

Hispanic (self-identified): 74%

Student experience: Agents-in-training

In Phase I of the analysis, the focus will be on the student's experiences, the backend data generated by the host server, and the backend apps used to collect information on the time students spend on the site. The subjects of the study will have taken part in *AREA154: Apocalypse Division*, a program designed with NGSS curriculum standards as its philosophical guide. NGSS programs are intended to be developed around natural phenomena that facilitate the learning of chemistry in conjunction with other sciences, such as earth science. AREA154 intertwines NGSS-inspired STEM experiences, both actual and virtual, to engage students. The thematic phenomenological structure is centered on STEM-based survival strategies. Five "case files" spanning the fall and spring semesters are provided, each focusing on a different type of world-altering event. The students play agents-in-training. They must have been enrolled in at least three of the five case files to qualify for this study, meaning participants will have experienced the uLearning technological design through the majority of the program.

Varied levels of experience, the same cultural foundation

The focus of the study is on collecting data that can be used to explain Hispanic success in STEM subjects. The literature suggested that one critical aspect of success is self-efficacy. Interestingly, years of anecdotal evidence suggest that multi-active students do not need to receive high grades to feel confident in their abilities. Many of the initial, informal comments by student participants indicated that their feelings of self-efficacy were self-assigned. Grades did not reflect their confidence as much as their ability to get work done on time, and one student stated, "Good grades means playing the game of school. It's not really about learning." As such, the students will be selected on basis of the following criteria:

Self-identifies as Hispanic:	Can identify at least three of the five multi-active psycho-social norms as behaviors that are prevalent in the student's school and home life.
Completed at least four case files:	Due to covid-19 conditions, many students did not finish the final case file. This is permissible due to their extensive exposure to uLearning technologies. Because the technological design of the content, not the content itself, is the focus, an exposure to four of the five case files suffices.
Self-expressive:	The qualitative nature of the study requires students who can recall, ponder, and express their thoughts about their experiences with a uLearning system. A translator has already agreed to participate if needed.
Traditional science classes:	If a selected student was from the 2019–20 school year, they would have to have been enrolled in a traditionally taught science class the previous year. Students from the 2018–19 school year would have to have been enrolled in a traditionally taught science class during the 2019-20 school year, meeting the criteria. The students' having a basis of comparison between traditionally taught (linear-active) STEM subjects and uLearning is essential to ascertain the impact the curriculum design has on their perceptions of success.

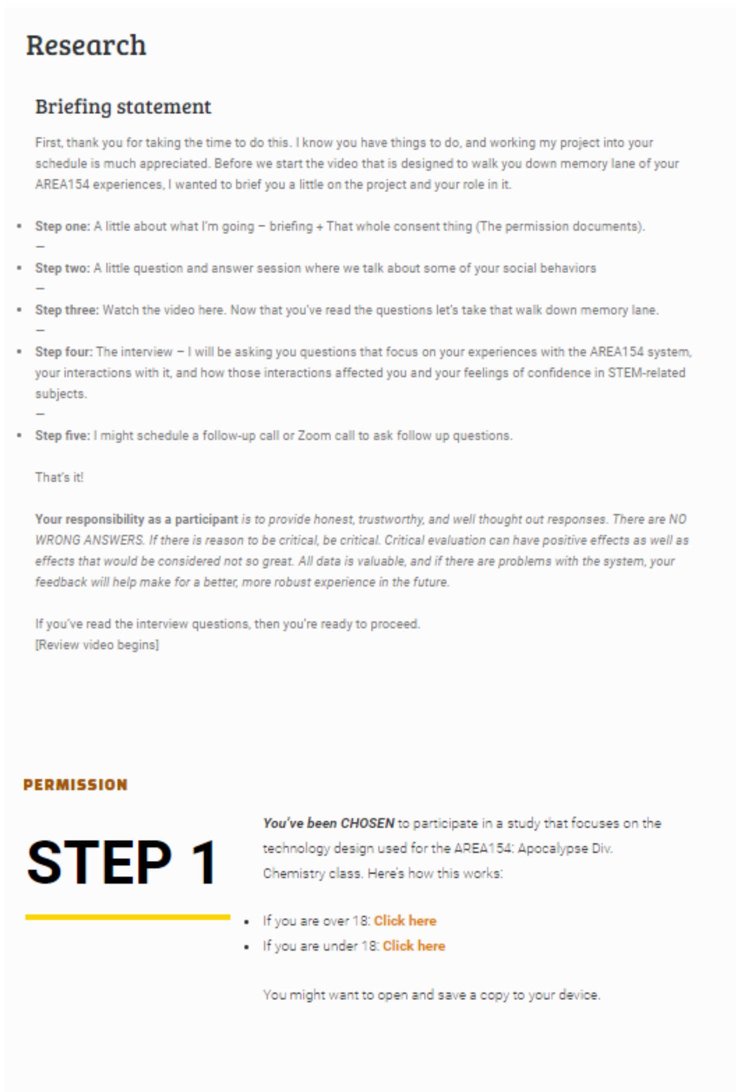
Various levels of achievement:	To clearly delineation academic success from self-efficacy, students will be selected who have grades of A, B, C, and D and below. The assumption is that students who received higher grades would naturally feel more skilled, and data are needed on that association and on the effects of uLearning on letter grades.
Comfort with negative views:	To ensure accurate data, one screening criterion includes the ability to freely offer negative feedback or communicate vocally or physically in ways that could be seen as disrespectful to the person asking the questions. Participants must understand that the honest reaction is the most desired one.

Context of data collection

A significant time will have passed between the students' exposures to the uLearning environment and the data collection. Due to COVID-19 pandemic protocols the original concept for face to face interviews in the classroom subjects were enrolled into during their AREA154 experience was changed. Instead, the interviews took place over Zoom calls. A time mutually agreed upon between the subject, subjects parents, and the researcher set the venue for the interview. Students were not overtly asked to keep their cameras on, but encouraged to do so for additional body language-based data collection. Some consideration might need to be made for poor connection bandwidth or the students comfort level with being on camera. In which case, the video will be muted and only the audio will be recorded. At the time of the online meeting, the students were provided a link to see the interview agenda. On the agenda page was located the meeting to-do list, the links for the appropriate consent or assent forms (Step 1), the link to the Multi-Active situational assessment (Step 2), the fifteen-minute review video (Step 3), and all of the questions for the interview (Step 4). The site page can be seen in its entirety in Appendix D. A clipped version can be seen in Image X, below, or visit the site page at https://temple.area154.net/rearch.

Image 1

A clip of the interview agenda page showing the agenda and Step 1.



Research

Briefing statement

First, thank you for taking the time to do this. I know you have things to do, and working my project into your schedule is much appreciated. Before we start the video that is designed to walk you down memory lane of your AREA154 experiences, I wanted to brief you a little on the project and your role in it.

- **Step one:** A little about what I'm going – briefing + That whole consent thing (The permission documents).
  –
- **Step two:** A little question and answer session where we talk about some of your social behaviors
  –
- **Step three:** Watch the video here. Now that you've read the questions let's take that walk down memory lane.
  –
- **Step four:** The interview – I will be asking you questions that focus on your experiences with the AREA154 system, your interactions with it, and how those interactions affected you and your feelings of confidence in STEM-related subjects.
  –
- **Step five:** I might schedule a follow-up call or Zoom call to ask follow up questions.

That's it!

Your responsibility as a participant *is to provide honest, trustworthy, and well thought out responses. There are NO WRONG ANSWERS. If there is reason to be critical, be critical. Critical evaluation can have positive effects as well as effects that would be considered not so great. All data is valuable, and if there are problems with the system, your feedback will help make for a better, more robust experience in the future.*

If you've read the interview questions, then you're ready to proceed.
[Review video begins]

PERMISSION

STEP 1

You've been CHOSEN to participate in a study that focuses on the technology design used for the AREA154: Apocalypse Div. Chemistry class. Here's how this works:

- If you are over 18: **Click here**
- If you are under 18: **Click here**

You might want to open and save a copy to your device.

The review video presented site videos, clips from briefings, shots of the ATN, images of the classroom, images of the Examulation, and other reminders of their experienced to jog their memory. A video was the next best most feasible option as meeting in the original classroom was prohibited by the pandemic.

Disclosure: Active involvement

The primary researcher in this investigation was also the student's instructor during their exposure to the uLearning curriculum. During that time, the program was always referred to as "AREA154" or the "Apocalypse Division." At no time was the program referred to as a ubiquitous learning environment. To ensure that they were open and truthful, students were also screened for comfort telling the teacher negative things about the program. A script will be read to interview participants informing them clearly that honest reflection is the most valuable form of data. At this point, they are all former students, so nothing they say or do will affect their grades, and they have greater freedom to speak honesty without worry of consequences.

Instrumentation and Data Collection

Ubiquitous learning system: AREA154: Apocalypse Division

With almost seven years of system implementation research behind it, *AREA154: Apocalypse Division* (http://temple.area154.net) is a progressive use of uLearning technology. Below is a technical breakdown of the uLearning system:

Hosted server (cPanel):	MidPhase Hosting Services, server blade rental: Enables high-bandwidth, 24/7 access to program materials. Uprate > 99.9%. The cPanel program provides detailed site information, including page requests and data transferred to clients.
Site software:	WordPress is the platform for distributing learning content, managing users and user data, and hosting the learning

	management system. Simple History is the backend app for tracking user login events and time spent on the site.
Learning management system:	Sensei, a free plugin that works exclusively with the WordPress authorware, is used to present lesson contents and track students' scores, progress, and gamification achievements.
Gamification:	BadgeOS & Leaderboard plugins, which work with WordPress and the Sensei LMS, are used to provide achievements and present them to members of the class.
Content distribution:	The learning materials are all contained in PDF documents with embedded active hotspots that can be clicked for on-the-fly or just-in-time instructional support. These documents were all created and supported using Adobe products such as Photoshop, InDesign, and Premiere.

A full content breakdown of the five Apocalypse Division case files is provided in Appendix E. The case files are largely independent which leaves the instructor open to organize and deliver them in whatever order fits their needs.

An evaluation method to help quantify qualitative data

Audio-recorded interviews provided additional information and a means to assess emotional intensity. Memos on subjects' response intensity were collected (summaries are provided in Phase II) as reminders of the response tone and the areas in which the subject's answers seemed more intense. The *affect number (AN)* will be used as a quantitative way to keep track of the qualitative data.

The Affect Number

The idea for the affect number of derived from English language acquisition researcher and distinguished professor, Stephen Krashen. His ideas about second language acquisition identified five hypotheses of learning. One of those was called the Affective Filter Hypothesis (Krashen, 1981). Conceptually, the Krashen imagined a filter that would block out learning content if there was a reason or some bias that afforded the student to do so. Influencing factors included learning motivations, physical well-being, the relationship with the teacher, past experiences with the learning material, seemingly the same type of factors that impede Multi-Active students from truly engaging STEM subjects. Saw and Chang (2018) noted Hispanic students in the study held a collective general bias that were not able to do math (or science). Perhaps that's enough to activate Krashen's filter hypothesis. The study aims to identify both confidence-building experiences (CBEs), to know what to continue to include. As well as CREs, which would be the restrictive kind. Those would need to be identified for possible reduction in frequency, if possible. The researcher, who was also the designer of the AREA154 system and the instructor for the subjects in the study will assign the Affective Numbers. The researcher's year-long exposure to the subjects provides a valuable insight into subject responses. Factors governing the Affect Number include:

- What were the subjects' responses positive in tone or negative?
- What words were used to describe the response?
- What was the tone of the response from the recorded interview?
- Knowing the student, what is the likely intent of the statement?

Assigning a number to qualitative data is not novel. The method was derived from a study by Snelson et al. (2020) in which middle school robotics students were recorded while working through various challenges. The study was mainly about the process by which qualitative video data could be used to quantify the degree to which specific computational thinking skills were observed in the students' behaviors. As the students performed specific actions, values were assigned on the basis of the observed intensity or strength of the actions. The affect number operates in a similar way: Values were ascribed as the data were being coded. And a similar procedure is used here: In the data analysis, the themes will take the average AN values assigned to the codes from the interviews. The affect number evaluation rubric is presented in Table 8.

Table 8:

Affect number evaluation rubric

Affect Number	Evaluation criteria
1	Subject used strong critical language, with vocal cadence and volume intensity that correspond to frustration and strong disapproval, in combination with other behaviors that indicate that the topic of discussion was a **strong area of success or confidence restricting.**
2	Subject used moderately critical language and vocal cadence and volume intensity corresponding to mild disapproval, or behavioral signals that similarly suggest the topic was a source of **mild success or confidence restricting.**
3	Subject gave no vocal or textual indication that the topic of discussion was promoted success or was an area of success or confidence reduction. The subject indicated a **neutral response.**
4	Subject gave vocal or textual indication and used vocal cadence and volume that corresponded to positive, success- or confidence-building experiences. The subject's overall demeanor suggested the topic of discussion was a source of **moderate success or confidence building**.
5	Subject used strong supportive language and vocal cadence and volume intensity that corresponded to pride and self-efficacy. In combination with other observable behaviors, this indicated that the subject experienced **strong areas of success or confidence building**.

Through constant comparison of these grouped themes, the AN values will be averaged to provide a semi-quantitative value for the observed qualitative criteria. For example, suppose that in the data analysis, the theme of organization arose, and the subjects gave a variety of responses on this theme. The text might indicate that some responses were similar in meaning: Subject 1 might say, “Oh yeah, it was just great,” and subject 2, “I was a great help.” Without the audio recordings, one might score these responses similarly. However, subject 1 used tones of sarcasm and resentment about the organization, and their response should receive an AN of 2. By contrast, subject 2’s tone indicated a genuine support and thankfulness, so subject 2 should receive an AN of 4. For the overall impact of the organization theme, the AN score is averaged to 3. Failure to consider the tonality of the conversation in situations like this could skew the data in unanticipated ways.

Backend user data on study participants

The Sensei LMS provides records of every students’ assessments and usage data reflecting their participation in the system. It also calculates and compares all students’ mean scores for each case file. The site’s data system can be used to triangulate information collected through the qualitative interviews to provide clarity and resilience for the data and conclusions derived from those data.

The WordPress backend app “Simple History” provides data on users’ login times and durations. It does not include activity history or frequency of interaction with the site while the subject is logged in, however. Errors could arise from students logging in and not logging out, skewing the data on their productivity. However, Simple History still provides a generalized representation of how often subjects log in, when, and for how long.

The AREA154 site is hosted by MidPhase (midphase.com) and uses a server management program called cPanel. This program includes an array of analysis tools that can provide stats on login frequency, page requests, site visits, visit frequency, and numerous other details. The cPanel tools and data can provide additional information that may support some coded themes while reducing the importance or validity of others.

Interview Data

According to Creswell (2019), the ideal number of students for interview-style data collection varies from case to case and from study to study. Suggestions from as few as five to as many as thirty have been made. Ideally, the data from the interviews should come from three students at each grade level, for a total of twelve. The interview questions will be open and conversational, but not as open or penetrating as those used in phenomenological interviews. The interviews will be recorded on a digital camera and then transferred to a secure laptop for analysis using NVivo QDAS tools.

Student Data Management and Collection

The data for this investigation come from three areas: students' official grades in STEM subjects and scores for content completed in association with but not directly in the uLearning system (ATN scores, for example); the *AREA154: Apocalypse Division* site records of the students' interactions, scores, and levels of completion for case files; and the interviews. The three types of data are stored and secured in the following ways:

Official grades:	All transcript-related materials are stored on encrypted, password-protected school servers.
UL system scores:	The site is password protected, and only the primary researcher has access to the backend data.
Interview data:	The interviews will be recorded using a tripod-mounted Sony HD Prosumer high-definition camera with a wireless mic to enhance the clarity of the responses. The video footage will be immediately transferred via an SD card to the researcher's password-protected computer and then deleted from other media. The SD card will then be put back into the camera for the next interview. The interview data will be analyzed in a secure location with a digital code-based lock. This will secure the data from outside access because of the computer at home and unlocked in the

	office.
Data analysis:	The data from the interviews and other descriptive data will be collected and processed into analytic categories, and potential themes will arise. The initial coding will follow a prescribed method of collection of categories based on the interview questions. The second coding pass will be used to develop specific sub-categories. As the categories become more robust, data from them will be compared. For example, categories stemming from uLearning codes can be crossed with those stemming from codes from multi-active character traits. Then the categories will be considered for how the data or themes could be connected. Logical connections between categories will give rise to theories that will be checked back against the data, most importantly against the negative data. Testimony from the participants will often be used to illuminate the theory and its resilience (Russel, 2000).

Strauss and Corbin (1990) and Glasser and Strauss (1967) provided additional, more specific ladder-like stages for the implementation of grounded theory in an investigation. Many of the steps are very similar, but enough vary that one methodology had to be included and another left out. This investigation involves the impact of psycho-social processes on STEM cognition and confidence in that cognition. The social processes must be identified (Glasser & Strauss, 1967). However, as the investigator also plays a necessary role in the participants' experiences with the *AREA154* program, the researcher's active role in the study must also be included (Strauss & Corbin, 1990). For that reason, the two schools of thought had to be combined to create the research framework for this study. Table 3.3 identifies the steps that were included and the schools from which they were derived.

Table 9

Grounded theory research from work for this study

Framework stage	Glaser & Strauss	Strauss & Corbin
Starts with a general idea of where to begin (some prior research or observation has been	X	X

Framework stage	Glaser & Strauss	Strauss & Corbin
done).		
Uses structured questions, possibly followed by natural lines of questioning.	X	X
Conceptual description of situations under investigation.		X
Development of theoretical sensitivity (the ability to derive relationships) from immersion in the data.	X	
Theory is built by data and then interpreted by the observer.	X	X
Basic social processes should be identified.	X	
The researcher is active.		X
Data are structured to reveal the theory.		X
Coding and continuous comparison of the data enable patterns to emerge.	X	
Two coding phases are used to develop concepts that explain the phenomena: simple (breaking data down into small segments and grouping them to capture patterns in the data) and substantive (open or selective choosing of a core category and relating other categories to it to explore emergent patterns).	X	
The qualitative data reveal the validity and any correlation to the original hypotheses.		X

(*Qualitative Research: Grounded Theory: What is it?* 2019)

A study using grounded theory is likely to begin with a question or even just the collection of qualitative data. As researchers review the data, repeated ideas, concepts, and elements appear and are tagged with codes extracted from the data. As more data are collected and reviewed, codes can be grouped into concepts and then categories. These categories may become the basis for a new theory. Thus, grounded theory is quite different from the traditional model of research, in which the researcher chooses an existing theoretical framework before collecting data to show how the theory does or does not apply to the phenomenon under study.

Research Timeline

The interviews should be completed as soon as possible to avoid excessive memory loss. After the initial interviews and follow-up questioning, the data may be analyzed more slowly. The proposed research schedule is as follows:

- IRB application — ASAP
- Send invitations for participation — September 2020
- Select participants — Late September 2020
- Distribute permission forms and contact parents — October 2020
- Conduct interviews — January 2021
- Complete first coding run — February 2021
- Ask follow-up questions for clarification — February 2021
- Correlate relationships and triangulate data — February 2021
- Organize initial results and conclusions — February 2021
- Complete chapters four and five of dissertation — February & March 2021

Ethical Considerations

Chamberlain (2013) discussed the ethical considerations that must be made when using grounded theory for qualitative investigation. There is a danger to undertaking grounded theory research in cases where it is important to produce evocative, descriptive, thematic accounts of the social sphere of influence. The drive to formulate a theory could supersede the collection of rich data. The researcher thus must be familiar with the people who are providing the primary data. Social familiarity might appear to be problem for bias-free ethical research, however, so guidelines from Creswell (2019) and the Australian Code for Responsible Conduct of Research (2007) will be used to develop research protocols and a framework of acceptable academic standards that includes the following:

- **Promote responsible research.** Maintain open communication between researchers, participants and parents or guardians throughout the data collection. Provide an expectation of high ethical standards and responsibility.

- **Provide competent management of acquired data.** All research will follow lawful practice and be conducted in a risk-free environment. Risk management and the safety of participants are the highest priority. The primary research data should be clear, consistent, and organized to minimize errors and be useful to future researchers who need access to primary information sources.
- **Report research responsibilities.** Findings of this research will be reported responsibly and disseminated properly. Findings by other researchers or sources outside the study will be noted and properly cited.
- **Disclose conflicts of interest.** Although there is no stated requirement to disclose the details of any conflict of interest, such a confidential agreement between parties for personal reasons, it is advisable that potential conflicts be disclosed.

Potential conflicts of interest

The *AREA154: Apocalypse Division* curriculum was researched, designed, and implemented by the primary investigator of this study, who was also the instructor for the students who participated in the study. In several interviews with site administrators, the topic of selling the curriculum was discussed. At that time, the program had not been appropriately vetted to ensure adherence to ubiquitous learning technology design factors. However, during the year in which the primary research was to be conducted, two schools asked to use the system to include more STEM materials in their own offerings. These were Hope Academy of Bishkek, Kyrgyzstan, and the Flabob Airport Preparatory Academy in Riverside, California. Permission to use the curriculum was granted to Hope Academy on the basis of opportunities for future research in that area of the world. No money was exchanged for the use of the curriculum.

Flabob Airport Prep was also offered permission to use the curriculum free of charge, but the academy insisted on donating $600 to help offset the $1,400 annual cost of the server that manages the high volume of traffic.

Given the potential market value of *AREA154: Apocalypse Division,* questions of data and conclusion reliability are important. If this study could produce astounding results, there would be a possible financial motivation for forging results that lead to a more marketable outcome. Moreover, questions about the integrity of the data could be asked simply on the basis of the bias toward receiving positive feedback about something produced for the use of others. People naturally seek praise for hard work and sacrifice. Ironically, after decades of designing, building, researching, redesigning, and re-implementing, a researcher and engineer would argue that these potentially result-altering biases are meaningless but ultimately counterproductive.

The following statement by this study's primary investigator may counter worries of bias or misrepresentation of findings:

> The *AREA 154: Apocalypse Division* program is the latest result of a long line of educational technology builds that go back decades. When I first started building EdTech-based learning systems, I really enjoyed the positive feedback, and because my products were a sort of labor of love, I resented and avoided the criticisms. What I quickly realized was that positive feedback has its place; it was largely useless. It told me that what I was doing was working for one type of person. The feedback that was the most meaningful was that which identified problems, issues, points of confusion, and user interface problems. As I matured in this process, I began to actively ask the students (participant users) to find any issues and

> problems they had and bring them to me. I would often reward their finds with some form of operant gratification, like a Jolly Rancher. After developing a thicker skin, so to speak, I realized that my systems were improving much faster and provided a much better working program for the students of the following year. Perfecting the interface was one of the reasons why this investigation was held off for several years so that the user experience and materials could be properly constructed. My primary motivation is to make powerful learning experiences for those who need them. That cannot be done unless the data acquired from the participants is open, honest, and collaborative in discovery. (Torrence G. Temple)

In short, the principal investigator, was also designed of the uLearning system and was the course instructor for the participants, claims that the potential for skewed results is minimal. The most important data are those that provide insights for progress, and inaccurate data always impede progress. This system is not in its final form, and the data acquired in this study will provide insights for improving it

Role of the Researcher

The researcher acted as observer, data collector, and interpreter of human interactions. These interpretations formed the foundation for evaluations and the semi-quantitative application of numeric values to qualitative data as described earlier. The research was the teacher who was also the systems administrator and the curriculum designer. The opportunity here for unfiltered intimate access to the interrelationships between these roles in an investigation could be considered to be unprecedented. Done right, it could reveal aspects of interdependence previously unseen and lead to insights that until now have not been exposed. Every effort on behalf of the researcher will be made to ensure data and process transparency to enhance the confidence and validity of the findings.

Limitations

Instructional limitations

This investigation focuses on the psycho-social behaviors of Hispanic (multi-active) people and the impact of a uLearning content delivery technology. Through it, I seek to understand the technology's effects on multi-active students' self-efficacy and sense of success in STEM-related subjects. As such, it is not a traditional curriculum—one in which an instructor produces materials that prepare the students for problems that are given later in the lesson, following the "I do, we do, you do" format. This method is narrative free and procedurally driven. It is one of the prevailing instructional methodologies in public high schools. The *AREA154* curriculum was designed to be the antithesis of the traditional educational experience which creates one potential limitation for the results of the study.

The instructor has specialized training in the implementation and use of a non-traditional curriculum. He has training in Hollywood-style narrative production and media that allow him to enhance the narrative element of the program far beyond what teachers who have been classically trained can do. If the research demonstrates that the narrative component of the curriculum had a profound impact on students' self-efficacy or perceptions of success, its results would not be reproducible except by someone with similar experiences, styles, and understanding of instructional narrative.

The AREA154 program was simultaneously implemented with Mrs. Rodriguez, another teacher at San Jacinto High School, to help her teach chemistry, which she had not taught before. She implemented the curriculum for three sections in the first year and two in the second year.

She was then informally interviewed and described her experience. One significant area of concern she noted was her inability to implement the narrative of the program. She also suggested that the lack of narrative made students wonder about the point of the course: they found it confusing because they didn't see the bigger picture. In response, the program developer held a briefing with Mrs. Rodriguez's students, and spent a class period explaining the narrative behind the program. Almost immediately, the students started showing more interest in the work. Because the presentation involved the specific skills of the program developer, this incident reveals a further limitation of this research, though it would be interesting to investigate the specific skills required of the teacher to implement such a program.

Correlative limitations

The purpose of this investigation is not to discover correlations. Statistical tools require pools of numeric data of specific sizes to confirm or deny trends. Statistics have solid predictive abilities and can assess correlations between factors that are not evident on the surface. Because this study has a limited pool of participants, does not have the predictive power that larger quantities of data might provide. Instead, I seek to find a theory that could improve specific aspects of the public school educational experiences of multi-active peoples. For this, it is necessary to present a causal argument for the relationship between Hispanic students and STEM subject areas. The statistical correlation has already been established. For that reason, this study will be limited in its application of statistical correlation.

Chapter III Summary

When the original iPhone was released in 2007, it was unlike anything anyone had ever seen. On a much smaller scale, the *AREA154*-style uLearning curriculum was unlike anything anyone had ever seen. In both cases, the first question one asked about the experience would probably be, “What was it like?” The question of one’s lived experience is almost certainly a phenomenological question, though it’s not clear that phenomenology is the best lens for the investigation.

In this study, I primarily seek implementable solutions: ways to reduce the increasing Hispanic STEM achievement gap in the U.S. In addition, to prevent the system from playing an antagonistic role in the student’s uLearning experience, years of user interface research were conducted to ensure that students’ feedback was about the system’s uLearning properties and not their frustration with using the technology. Grounded theory was chosen as the research framework because it included phenomenological data on the students’ experiences and used those data to formulate a working theory.

Data collection will take place in the fall of 2020 continuing through early spring 2021, according to the preliminary schedule. The interviews will be recorded and then transcribed. Coding passes will include both spoken and visual communication cues. Lewis (2010) claimed that multi-active people are very physically expressive, so video analysis will be used to capture the entirety of the communications. The participants will include at least two years of students who experienced at least four-fifths of the curriculum. The covid-19 pandemic prevented the completion of the program in the 2019–20 school year, and students from that year will have had a slightly different experience from those in previous years. The students should also come from a variety of achievement levels. Anecdotal teaching experience revealed that students’ content self-efficacy can differ substantially from their ability to turn in work for grades. Grades tend to measure a student’s capacity to complete tasks on time and competently. However, the ability to do so can be hindered by personal events (Boyle, 1993; Kärner & Kögler, 2016). Students from the D–F, C, B, and A grade ranges will be interviewed to mitigate the potential for grades alone to be the measure of self-efficacy and perceptions of STEM success.

Results

The grounded theory qualitative lens provides a unique path toward something that other lenses do not overtly offer: a rigorously vetted reason for why a phenomenon occurs. Glaser and Strauss (1967) saw it as a sound methodological approach wherein the researcher's preconceived biases could be kept in check by the constant contrast of newly introduced data. However, the continuous comparison of data to develop an evolving and increasingly complete theory has potential pitfalls. Wu and Beaunae (2012) posited a warning and anecdotal tale about coding and making categories, and then coding data and codes to create more categories, among an influx of ever-increasing amounts of new data. Their cautionary tale begins with a research team eagerly coding, theming, and categorizing. Themes and trends arise; they feel applicable. Rather than stopping to test the theory, though, the research team continues to split data, codes, and categories. Eventually the volume of fragmented data becomes so vast that the researchers lose sight of the forest for the trees. According to Grbich (2007), researchers are subject to missing the big picture when following their intuitive ideas, while getting lost in the fracturing process. This process was experienced first-hand during the break down of 23 hours of transcript interviews, students' Aeries data, and activity data acquired from the backend of the AREA154 content delivery site. It became apparent just how quickly the data can become fractured into something that begets a misdirected theory.

The purpose of the results section is to present the data and the outcome of the qualitative analysis. Quantitative studies have more prescriptive and condensed presentational morays, and math offers a trusted sense of logic on which everyone agrees. Grounded theory, or qualitative research in general, lacks such collectively agreed upon foundations. Those methodological foundations absolutely exist, but they are not as clear-cut as quantitative statistics. Presentations of GT results require something more akin to a narrative or an attorney's thoughtful argument in a court case wherein the readers are the jury. As mentioned in the study's introduction, the AREA154 uLearning STEM content delivery system was developed over three years ago. NGSS chemistry students at San Jacinto High School would experience the program at school, interact with it, take it home, live with it, and learn with it. Learning about the students' successes and failures, comments and complaints, and anecdotal feedback about the challenges in their lives functioned as a sort of initial preemptive sequence of data gathering. The program remains active now as a testament to the feedback of those past students. After two years (2017–2019) of feature-building and testing, the time came to formally ask the questions that kept cropping up over the development period. How did this system transform a course (chemistry) that saw an over 40% failure rate to a course where only 9% of the students could not pass? The analysis that postulates a theory to explain this phenomenon occurred in four phases, as this chapter will explain.

Phase I examined the students' online experiences with the website as a user interface. Additionally, back-end user data and interview data were rated using a five-point scale. Numbers were assigned at the researcher's discretion. The combination of descriptive numeric data (from Aeries and back-end server analytics) and student interview data will provide an affect number. Affect number (AN) values over 3 indicate that the subject had confidence-building experiences (CBEs). Values below 3 indicate the opposite, showing that the subject had confidence-restricting experiences that would lower the subject's overall confidence in STEM subject matter. Phase II investigated subject testimony through the axial lens of the uLearning criteria list generated by Huang (2018). This phase provided theoretical input about the confidence-building experiences (CBEs) associated with the uLearning design guides. A second reflection and categorical cross-checking occurred in this phase. The data resulting from phases I and II were rigorously compared and contrasted, and affect numbers were assigned to each of the uLearning criteria. A revision then took place so the theory could further evolve. Phase III analyzed noncategorical factors outside of the uLearning system. These factors are, generally speaking, not within the control of the instructional design. However, they still may influence the summative impact of the uLearning experience on the subjects. Each factor was evaluated and assigned an affect number. Then a final AN value was set, indicating the affect number for the whole phase. At this point, the evolving theme passed through a third categorical cross-checking, allowing the theory to grow and evolve with the new input. Phase IV analyzed the foundational assumption about the multi-active psycho-social behaviors of the subjects. The compiled subject profiles included data from Aeries (a student data-management program), memos covering in-class observations, memos reflecting on the interview, and the results of the multi-active questioning sequence. The student profiles were lengthy but added to the transparency of the theory-generation process. This section not only established the validity of Lewis' (2012) multi-active behavior profile, but Phase IV acted as a filter or validation gateway to help ensure that the final categorical analysis would confirm evidentiary validity for the cultural assumptions and the qualitative interview data.

Phase I: Categorization.

This section will present the acquired data in several steps. The data collected on the back end of the site will demonstrate the path-interface usage of the temple.area154.net site. Data from the host server, cPanel user data, and site traffic offer additional means of cross-checking the students' testimonial data for congruency. In addition to the host's descriptive statistics, the site employs apps that keep track of login/off times and the average daily login time of each user.

Once the site usage data are collected and cross-checked with the subjects' experience data, the affect number for the entire phase arises from the average of the subcategorical affect numbers.

Phase II: The uLearning system impact.

This section will present how student interview data were coded and themed according to the qualities that describe uLearning systems developed by Huang et al. (2018). Each uLearning category presents themes generated from coding data collected from student interviews on specific uLearning criteria. System users' comments about how each of the uLearning criteria affected their experience rendered a collective experience portrait. As in the previous phase, each uLearning theme generated an affect number based on the subjects' input. Those affect numbers were then averaged together to create the Phase II affect number, which describes the overall impact the uLearning criteria made on the subjects' CBEs. A value of more than 3 suggests that the collective usage of these tools produced confidence-building experiences. Phase II represents the effect of the technology design on learning. However, this effect may only be valid when compared to student populations with a culturally similar clientele.

Phase III: Noncategorical influences.

Educational success is known to be very nuanced and influenced by factors that can vary widely from home to home. To adjust for these unforeseen variables, Phase III coded student interview data to address these issues:

- Motivation
- Sources of struggle with being successful
- Extracurricular influences
- Intrafamilial experience sharing
- Learning factors outside of the classroom

- Personal motivations for learning
- Potential influences of career choices

The influence of the instructor cannot be ignored in an analysis that seeks to generate a theory explaining the past-reported success of the AREA154 system. It can be argued that the instructional curriculum and the teacher, if integrated to a high degree, are one inseparable force for student learning. They represent not separate entities but a single experience. Phase IV asks questions about the qualities of the teacher to ascertain the impact of the instructor. Additionally, if the AREA154 system has any large-scale potential for imparting confidence-building experiences that prove transferable from one NGSS classroom to another, data about the skills needed to run the program should be analyzed. Subjects were questioned about the qualities an instructor would need to possess in order to effectively present the curriculum. The results were averaged with the AN values of the previous variables to create an affect number for the entire phase.

Phase IV: Categorization.

The study presumes that the subjects (the cross-section of a multi-active student population) represent the multi-active psycho-social behavioral influence presented by Lewis (2012). The argument that the AREA154 uLearning system was beneficial to the students only supports the theory if the evidence establishes the study participants as possessing multi-active traits. In an effort to demonstrate multi-active congruity, detailed profiles compiled through a variety of data sources display a progression of the students' year-long grades in the program, their AREA154 spring semester final grade in comparison to all the other spring grades, and their site-user data provided by the Simple History app that works in the background on the temple.area154.net website. Additional thick descriptive data displayed as reflective in-class behavioral memos present other qualitative data about the subjects. Memos on subjects' Zoom interviews also serve to enhance the student profiles and contribute to transparency.

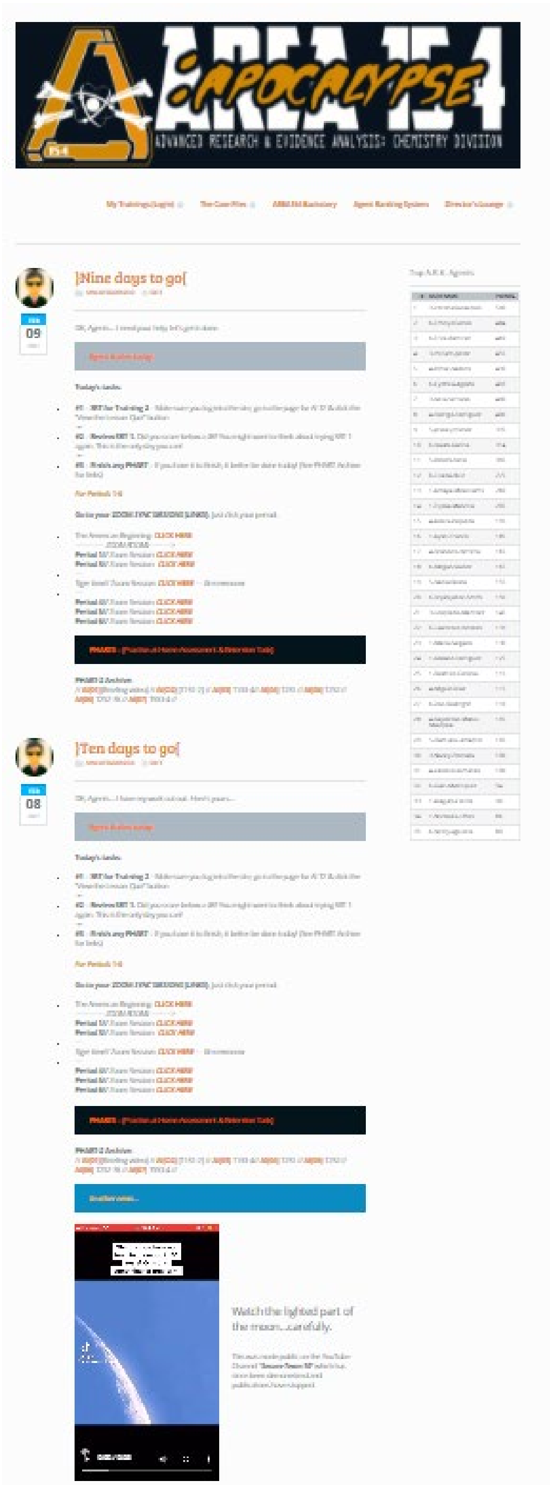
Phase I: The Student Experience

The site interface

The address that students use to access the website is http://temple.area154.net. If accessed from a computer, Chromebook, or laptop, the screen looks like Image 2 and Image 3. If the student loads the site on a mobile device similar to a cellphone, the screen appears as Image 4.

Image 2

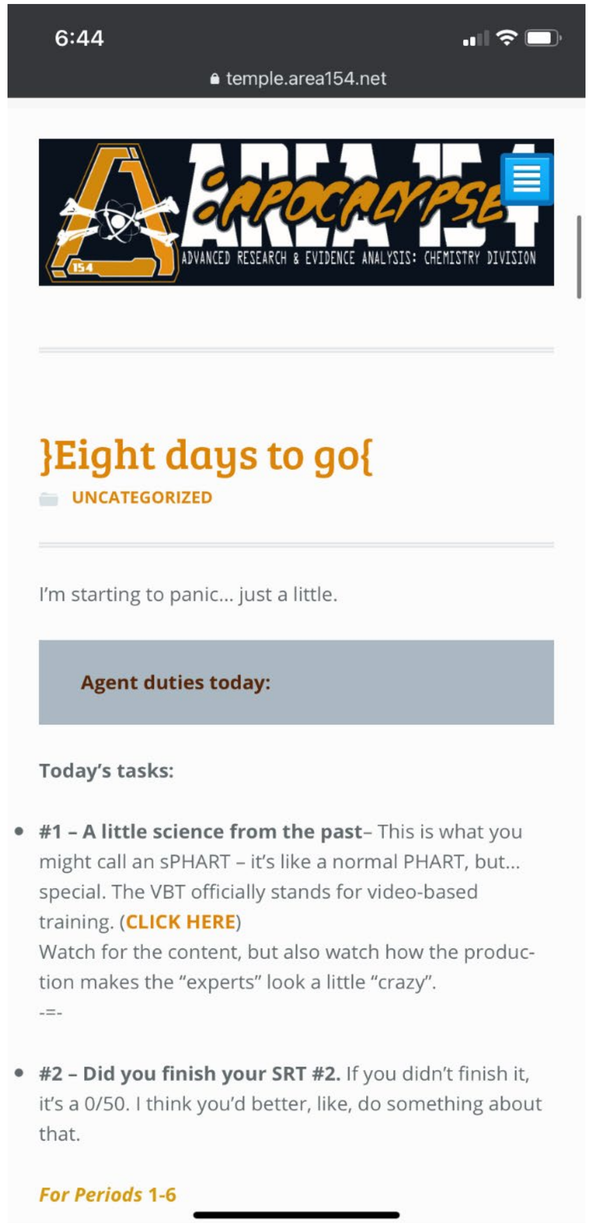
Screen Shot of AREA154 Home Page



Note. A zoomed-out screen shot of the AREA154 home page as seen on a PC, Mac, or Chromebook.

Image 3

iPhone 11 Screen Shot of AREA154 Home Page



Note. A screen shot of the AREA154 home page taken on an iPhone 11.

Image 4

Site home page with labels for identifying the primary interactives

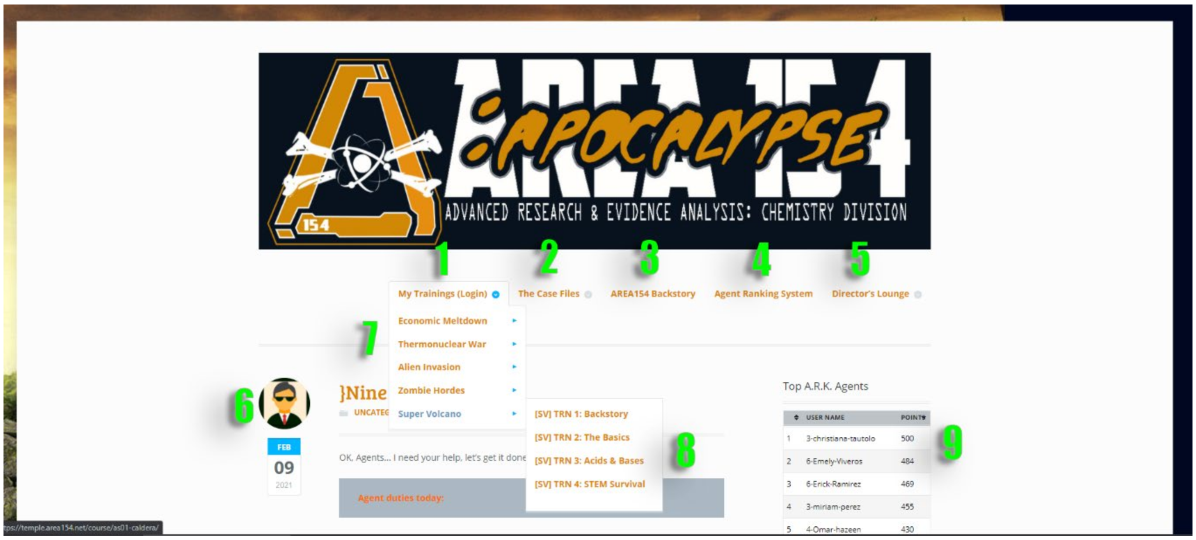


Image 4 displays labels representing user interaction areas, and corresponding user data are located in the table below. Each time a user clicked on one of these links, it sent a "page request" to the server. The site keeps track of every page request. The page-request data were termed "clicked," but both terms refer to the same data. As of February 9, 2021, 341,758 successful page requests were recorded for the entire site, starting in August 2018 (the date the site was switched to a dedicated server). That translates to 5,655 per week.

Additionally, 108,663 files were requested in total—the complete bandwidth to date measures around 33 terabytes of information, or roughly 28 gigabytes daily. Table 10 presents the click data from the site's cPanel analytics software.

Table 10

Site usage data broken down by link activity

Site Location	Clicks	Link Function
1	297,329	This link takes the user to the login page. This access point is a critical and prevalent step in imparting access to the interactive PDF files. The course data are not accessible unless the student logs in.
2	74,548	Link action is only required once to enroll in a specific case file. However, students can access case-file trainings through this menu, though it is not commonly done.
3	22,909	The link leads to the page that contains the thematic backstory. Videos depicting the role of the “ARK agent” are stored here to share with parents or friends. More commonly, this is where the journey starts and how students are introduced to the system.
4	1,925	Very little is on this page except for the ARK agent ranking system. Students typically visit this page once, if at all.
5	2,235	The director’s lounge has extracurricular studies and theme-oriented information not covered in the curriculum. However, the most important feature is not designed for the students but for other instructors who wish to implement the system and need content answer keys, like a digital teacher’s guide.
6	Loads with home page	Site location is the “daily post,” which serves as the starting point for each day of new instruction. The post is new each day and connects students with the agenda, due dates, class-based news, and other information related to the content covered that day or week. It functions as a connection point for each student and as a guide for students who were not physically present in the room during the instructional period.
7	~ 6,000	Average across each of the case files.
8	~ 7,200	Average per training (4 training PDFs per case file).
9	Loads with home page	The ARK Agent Top Agent Leaderboard. The 35 highest-ranking agents are ordered by achievement points.

Phase I theme: Organization

Table 10 represents subject interview data that reflect their experiences using the site. The saturation of responses is presented with the quotes. Below the subject interview data are the derived themes, which indicate a positive or negative experience, followed by an initial set of derived categories. As mentioned previously, the developing themes will be assigned affect numbers that convey a collective sense of the subjects' confidence-restricting experiences (CREs) or confidence-building experiences (CBEs). (The affect number [AN] has been described in more detail in Chapter 3.) These numeric values aid in building a semi-quantitative method of tracking and defining the qualitative data. Table 11 displays subject interview data reflecting the theme of site organization.

Table 11

Saturated data on the theme of site organization

Subject ID:	**Comments** [Interview time code] [R = No. of times a similar comment is repeated]
Stu-M-8-19	"It [the site] was kind hard I never really figured out how to use it." [00:12:30.130] [AN = 1] [R = 1; AN for all responses = 1,1]
Stu-F-8-11	"The site was a little hard to figure out. I was sort of lost." [00:09:25.658] [AN = 2] [R = 2; AN for all responses = 2,2]
Stu-M-7-14	"Finding and using the site was no issue to me." [00:01:38.250] [AN = 3] [R = 0; AN for all responses = 3]
Stu-F-9-7	"It (the site) was certainly not designed like anything I have ever had to use. It took some time to figure out. Not too long after that, it was amazingly easy to use and predictable. I always knew where everything was." [00:09:33.258] [AN = 4] [R = 3; AN for all responses = 4,4,4,4]
Stu-F-6-1	"I have never seen anything so complete and so well organized in a science class. Any class." [00:02:52.360] [R = 3] [AN = 5] [R = 2; AN for all responses = 5,5,5]
Affect Numbers	(CRE): [Organization AN = 1,2.1] (Neut): [Organization AN = 3] (CBE): [Organization AN = 4,4,4,4,5,5,5]
Theme [Organization]	**Average Affect Number (AN) Score: 3.5**

Phase I theme: Usability.

The second prevalent theme that arose around the site structure and deployment was usability. The theme of usability included codes that referred to how well the students could facilitate daily activities on the site. These activities included using the home page navigation, getting important information from the daily posts, reaching SRTs, and performing during the Examulations. Table 12 displays the data surrounding the usability theme.

Table 12

Saturated data on the theme of site usability

Subject ID:	**Comments** [Interview time code] [R = No. of times a similar comment is repeated]
Stu-M-8-19	"I don't remember where those were located or really taking them [SRTs]." [00:19:28.838] [AN = 1] [R = 0; AN for all responses = 1]
Stu-F-9-18	"Everything was good, I sort of fell off in the end. That was my part. It was just me." [00:09:25.658] [AN = 2] [R = 1; AN for all responses = 2,2]
Stu-M-7-17	"I would need things and then they would be pointed out in class, and I was like, where was this when I needed it?" [00:25:01.460] [AN = 3] [R = 0; AN for all responses = 3]
Stu-F-6-5	"I had no problems getting what I needed or doing the class stuff. Sometimes I would have network issues, but that's not the site really." [00:09:33.258] [AN = 4] [R = 6; AN for all responses = 4,4,4,4,4,4,4]
Stu-F-9-7	"I could access and use the site on my Chromebook, phone, tablet. I would even take my classwork to picnics and do it there." [00:41:00.800] [R = 2] [AN = 5] [R = 2; AN for all responses = 5,5]
Affect Numbers	(CRE): [Organization AN = 1,2,2] (Neut): [Organization AN = 3] (CBE): [Organization AN = 4,4,4,4,4,4,4,5,5]
Theme: [Usability]	**Average Affect Number (AN) Score: 3.8**

The third revealed theme for Phase I: Content Accessibility

The third theme that arose around the subjects' site experience was content accessibility. This theme addressed the functionality of the links, responsiveness of the LMS functions (keeping track of assessment scores), site up-time, login speeds, download speeds, and the site's performance at school (on the SJHS network) and on home networks. Table 4.5 presents information about the theme of content accessibility. Sometimes accessibility means getting access to assessment results, and if buttons do not work, learning stops. Accessibility can play a role in the amount of effort a subject may utilize before giving up and moving away from the learning content.

Table 13

Saturated data on the theme of site content accessibility

Subject ID:	**Comments** [Interview time code] [R = Repetition of similar comments]
Stu-F-6-7	School network: *No subject data in this range.* Home network: "We had problems with our home internet. There were days where I would try, and just give up." [00:09:25.658] [AN = 1] [R = 0; AN for all responses = 1]
Stu-M-9-8	Downloads: "I only had problems at home, lots of buffering." [00:02:45.590] [AN = 2] [R = 1; AN for all responses = 2,2]
Stu-F-6-5	Responsiveness: "There were times where I wasn't sure if my SRTs were submitted or not. Oh, and sometimes the "Save" button doesn't really save." [00:51:32.654] [AN = 2] [R = 2; AN for all responses = 2,2,2]
Stu-M-7-9	Home network: "NO, it [loosing network access] wouldn't happen like a handful of times, maybe not too often." [00:06:15.611] [AN = 2] [R = 2; AN for all responses = 2,2,2]
Stu-M-9-15	Downloads @ school: "I would sometimes watch the [content] videos, while also watching [my partner] stream YouTube videos." [00:22:55.140] [AN = 3] [R = 2; AN for all responses = 3]
Stu-F-6-7	School network: "I would come to school early to use the internet because my internet at home is garbage." [00:18:20.390] [AN = 4] [R = 4; AN for all responses = 4,4]
Stu-M-3-3	Responsiveness: "Some teachers took days to grade my work. I liked how quick the site graded the quizzes." [00:09:02.010] [AN = 4] (Same value, different aspect of accessibility)
Stu-F-6-1	School network: *No subject data in this range.* Home network: *No subject data in this range*. Downloads: *No subject data in this range.* Responsiveness: "The STRs would get graded really fast. I loved that part. I felt like I had a chance to relearn what I missed and redo it [the SRT]. I really loved that part." [00:03:45.060] [R = 2] [AN = 5] [R = 1; AN for all responses = 5,5]
Affect Numbers	(CRE): [Content Accessibility AN = 1,2,2,2,2,2,2,2,2] (Neut): [Content Accessibility AN = 3,3,3] (CBE): [Content Accessibility AN = 4,4,4,5,5]
Theme [Content Accessibility]	**Average Affect Number (AN) Score: 2.8**

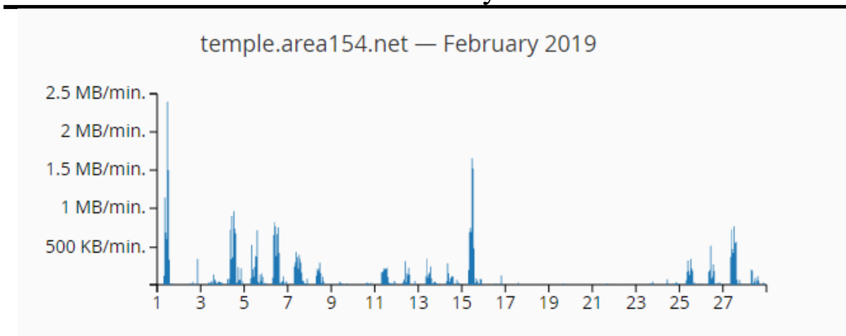
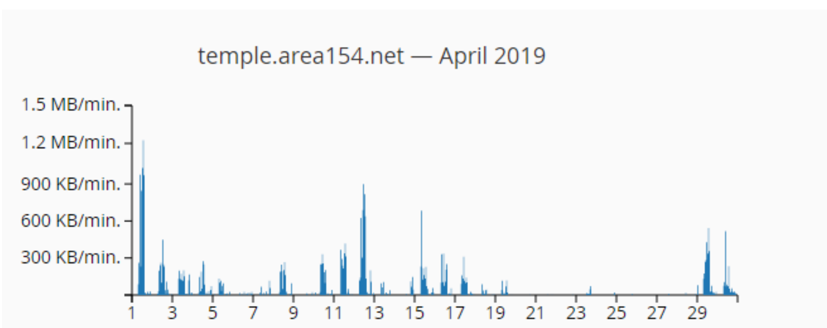
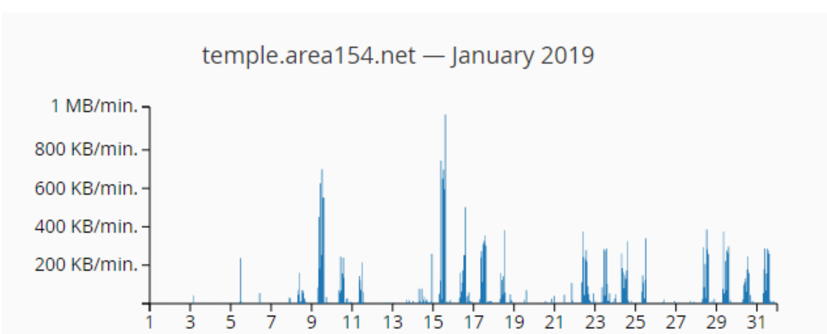
Note: Comments reflecting negative experiences appeared heavily focused on the subject's ability to get network access away from school. Comments reflecting school access appeared to help in the view of several subjects, who said they came to school specifically to use a reliable network. This result is consistent with informal data collected during the AREA154 development period. Students would often complain about their home connectivity. The phrase, "Bro, my internet sucks" was fairly commonplace.

Additional site data analysis

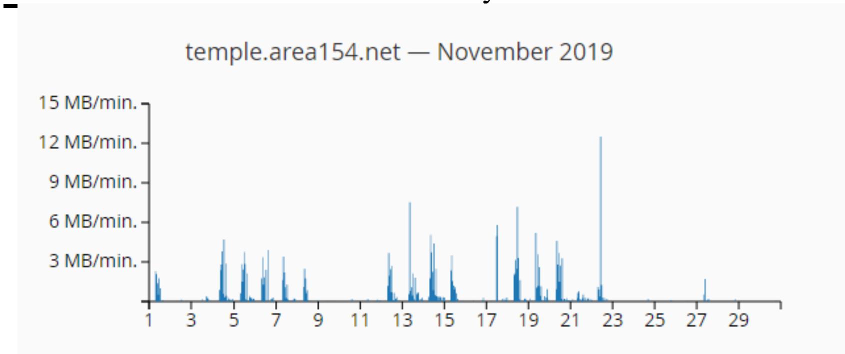
The cPanel generated the following graphs via the site usage application that tracks user statistics. The themes developed by this analysis appear next to each of the images. Table 14 presents the site usage statistics for different months of the 2019 and 2020 school years.

Table 14

Server traffic data broken down by month and themes associated with the traffic data

<table>
<tr><th>Server Traffic by Month</th><th>Site Traffic Memos</th></tr>
<tr><td>
</td><td>The SJHS school district has a unique spring break schedule. The two-week period is broken up into one week in February and one in April. Note that between 2/16 and 2/25, almost no activity occurred. The same types of patterns appeared to happen each weekend. Note the lack of activity on 2/2 and 2/3 and again on 2/9 and 2/10.</td></tr>
<tr><td>
</td><td>The same pattern occurred here during the spring break week in April (4/20 – 4/29). As this chart shows, some traffic appeared to be occurring over the weekend of 4/6 and 4/7 and again on 4/13 and 4/14. However, in general, the same pattern of inactivity is present.</td></tr>
<tr><td>
</td><td>The site traffic report for January repeats the general patterns of inactivity. The timespan from 1/1 to 1/8 is the last week of the SJUSD winter break. Any activity here would likely be due to the instructor uploading content and readying the site for the new semester.</td></tr>
</table>

Server Traffic by Month	Site Traffic Memos



Site traffic for weekends and holidays in November 2019 appears to be slower than at the beginning of the year. In January and February 2019, at the beginning of the semester, there was evidence of more traffic on the weekends. However, toward the end of the term, weekend and holiday traffic dropped to almost zero. During the Thanksgiving break from 11/22–11/30, there was an enigmatic amount of traffic on 11/27 (Wed.). Its source is unknown.

Each unit (▬) represents 1,500 requests for pages or part thereof.

day	#reqs	#pages
Sun	23353	2232
Mon	228249	38332
Tue	247821	39488
Wed	223745	42661
Thu	240662	46841
Fri	219541	37701
Sat	16685	1344

The data in this chart represent the number of page requests over the life of the site's publication broken down by days of the week. According to the server data, about 1,200–1,800 of these page requests are due to bots and prods by outside interests aiming to access the site. This data reaches back to August 2018. Subtracting the nonstudent traffic, Sunday and Saturday experience a fraction of the traffic of the normal school days.

Testimony regarding working at home:

Stu-F-8-11	"Mom was more, like, monopolizing what I have to do around the house. But yeah." [00:27:00.370] [R = 3]
Stu-M-7-17	"It was the most interesting stuff first, I threw everything else out the window." [00:15:08.940] [R = 1] *Note: Subject was referring to abandoning his world history and math classwork. His stated interest in the AREA154 subject matter was high.*
Stu-F-9-18	Q: "What was your standard experience with the site when working at home?" A: "I didn't really do work at home. I probably should have. But, I was just lazy … put it off." [00:13:32.879] [R = 4]
Stu-F-7-2	Q: "Did you get most of your work done in class?"

During the student interviews, very little was mentioned about this phenomenon. Students made comments about working at home. However, there was no indication of whether they were talking about working at home on a weekday or on the weekend.

These responses appear to illustrate that one of three options could be contributing to the lack of traffic on the weekend and holidays.

1. **Could not** get to class site because mom or family interfered with plans to do work.

Server Traffic by Month		Site Traffic Memos
Stu-M-9-15	A: "Yes, just about every day." [00:25:48.130] [R=6] "My internet goes down a lot. I don't know why. It might not even be our internet. I think my mom put our neighbor's wi-fi in our stuff." [00:31:54.332] [R = 1]	2. **Would not** do the work due to a lack of motivation or discipline. 3. **Did not need to** do the work because they had finished in class. 4. **Were prevented from** gaining access to the site because of unreliable internet connections.
Developing themes: [No-traffic weekend] [No-traffic breaks] [Home/school separation][Opportunities missed] [Mom-dominated] [Finished at school]		

Theory Development

Phase I focused on the subject's experiences with the website interface and their experiences with the site functions' performance, overall organization, and content accessibility. The analysis of student experiences yielded three specific themes related to the subjects' interactions.

Organization.

The theme "organization" revealed that some students experienced problems with the site and its organizational style. Some characterized it as confusing, saying it took some time to learn. Others stated that the interface was unlike anything they had worked with before, so it appeared strange. The majority of the students who contributed to this theme voiced responses that seemed to express success and confidence in using the site. Averaging all of the evaluated subjects' responses produced an **affect number of 3.5**. This result suggests that the site's organization does have a slightly positive effect on building success and confidence with the subjects who used the site.

Usability.

A small portion of the data surrounding the site's usability involved statements about forgetfulness and a general sense of unfamiliarity, or just forgetting the rules for using it. Most of the subjects' responses appeared to support the site's responsiveness, reliability, and stability on every platform. Of course, this depended on whether the network they were on was functioning well enough to match the performance of the AREA154 site server. The AN data reveal an **affect number of 3.8.** The AN value seems to indicate that the usability of the site enhances subject CBEs.

Content accessibility.

More of the subjects appeared to have issues with the content accessibility, specifically in terms of losing passwords, losing their SRT scores because the site did not record them, and other experiences with the site. The observational data collected by the instructor indicated that most of the time, the error in SRT score recording stemmed from a student's misunderstanding of what constitutes "submitting the test." There are two potentially confusing buttons on the SRT page. One reads, "Complete," and the other reads, "Save." Students would often click "Save" thinking that they had turned in the test. However, clicking "Save" paused the quiz and put the student in a state of "In progress." The SRT has a score of zero until it is marked "Complete" and graded. Data related to this theme also demonstrated the effect that a good network connection can have on student learning. Comments from subjects reflected frustration with download times, connectivity, buffering, and other connection and network-related issues. Notably, though, these comments changed when students discussed their experiences while logged into the SJHS student network. While a notable influence, network experiences were not assigned an AN value due to a lack of specific data. Thus, they were color-coded and added to the grounded theory diagram to represent their undeniable influence. The AN data presented an **affect number of 2.8.** This score indicates that network access plays a critical role in the student's ability to access the data and the level of success and confidence-building experienced by the subjects while working. The overall score suggests that the theme of content accessibility, especially if accessed outside of school, has a slightly restricting effect on the subjects' sense of success and confidence.

Additional themes from site data.

The last part of Phase I analyzed the subjects' user patterns on the AREA154 site. Consistent patterns of little to no activity over weekends and school breaks were common over several monthly bandwidth reports. Additionally, the separation of school and home activities grew starker as the semester progressed. By the Thanksgiving break, weekends and vacation days were utterly devoid of site traffic. Subject interview data suggested four possible explanations for the drops in activity.

1. Students **could not** get to the class site because their mom or family interfered with plans to do work.
2. Students **would not** do the work due to a lack of motivation or discipline.
3. Students **did not need to** do the work because they had finished it in class.
4. Students **were prevented from** accessing the site due to unreliable internet connections.

The comments about the subjects' experiences with accessibility appeared to support some of the notions about networks made in the section about content accessibility. Other comments, however, appear to be beyond the scope of the uLearning paradigm. The focus of the study was to investigate the uLearning system's role in creating confidence-building experiences. As such, an affect number may not apply here. Many of the factors that appear to be affecting the subjects' experiences are not part of the uLearning paradigm. That said, the network traffic may support the multi-active assumption that Hispanic families put a high value on family time. Anecdotal evidence collected during the school year would support that assertion. Students would often comment about how they cannot do schoolwork until late in the evening due to family responsibilities. Several subjects made comments about "home being home" and said that "school is done at school." Stu-F-7-9 stated, "It wasn't like that at my house, but I know a lot of kids who were like that. As soon as they got home, it was chores, cleaning, help their mom with stuff. There'd be no time for school until way later" [00:39:53.150]. If these comments are accurate, they lend credible evidence to support the notion that these students display multi-active psycho-social behaviors and add a sense of validation to one of this study's fundamental assumptions.

Theory visualization. In Figure 4.3, the themes and influences have been presented in a colorized flow chart. The developing theory begins in stage one by grouping the AN scores for each of the themes. Averaging together the AN scores from each theme provides an overall AN score. This value imparts some idea of the relative impact that Phase I factors have on the developing theory. For visualization purposes, the AN scores have colors that visually denote their numeric value. Colors are averaged along with the numbers. The numbers of each color are as follows:

Areas of high confidence-restricting experiences (CREs)

- **Red** = Affect number of 1.0 – 1.7

Areas of moderate to low confidence-restricting experiences (CREs)

- **Orange** = Affect number of 1.8 – 2.5
- **Yellow** = Affect number of 2.6 – 3.0

Areas of low to moderate confidence-building experiences (CBEs)

- **Green** = Affect number of 3.0 – 3.5
- **Blue** = Affect number of 3.6 – 4.2

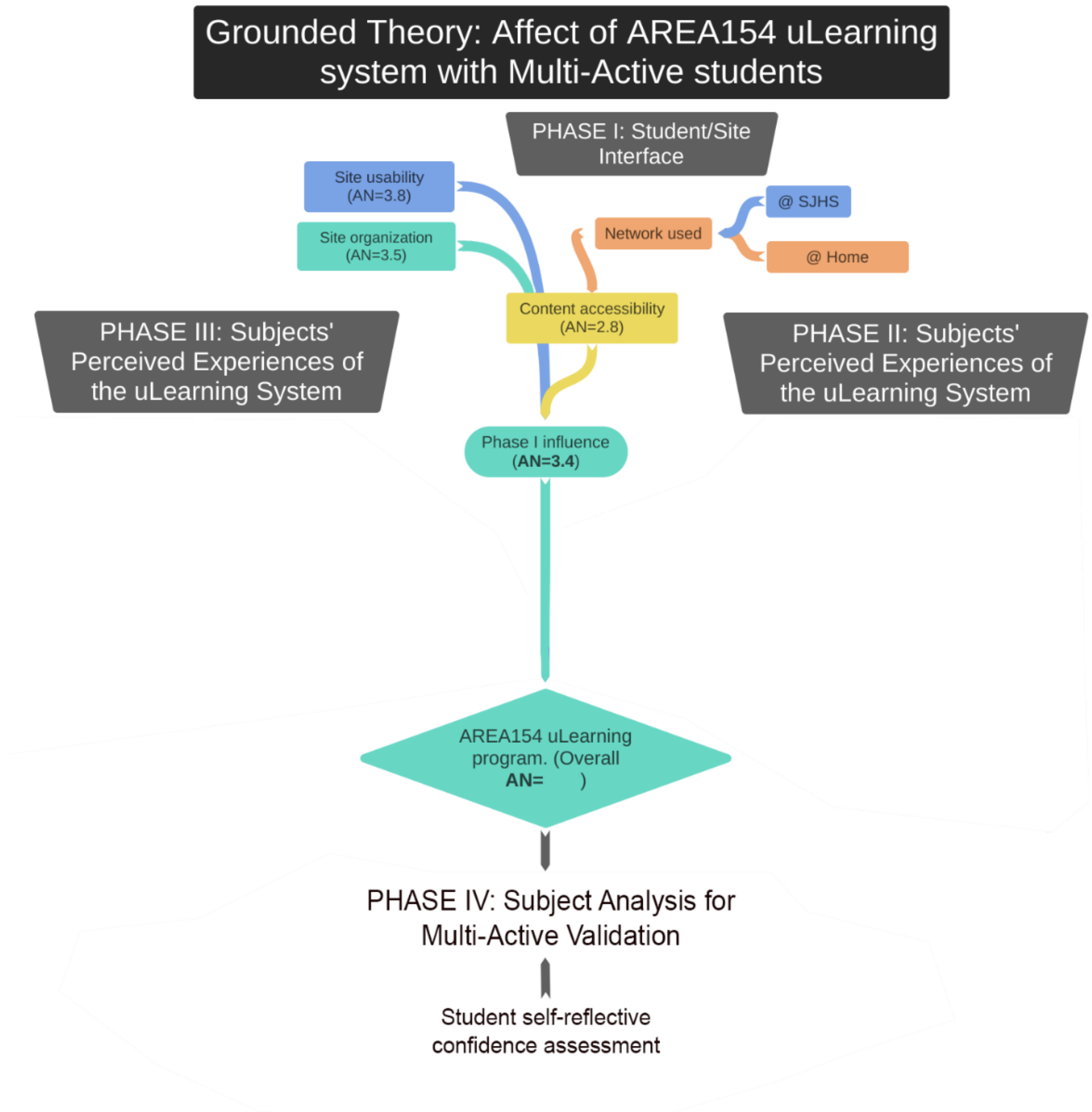
Areas of moderate to high confidence-building experiences (CBEs)

- **Purple** = Affect number of 4.3 – 5.0

The colors help communicate the magnitude of the influencing factors more clearly and completely. Figure 6 contains the initial stages of the developing theory. Spaces for additional phases have been labeled and left open. Additionally, the overall AN value for the AREA154 uLearning node was left blank until all three phases were tabulated.

Figure 6

Visualization of developing theory through Phase I



Phase II: System impact—subjects' perceptions of uLearning system features

The investigation began on the surface of the uLearning system, the site interface, in Phase I. The second-phase results represent the subjects' experiences and responses for each of the uLearning criteria described by Huang (2018). The results of the coding appear in the same format as they did in the prior section. Each of the uLearning criteria has subject-specific feedback that reflects each of the five layers of impact. Each example displays a value reflecting how many times a similar comment was made at that same affect level. The goal of this phase was to develop a numerically derived affect number for each of the uLearning criteria, which assessed each criterion's individual impact. All of the particular criteria were then totaled to provide summative value for the collective impact of the uLearning design on the overall AREA154 experience. The results of the data analysis begin with a description of the themes developed around the uLearning criteria, their association with Huang's (2018) uLearning standards, and whether the AREA154 system meets each uLearning criterion. Table 15 lists the generated themes.

Table 15

The developed themes, uLearning criteria, and AREA154 features meeting the criteria

Theme	uLearning Definition (Huang)	AREA154 Examples
Self-paced	Content that can be completed on a schedule that fits the needs of the individual learner.	Flexible deadlines with SRTs and ATN checks (formative assessment). Site access 24/7.
Anytime/anywhere	Anytime/anywhere access to the curriculum.	temple.area154.net, accessible by any internet-connected network.
Fast feedback	Immediate feedback on formative assessments.	SRTs (Survival-readiness tests—formative assessments) provide instant feedback to learners and opportunities to learn from mistakes.
On-demand instruction	Need-driven availability of curriculum resources—support instruction is available in predictable places and on-demand to help explain content away from the classroom.	PDFs can be downloaded from the site and contain built-in instructional guides for students who need procedural and content-related assistance 24/7.
Real-world	Content is directly applicable to the real world or a theoretical real-world condition.	The uLearning system is based on scientifically sound but improbable real-life world-altering scenarios. Surviving these events depends on being able to apply STEM skills to real-world conditions in order to survive.
Narrative	Thematically driven and applied narrative.	*AREA154: Apocalypse Division* contains five self-contained world-altering events.

Theme	uLearning Definition (Huang)	AREA154 Examples
		Each begins with the start of the event, the impact, the event's power, environmental effects, and new threats that evolve due to the event.
Gamification	System has a competitive or game-like design to provide multiple avenues for engagement.	The "TOP AGENT" Leaderboard listed students in decreasing point total. The board can be customized to fit as many or as few agents as are enrolled in the program. Points are gathered by getting perfect scores on SRTs and completing extracurricular challenges.
Connections	Provides social-emotional interaction.	The ATN (agent-training notebook) is a dedicated paper-based notebook that students present to the "director" for evaluation. The interaction in class (or via email) provides opportunities for social-emotional connections between instructor and student. Examulations—the summative assessments of each case file—are done in groups. As with every chaotic event, one never can predict who will be around you, and these teams will need to work together to survive.
Site-central	A centrally located curriculum, a server-based internet-connected hub where all the learning content is located.	The site area: 154 is the parent domain for temple.area154.net (and several other subdomains that are in use by other instructional teams). The site is hosted by MidPhase.com, based in Chicago. All back-end management and SQL database management were created and managed by the primary investigator.
Any device	Curriculum can be accessed on any internet-accessible device (device-independent).	The site is typically accessed by Chromebook (district-provided) and by students' cell phones. However, the site and its functions are also accessible via any web-based device.
Backend	Learner-specific back-end data can be used to address specific user needs.	WordPress powers the AREA154 Apocalypse Division site and has a number of robust plugins that monitor student login time and duration, changes

Theme	uLearning Definition (Huang)	AREA154 Examples
		made to the site, intra-site student messaging, and plugins for the LMS that runs the learning experiences. It also has detailed user schematics that track students' progress.

Note: The "Backend" code was analyzed in the previous phase. For detailed information on the backend systems used in AREA154, please refer to the Phase I analysis.

The following results reflect the experiences of the subjects and their perspectives. The subjects were selected from a variety of different academic achievement levels. It should therefore be noted that experiences and educational priorities vary among the sample pool. Phases III and IV address the noncategorical and personal factors that may influence subjects' Phase II experiences to balance that variable. The results begin with Table 16, which focuses on students' ability to self-pace within a uLearning environment.

Table 16

Saturated data uLearning theme analysis. Theme: Self-pacing and flexible deadlines

Subject ID:	**Comments** [Interview time code] [R = Repetition of similar comments]
	No responses given at this level [AN = 1]
	No responses given at this level [AN = 2]
Stu-M-7-17	"It didn't kill me with the deadline getting tremendous stress on you saying ask me, do then. At least I knew I had a little bit of lengthy period to fix it, helped that play a role in being able to get things done, or did it was it not good because it fed into procrastination? It really depends on the person." [00:32:39.250] [AN = 3] [R =7; AN for all responses = 3,3,3,3,3/3,3,3]
Stu-F-9-7	"I would also be able to do everything on my own time, which even if we had a like with the, a deadline where we had turned in the work, it was still mostly at my own pace and my own time." [00:19:56.380] [AN = 4] [R = 6; AN for all responses = 4,4,4,4,4/4,4]
Stu-F-8-4	"You know, we're all human and we have bad and good days and we're not sometimes all in. And he just helped a lot because I, I get to work on my own time sometimes. And I know when I had it when I needed it to be done." [00:19:13.520] [AN = 5] [R = 3; AN for all responses = 5,5,5,5]
Affect Numbers	(CRE): [Organization AN = *No such responses*]

Subject ID:	**Comments** [Interview time code] [R = Repetition of similar comments]
	(Neut): [Organization AN = 24] (CBE): [Organization AN = 48]
Theme [Self-paced]	**Average Affect Number (AN) Score: 3.8**

Note: Affect numbers were calculated by taking the average of the total responses in a category. Restrictive experiences occurred in AN ranges of 1 and 2. Neutral experiences are 3. AN scores of higher than 3 represent confidence-building experiences that have occurred.

Table 17

Saturated data from the analysis of uLearning criteria. Theme: Anytime/anywhere content access

Subject ID:	**Comments** [Interview time code] [R = Repetition of similar comments]
	No responses given at this level [AN = 1] *No responses given at this level* [AN = 2]
Stu-M-8-16	A: "I didn't usually do it (chemistry classwork) at home." Q: "What if you were behind and needed to catch up?" A: "I would do it in class or come in before school or lunch and do it." [00:32:39.250] [AN = 5] [R =9; AN for all responses = 3,3,3,3,3/3,3,3,3,3]
Stu-F-8-4	"What was mostly when I finish my work in class or I would have some spare time and just look through them because I, I believed everything was really interesting." [00:24:15.270] [AN = 4] [R = 4; AN for all responses = 4,4,4,4,4]
Stu-F-6-1	"I was in the car going to the airport and I got an email that I hadn't finished an SRT. I panicked, like freaked out. My parents mentioned that I could probably do it on my phone. I don't know why I didn't think of that … I was done before we parked the car." [00:39:53.150] [AN = 5] [R = 1; AN for all responses = 5,5]
Affect Numbers	(CRE): [Organization AN = *No such responses*] (Neut): [Organization AN = 30] (CBE): [Organization AN = 30]
Theme [Anywhere/ anytime]	**Average Affect Number (AN) Score: 3.2**

Note: Affect numbers were calculated by taking the average of the total responses in a category. Restrictive experiences occurred in AN ranges of 1 and 2. Neutral experiences are 3. AN scores of higher than 3 represent confidence-building experiences that have occurred.

Table 18

Saturated data from analysis of uLearning criteria. Theme: Fast feedback on SRTs and ATN work

Subject ID:	**Comments** [Interview time code] [R = Repetition of similar or like comments]
	No responses given at this level [AN = 1]
Stu-M-8-16	"So, yeah, I like the signatures. It was kind of, at times, I feel like it was kind of tough because any time I'm there was sometimes when you were, like, extremely busy, I would ask you to turn you off for another day. And I would just want asking you would hold me up for, like, another day." [00:26:32.790] [AN = 2] [R = 0; AN for all responses = 2]
Stu-M-7-14	A: "I feel good knowing that I have an A. It [the system] would tell you exactly what your grade was." Q: "And how many times did you take the SATs typically?" A: "Like, let's say … five or six times." [00:11:06.090] [AN = 3] [R = 2; AN for all responses = 3,3,3]
Stu-M-4-3	"And to go back and do it again, I would like very much to see what I did wrong. Go back to my book and see if I can get it right, retake it. And if I got it right, I'm fine. If not, I just do it again." [00:19:56.380] [AN = 4] [R = 6; AN for all responses = 4,4,4,4,4/4,4]
Stu-F-7-13	"So being allowed to work past the self-doubt and be on your way to a more confident state while taking quizzes is amazing!" [*Written response*] [AN = 5] [R = 9; AN for all responses = 5,5,5,5,5/5,5,5,5,5]
Affect Numbers	(CRE): [Organization AN = *No such responses*] (Neut): [Organization AN = 15] (CBE): [Organization AN = 78]
Theme [Fast feedback]	**Average Affect Number (AN) Score: 4.79***

** The score was a composite of two individual questions on the interview list. One focused on the SRT and the automatic grading. The ATN was (upon the student's request) graded in front of them immediately and feedback and/or skill affirmation would take place.*

Note: Affect numbers were calculated by taking the average of the total responses in a category. Restrictive experiences occurred in AN ranges of 1 and 2. Neutral experiences are 3. AN scores of higher than 3 represent confidence-building experiences that have occurred.

Table 19

Saturated data from the analysis of uLearning criteria. Theme: On-demand instruction

Subject ID:	**Comments** [Interview time code] [R = Repetition of similar comments]
	No responses given at this level [AN = 1]
	No responses given at this level [AN = 2]
Stu-M-9-18	A: "It wasn't too frequently where I would use them. I was confused on something that I would that."

Subject ID:	**Comments** [Interview time code] [R = Repetition of similar comments]
	Q: "Was that something that you would more likely do at home or at school?" A: "It was at home." [00:10:08:320] [AN = 3] [R = 1; AN for all responses = 3,3,3,3]
Stu-M-4-3	"So the fact that there was something there that guided you whenever you needed help was that was something that I used frequently." [00:07:07.300] [AN = 4] [R = 6; AN for all responses = 4,4,4,4,4/4,4,4,4]
Stu-F-9-7	"And that really helped the PDFs even gave, like, tools like a calculator. I don't know little websites like that. So you felt like everything you needed was in that that place. And that added to the sense of confidence. Oh, yeah." [*Written response*] [AN = 5] [R = 9; AN for all responses = 5,5,5,5,5/5,5]
Affect Numbers	(CRE): [Organization AN = *No such responses*] (Neut): [Organization AN = 12] (CBE): [Organization AN = 78]
Theme [On-demand instruction]	**Average Affect Number (AN) Score: 4.4**

Note: Affect numbers were calculated by taking the average of the total responses in a category. Restrictive experiences occurred in AN ranges of 1 and 2. Neutral experiences are 3. AN scores of higher than 3 represent confidence-building experiences that have occurred.

Table 20

Saturated data from the analysis of uLearning criteria. Theme: Real-world applications

Subject ID:	**Comments** [Interview time code] [R = Repetition of similar comments]
	No responses given at this level [AN = 1]
	No responses given at this level [AN = 2]
Stu-M-8-16	Q: "Do you think your parents or any other family you have would turn to you for input on what to do, knowing that you've been through this experience and that you've talked to them about it?" A: "Probably not." [Implying there would be little reason for real-world application.] [00:11:06.090] [AN = 3] [R = 5; AN for all responses = 3,3,3,3,3/3]
Stu-F-8-4	"And it definitely helped me to me, I find it more engaging, think like it had a real-world application." [00:16:44.840] [AN = 4] [R = 6; AN for all responses = 4,4,4,4,4/4,4,4]
Stu-F-7-13	"Having always been fond of the drama in which the end of the world comes, I think the program just made me even more aware of the true possibilities of such a thing happening. I went home thinking about this quite often." [*Written response*] [AN = 5] [R = 9; AN for all responses = 5,5,5,5,5]
Affect Numbers	(CRE): [Organization AN = *No such responses*] (Neut): [Organization AN = 18] (CBE): [Organization AN =]
Theme [Real-world]	**Average Affect Number (AN) Score: 3.9**

Note: Affect numbers were calculated by taking the average of the total responses in a category. Restrictive experiences occurred in AN ranges of 1 and 2. Neutral experiences are 3. AN scores of higher than 3 represent confidence-building experiences that have occurred.

Table 21

Saturated data from the analysis of uLearning criteria. Theme: Learning through narrative

Subject ID:	**Comments** [Interview time code] [R = Repetition of similar comments]
	No responses given at this level [AN = 1]
	No responses given at this level [AN = 2]
Stu-M-7-14	*No responses given at this level* [AN = 3]
Stu-F-9-7	"But I think it's like it was really interesting was like the whole set like really serious things that are like very useful in real life. I things like it's good to know. And it was really fun." [00:27:47.970] [AN = 4] [R = 6; AN for all responses = 4,4,4,4,4/4,4,4,4,4]
Stu-F-8-11	"I think it made it more exciting to do this because, like, it looks more engaging, like work, I mean, so yeah, I liked it, a lot. I told my sisters about the stuff we did." [00:09:15:300] [AN = 5] [R = 9; AN for all responses = 5,5,5,5,5/5,5,5,5]
Affect Numbers	(CRE): [Organization AN = *No such responses*] (Neut): [Organization AN = *No such responses*] (CBE): [Organization AN = 85]
Theme [Narrative]	**Average Affect Number (AN) Score: 4.5***

* *The application of a "theme" covered the website, the design of the ATN, and the Examulation, which all applied to a single piece of content all year long. While observations from years of implantation development have indicated that some students have not cared for the thematic approach, none of the subjects reflected negative or even neutral opinions about their experiences in a thematic learning environment.*
Note: Affect numbers were calculated by taking the average of the total responses in a category. Restrictive experiences occurred in AN ranges of 1 and 2. Neutral experiences are 3. AN scores of higher than 3 represent confidence-building experiences that have occurred.

Table 22

Saturated data from the analysis of uLearning criteria. Theme: Gamification

Subject ID:	**Comments** [Interview time code] [R = Repetition of similar comments]
	No responses given at this level [AN = 1]
Stu-9-18	"Never seeing my name on the list, sometimes, made me feel bad." [00:11:06.090] [AN = 2] [R = 2; AN for all responses = 2,2,2]

Subject ID:	**Comments** [Interview time code] [R = Repetition of similar comments]
Stu-F-7-6	Q: "Did you pay attention to your own achievement points?" A: "Hmm, not too often. I really I really wanted to, but I don't know, I guess I just got caught up into, like, doing my ATN and, like, focusing on that." [00:24:52:630] [AN = 3] [R = 6; AN for all responses = 3,3,3,3,3/3,3]
Stu-M-4-3	"If I mainly got up there, I knew I was doing good and I know that I'm on top of things. And when my name would get lower, I'm like, okay, something's wrong. You need to start paying more attention and finishing it." [00:20:12:880] [AN = 4] [R = 6; AN for all responses = 4,4,4,4,4/4]
Stu-M-9-15	"That was the absolute best. Me and [student's name withheld] would, like, see who would be higher on the leaderboard. I'd come in a lunch, right? Come in and get help with the quizzes (SRTs) so I could be higher than him … also the points, that's what really made my grade good." [00:21:51:870] [AN = 5] [R = 9; AN for all responses = 5,5,5]
Affect Numbers	(CRE): [Organization AN = 6] (Neut): [Organization AN = 21] (CBE): [Organization AN = 39]
Theme [Self-paced]	**Average Affect Number (AN) Score: 3.7***

**Only 18 subjects of the 19 total responded on the topic of gamification and its effect on their experience.*

Note: Affect numbers were calculated by taking the average of the total responses in a category. Restrictive experiences occurred in AN ranges of 1 and 2. Neutral experiences are 3. AN scores of higher than 3 represent confidence-building experiences that have occurred.

Table 23

Saturated data from the analysis of uLearning criteria. Theme: Social connection

Subject ID:	**Comments** [Interview time code] [R = Repetition of similar comments]
	No responses given at this level [R = 1]
	No responses given at this level
Stu-F-7-10	Q: "The daily posts, did you read them or interact with them?" A: "No." [00:11:06.090] [AN = 3] [R = 5; AN for all responses = 3,3,3,3,3/3]
Stu-M-9-8	Q: "Did you use the daily posts on the site?" A: "Yeah, I think I helped." Q: "Did you frequently use them, semi-frequently use them? How frequently do they become part of your classroom experience?" A: "Yeah. Probably two or three times a week." Q: "Would you say that was maybe more on demand or just out of curiosity or out of habit?" A: "I think is more out of curiosity. Like, what are we doing today?" [00:18:50.040] [AN = 4] [R = 7; AN for all responses = 4,4,4,4,4/4,4,4]

Subject ID:	**Comments** [Interview time code] [R = Repetition of similar comments]
Stu-M-4-3	"If you remember, there was a two-week period that I was out. I was sick. Every day, I would check the site and the post thing to see what we were doing. It was the only class I could do that with." [00:10:28:650] [AN = 5] [R = 1; AN for all responses = 5,5]
Affect Numbers	(CRE): [Organization AN = *No such responses*] (Neut): [Organization AN = 18] (CBE): [Organization AN = 42]
Theme [Self-paced]	**Average Affect Number (AN) Score: 3.8**

** Only 16 of the 19 subjects were found to have commented on this topic.*
Note: Affect numbers were calculated by taking the average of the total responses in a category. Restrictive experiences occurred in AN ranges of 1 and 2. Neutral experiences are 3. AN scores of higher than 3 represent confidence-building experiences that have occurred.

Table 24

Saturated data from the analysis of uLearning criteria. Theme: Centralized network resources

Subject ID:	**Comments** [Interview time code] [R = Repetition of similar comments]
	No responses given at this level [AN = 1]
	No responses given at this level [AN = 2]
Stu-M-7-14	*No responses given at this level* [AN = 3]
Stu-F-8-4	"What it was made everything a lot easier because I had all the information that could help me with the quizzes and tests, and I would also be able to do everything on my own time, which even if we had a like with the, a deadline where we had turned in the work, it was still mostly at my own pace and my own time." [00:32:39.250] [AN = 4] [R = 6; AN for all responses = 4,4,4,4,4/4,4,4,4,4/4]
Stu-F-7-13	"Having everything located (and organized!) in one place is always preferred to opening 10 different tabs and becoming a confused mess. The clarity and centralization was one thing every other teacher should take notes on including." [*Written response*] [AN = 5] [R = 9; AN for all responses = 5,5,5,5,5/5,5,5]
Affect Numbers	(CRE): [Organization AN = *No such responses*] (Neut): [Organization AN = *No such responses*] (CBE): [Organization AN = 78]
Theme [Self-paced]	**Average Affect Number (AN) Score: 4.4**

Note: Affect numbers were calculated by taking the average of the total responses in a category. Restrictive experiences occurred in AN ranges of 1 and 2. Neutral experiences are 3. AN scores of higher than 3 represent confidence-building experiences that have occurred.

Table 25

Saturated data from the analysis of uLearning criteria. Theme: Any device

Subject ID:	Comments [Interview time code] [R = Repetition of similar comments]
	No responses given at this level [AN = 1]
	No responses given at this level [AN = 2]
Stu-M-8-16	Q: "Did you ever attempt to access the website through something besides your Chromebook?" A: "No." [00:32:39.250] [AN = 3] [R = 11; AN for all responses = 3,3,3,3,3/3,3,3,3,3/3,3]
Stu-F-9-7	"I remember those times where, I mean and if you remember [student's name] and we would walk home. He would forget, like, what do we do in class? I would get my phone because I had I had it bookmarked on my phone too." [00:19:56.380] [AN = 4] [R = 4; AN for all responses = 4,4,4,4,4]
Stu-F-8-4	"My phone got taken away, we because 'reasons' and I really needed to finish an SRT. So my older brother had me do it on his Xbox. Forgot that thing has internet on it." [00:22:17.111] [AN = 5] [R = 0; AN for all responses = 5]
Affect Numbers	(CRE): [Organization AN = *No such responses*] (Neut): [Organization AN = 15] (CBE): [Organization AN = 46]
Theme [Self-paced]	**Average Affect Number (AN) Score: 3.4***

**Only 17 of the 19 subjects provided feedback on this uLearning criteria.*
Note: Affect numbers were calculated by taking the average of the total responses in a category. Restrictive experiences occurred in AN ranges of 1 and 2. Neutral experiences are 3. AN scores of higher than 3 represent confidence-building experiences that have occurred.

Phase II: Theory Development

Phase II focused on the subject's experiences within the uLearning system (AREA154). Their experiences reflect what they could recall from across the course of the 2019–2020 school year. Each of the themes was derived directly from the list of uLearning criteria presented by Huang (2018), which also guided the axial code development. In Phase II, the researcher aimed to understand the effect of the collective uLearning design on confidence-building experiences as well as the influence of each category. The coagulation of affect numbers below summarizes the overall effect of each uLearning design criterion. Aspects of grounded theory development in Phase II specifically address Concept Application Proof - 2 (CAP 2).

- RQ2: Did the students' data sustain the assumption that the uLearning system bolstered the student's perceptions of STEM course confidence?

Self-paced.

As one might expect, there was little to no resistance to having flexible deadlines. Lewis (2012) noted that the adherence to deadlines appears to be more of a suggestion to multi-active people. When deadlines are harshly enforced, it can often lead to resentment and a reduction in productivity by a multi-active student. While not considered a point of opposition, a point brought up by Stu-M-7-14 is worth considering. He stated, "I like the flexible deadlines, but sometimes because I know I have more time, I put things off. I kinda procrastinate. I did it more so in this class." These types of comments were also noted during the first year of the system's implementation. Chronic procrastination touched on a possible design flaw that brought about a procedural change: the development of an absolute deadline at the end of the case file. The new procedure would allow students to engage in some self-pacing without eliminating the concept that deadlines are very real. This change provided the subjects with five to eight weeks to complete assignments. After the case file Examulation, the case ended and everything was due. Stu-M-7-14 made those remakes with this zero-barrier policy in place. Many of the students viewed self-pacing as beneficial. However, some did feel that six to eight weeks was too much flexibility. The affect number for *self-paced* was **3.8**.

Anytime/anywhere.

This theme did not receive any restrictive comments. No members of the study indicated that the ability to do work anywhere and at any time detracted from their learning experiences.

As noted in the analysis, most of the students indicated that they did not do schoolwork at home. It was unclear if this was due to not *wanting* to do work at home or not *being able* to do work at home. The majority of the subjects stated that if they did not finish work in class, they would do it the following day. The flexible deadlines could play a significant role in encouraging this behavior. Students also mentioned a preference for coming into the classroom at lunch or before school to complete schoolwork. That being said, the subjects who responded with an affect number of 5 cited some extreme applications of system usage. One subject reported finishing an SRT in the car on the way to the airport—an emergency completion because grades were coming out soon. In another level-5 response, the subject was stuck at Walmart in the car. Being behind and needing to catch up, he facilitated his phone to catch up on his ATN with the full support of the website and PDFs while waiting for his mother to finish shopping. The overall affect number for this criterion was **3.2.**

Fast feedback.

The ability to receive immediate feedback on one's assessment or classwork was the highest-rated affect number of those analyzed throughout the uLearning criteria. The limited amount of negative feedback came from subject Stu-M-8-16. He stated that the immediate feedback on the ATN was not actually so quick. He felt he was often told to wait to be helped due to the excessive demands the instructor was facing. Often that led to forgetting to have his ATN checked. The instructor was responsible for checking the ATN, and feedback could be considered slow. However, every person who had the experience of receiving feedback felt that it fostered a high level of self-confidence and self-validation. Feedback speed was limited because the assessment was not automated and was truncated by the instructor's availability. According to Huang, this interaction is not part of the uLearning platform. uLearning systems are generally autonomous and self-driving. The ATN checking procedure, however, was not uLearning design-compliant.

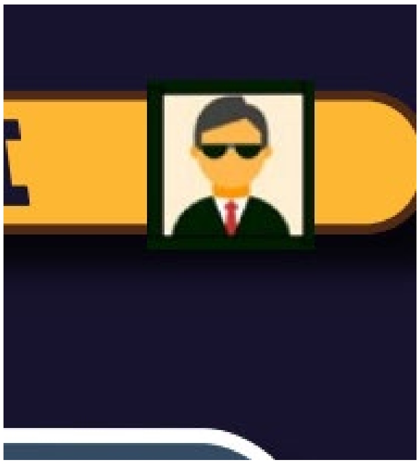
The other part of the AREA154 system that boosted immediate feedback—the SRT, or the Survival Readiness Test—was self-driving and operated on student demand. In the early iterations of AREA154, students were supposed to take these SRTs at home. Ideally, this would take full advantage of the flexibility of the uLearning system. However, according to the backend data on the site, roughly 50% of the students did not or could not complete the SRT outside of class. As a result, the SRT protocol was changed to reflect the budding observation that multi-active students and families tend not to complete work at home. From that point forward, students were provided with class time to at least start the SRT. Most would finish, while others never would. Unfortunately, the Sensei LMS does not keep track of attempts made by the student. The app does not say whether the grade acquired was the result of one attempt or 23. The impact of this observation is discussed further in the results section. The overall affect number for instant feedback was **4.7.**

On-demand instruction.

Arguably, the idea of gaining information that you need *when* you need it and *where* you need it is the heart of the uLearning system experience. The network-centered location for all of the AREA154 content that provided 24/7 site access was the pedestal on which this uLearning criterion stands. Subjects repeatedly noted just how valuable this tool was in allowing them to maintain a sense of confidence in the STEM class. The apparent segregation between the higher-achieving and lower-achieving students was noteworthy. The higher-achieving students demonstrated a much higher appreciation for the "Director's Icon" (Figure 4.4) and the "Media Icon" (Figure 4.5), presented here.

Image 5

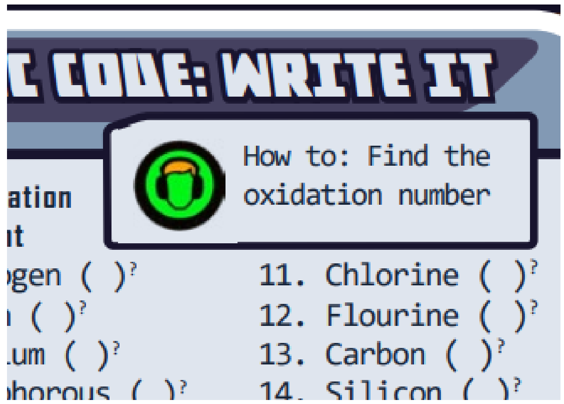
The "Briefing Icon"



Note: The "Briefing Icon," a character dressed like a CIA agent, has a link to a video that describes exactly what the agent needs to focus on and produce inside their ATN for credit.

Image 6

The "Media Icon"



Note: The "Media Icon" is the green circle that displays a person wearing headphones. This link takes students to specific tutorials on the subjects being taught in the section.

Every downloadable HyperDoc-style PDF on every case file came with these icons, which were there to support the learners when they needed particular information. As noted by some of the subjects, they rarely maintained 100% focus in class. A lot of "drifting" took place. The subjects indicated that having a place to go to find out what to do greatly helped build their confidence. The affect number for this criterion was **4.4.**

Real-world.

The ability to access the learning content that is most immediately relevant to the learner's world qualifies as real-world applicable. Huang (2018) addressed this concept in connection to VR, with the implication that "real-world" could also be applied to the world relative to the user regardless of what "reality" they found themselves occupying. In AREA154, the real world was defined by what "could happen." All of the system content experienced by the subjects supposes a world that is in constant threat, and the learned content could be applicable at a moment's notice. It is a conditional sort of "real world." The direct applicability of the learning context is hypothetical and predicated on the possibility of an event happening in the real world. Students across the achievement spectrum demonstrated support for know-how that they could apply to situations that, in their reality, could happen any day.

Interestingly, although most of the subjects had shared information about the class, its learning content, and the skills gained, they also stated that their parents would not be likely to seek their help in the event of an emergency. Aaccording to interview data, most subjects believe that their perceptions of reality are often not shared by their parents. It is unknown to what extent this disqualification of the subjects' experiences effects their CBEs within the program. The affect number for this criterion is **3.9.**

Narrative.

The uLearning criterion of learning STEM subjects (or anything, for that matter) through an applied narrative was not very high on the priority list of uLearning criteria. Huang (2018) described it as something nice to have but not an overly critical element. The subjects of the study might disagree with that notion. Not one student in the study presented any restrictive or even neutral data about how the AREA154 narrative affected their STEM class experience. Comments about the theme were exceptionally positive, ranking it as one of the most significant elements of the entire experience. This theme served as a part of the course that made the subjects "feel" about the content. An analysis of all of the interview transcripts in NVivo found that the word "feel" appeared 55 times in the section dedicated to discussing the "theme" of the class. Divided by 18 recorded interviews, the word "feel" arose 3 times for each person who spoke about AREA154's apocalyptic theme. The application of the theme was not limited to the website and the PDFs. The ATN was developed specifically and thematically for the class.

Subjects noted a sense of camaraderie when they saw students whom they did not know pull out their ATN. Subject Stu-F-7-10 noted, “Seeing the ATN in another class was, like, a sign that you and this person you don’t even know have this connection.” The classroom was surrounded by AREA154-themed images. Two 55” flat-screen TVs would commonly promote AREA154 imagery, post the live website, or show world-related data like volcanic hotspots or areas of high concentration of sulfur dioxide gases near Yellowstone National Park. The theme was very immersive and positively received by students, parents, and the administration. On multiple occasions, district administration toured the room. However, that is not to say that in the three years of implementation, students have not expressed concerns about the over-the-top class theme. Only two students have opted to transfer out of the class—not because they did not find it interesting, but because they took it too seriously. The two students both noted concerns about how this class was exacerbating their anxiety issues. In this study, however, the subjects displayed no signs that the theme was in any way curtailing their confidence. The affect number for this criterion was **4.5.**

Gamification.

Gamification is an element that is listed as a uLearning criterion, yet it is not included in all uLearning systems. Interestingly, students were not as favorable about this part of the program. Since they are a population-age demographic often associated with being “gamers,” the assumption would have been that this element would have been better received. Most of the subjects replied with either neutral or slightly positive feedback about the gamification aspect of the system. A few subjects noted slightly negative feedback experienced by not being on the Top Agent Leaderboard. In other words, the felt the Leaderboard at times to be restrictive in confidence building.

Interestingly, the students who made those comments were also three of the lowest five achievers in the subject group. On the opposite side of the spectrum, three subjects noted the compelling effect of gamification on their performance. One subject, Stu-M-9-15, stated that it was the primary thing that helped him earn a respectable grade. The affect number for this criterion was **3.7.**

Social connection.

The elements of social interaction within the system were intentionally limited for managerial reasons. No known formal protocol exists for how uLearning social connectivity should be represented in this sort of network. That being said, the collective social interactions within the AREA154 program were limited to in-class communications and the "Daily Post." Each day, the "Director" would post information on the site regarding the day and world training regimen or regional events that related to the case file. Students had the option to comment and reply to each post. Posting and replying to posts was not an encouraged practice. Some students experimented with it to ask others for help. However, those posts went unanswered by the agent community. After that, the practice stopped altogether. As such, the "Daily Post" was largely one-directional, as noted by the interview data. Some students would check in on progress and see what they had missed if they had been out, while others noted that they didn't look at the "Daily Posts" much at all. The affect number for this criterion was **3.8.**

Central site

The comments about the site, the level of organization, and the deployment of content, assessments, and gamification elements would have been nearly impossible without a centralized location in which to put all of the site data. The WordPress-powered site hosted by MidPhase provided the server space for the site. The videos sourced from outside locations were downloaded and stored on the AREA154 servers. Students behind the SJUSD firewall were often unable to use links made directly to videos on YouTube or other video-hosting sites due to district security restrictions. The filtering and blocking of content were notably frustrating for everyone involved. The subjects' feedback on this theme reflects an active effort to localize every support video so all the support media can be accessed all the time. While some external links continued to connect to sanctioned websites, and a couple of videos may exist online that are not on the local server, but none-the-less the vast majority of the learning content does not need the external internet. Subject Stu-F-7-13 lamented that learning in some other classes was spread out in so many directions. She was not the only person to pan how others teachers spread the learning content all over the internet. The apparent frustration experienced by the subjects in other classes may be what prompted the positive reactions to the concept of content centralization. The affect number for this criterion was **4.4.**

Any device.

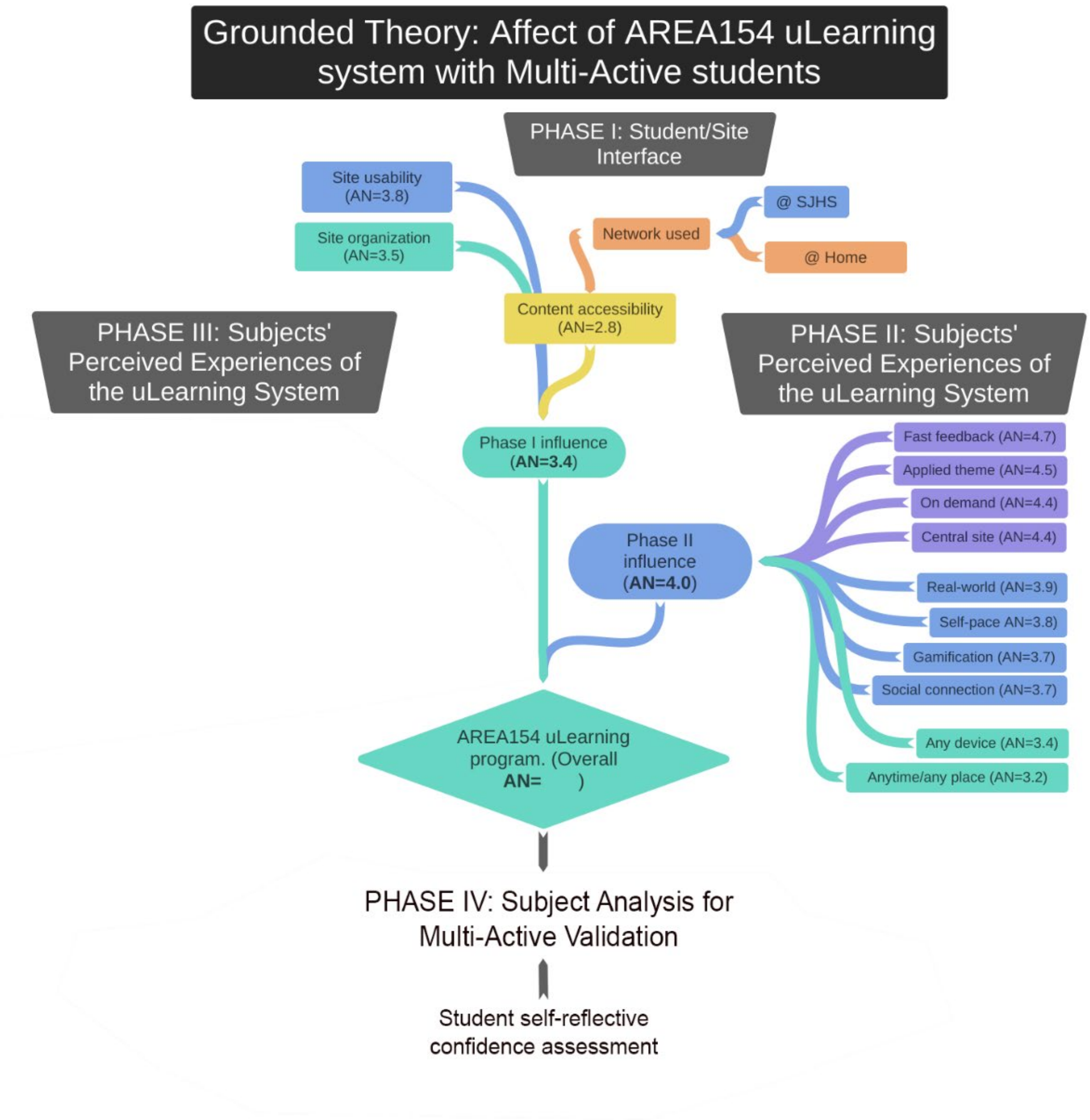
Huang (2018) noted that a uLearning network should be accessible by various devices to be truthfully labeled as ubiquitous. However, as a website, AREA154 was accessible by any network device connected to the internet. During the building phases, the temple.area154.net website was successfully tested when loaded on gaming platforms, iOS devices, Android devices, tablets, phones, smart TVs, and an internet-connected refrigerator. Despite the broad base of devices that could host the AREA154 experience, very few of the subjects found themselves accessing the site on anything but their district-provided Chromebook and possibly their phone. In one extreme example, a student took a quiz on an Xbox. However, Stu-M-9-15 was the only known student to have ever done this. Overall, the open platform seems like a perk, but evidence suggests that it plays a relatively insignificant role in the students' confidence-building experiences. The affect number for this criterion was **3.4.**

Phase I and II compilation for theory revision

After two phases of analytical cross-checking, the grounded theory grew to include explaining how the uLearning system (as experienced through AREA154) provided the means to build student confidence and success in STEM-related subjects. Figure 4.6 illustrates the developing theory.

Figure 7

The developing theory through two phases of analysis



Note: Factors labeled in purple (4.3 – 5.0) and blue (3.6 – 4.2) represent areas of higher confidence- and success-building. Factors in green (3.0 – 3.5) represent medium-low or neutral confidence- and success-building. Yellow (2.6 – 3.0) represents neutral to medium-low confidence-building (success-restricting). Orange (1.8 – 2.5) and red (1.0 – 1.7) represent higher areas of confidence- and success-restriction.

Phase III: Noncategorical experiences

The AREA154 experience exemplifies uLearning design principles. Phase II demonstrated that, overall, the uLearning elements had a notable influence. However, the study must also examine program factors that might be enhancing the uLearning system or detracting from it that lie outside of the influence of the instructional designer. The purpose of this study is to identify a theory that could potentially explain the decrease in failure rate and the observed success experienced in the first three years of the program. As seen in Phase I, the site interface, organization, and back-end data demonstrated a notable contribution to the overall affect number. Phase II's contribution provided the data reflecting curriculum and technology integration. Phase III analyzes factors affecting success and confidence-building that are not categorized as part of the traditional uLearning system.

It should be noted that through the extensive examination of literature on uLearning systems, no visible evidence showed this type of system had ever been deployed in brick-and-mortar schools in the United States. There were no references to studies involving Hispanic students and uLearning systems. Given the dearth of studies that could provide insight into different types of noncategorical factors and their influence on the student experience, Phase III has been dedicated to acquiring this information through open coding and theme generation.

Noncategorical themes derived from the student data considered how factors in the students' uLearning system environment could play an influential role in student learning or the students' direct interaction with the uLearning system. A list of noncategorical themes from the interview data and the Aeries student-management system are listed below.

Table 26

The coding list, code descriptions, and the uLearning criterion each code represents

Theme	Definition	AREA154 Impact Areas
Subject-area interest	Subject area interest was ascribed to any inherent or innate interest in STEM that would, by itself, create confidence-building experiences. Oppositely, it could be argued that aspects of AREA154 could restrict	If the subject has a natural inclination for science, a possibility exists that some elements of uLearning might interrupt the interest of a pure subject.

Theme	Definition	AREA154 Impact Areas
	confidence because of its additional complexities.	
Personal-learning motivations	Learning motivations were ascribed to emotionally fulfilling parts of the curriculum that provide the momentum for students to have confidence-building experiences (CBEs) vs. confidence-restricting experiences (CREs).	A student motivated by grades and a high GPA could influence the affect number of the AREA154 system. To avoid giving credit to the system that is not due to the system, subject responses should be analyzed to assign evidence-based credit to any affect number earned.
Family interactions	Familiar interactions are ascribed to any effect that family, or extended family, may have on the subjects' confidence-building or -restricting experiences.	Subjects occasionally noted that they would share interesting topics with family members. This interaction could build or restrict the confidence of the subject in the program. Additionally, family activities or priorities could also restrict student success or STEM confidence. These factors are largely outside of the uLearning system's influence but can substantially affect the subject's perceptions of the system or performance in the class.
External struggles	Sources of struggle were ascribed to any factor outside of the uLearning process. Family and personal issues that detracted from the experience were assigned numbers of 1 and 2 to account for their restrictiveness. Any struggle that appeared to be aided by some portion of the uLearning system was provided a value of 4 or 5. Values of 3 indicated the presence of no external struggles that would restrict class experiences.	All students have the potential to have negative and success-restricting experiences that are outside of the influence of the AREA154 program, yet still affect their success within the program. This theme analyzed how the uLearning system played a role in addressing external factors that could restrict learning.
Instructor influence	The instructor-influence theme reflects student interviews that note the impact the instructor had on the STEM uLearning experience, including but not limited to the instructor's demeanor, personality, discipline policies, professional experiences, and the fact that the instructor was the developer of the	A good teacher can arguably make any system come to life. As such, the instructor's influence over the system's performance must be taken into account. In face-to-face environments, no academic program works alone, and the influence the teacher has on the program's success can add substantially to CBEs or equally contribute to the addition of CREs.

Theme	Definition	AREA154 Impact Areas
	AREA154: Apocalypse Division uLearning program.	

Noncategorical themes: Analysis

The following list of tables show the results collected from the interview transcripts. Coding and forming themes based on the codes generated categories pertaining to students' lives outside of the uLearning system that could still be considered part of the AREA154: Apocalypse Division experience.

Table 27

Saturated data from analysis of noncategorical uLearning criteria. Theme: Subject-area interest

Subject ID:	**Comments** [Interview time code] [R = Repetition of similar comments]
	No responses given at this level [AN = 1]
	No responses given at this level [AN = 2]
Stu-M-8-16	Q: "Did the AREA154 experience interest you in taking another STEM course?" A: "Maybe, I don't know." [01:01:20.870] [AN = 3] [R = 6; AN for all responses = 3,3,3,3,3/3,3]
Stu-M-9-13	"Pertaining to this class did peak my interest into more STEM related courses- like earth and space science, marine biology etc…" [*Written response*] [AN = 4] [R = 4; AN for all responses = 4,4,4,4,4]
Stu-F-8-5	Q: "So what science classes are you taking this year?" A: "I'm taking AP advanced chemistry." Q: "That's a tough class; did you always plan on taking it?" A: "No, I actually wasn't really into science at all until this class." [00:25:38.360] [AN = 5] [R = 6; AN for all responses = 5,5,5,5,5/5,5]
Affect Numbers	(CRE): [Organization AN = *No such responses*] (Neut): [Organization AN = 21] (CBE): [Organization AN = 45]
Theme [Subject-area interest]	**Average Affect Number (AN) Score: 4.0**

Note: Affect numbers were calculated by taking the sum of each category. CREs: Restrictive experiences incurred a value of less than 3. Neutral is the sum of all responses warranting a 3. CBEs: AN values above 3 were associated with confidence-building experiences, and those are summed here as well.

Table 28

Saturated data from analysis of noncategorical uLearning criteria. Theme: Personal motivations

Subject ID:	Comments [Interview time code] [R = Repetition of similar comments]
Stu-F-6-5	*No responses given at this level* [AN = 1]
Stu-F-7-2	"It's not like the course was boring. But if I don't get As, my mom is, you know, like, all over me." [00:024:08.590] [AN = 2] [R = 0; AN for all responses = 2]
Stu-M-9-8	A: "In the first semester, I was, uh, not into [motivated by] school. More like into other things." Q: "What sort of other things?" A: "Like, just having fun, partying." Q: "Why only first semester? What happened?" A: "I learned about the evidence for aliens on Earth in the case file. It was at that point that I was interested. It was after that I started doing my work." [01:01:20.870] [AN = 3] [R = 3; AN for all responses = 3,3,3,3]
Stu-F-8-11	Q: "The class was themed, and the class had a narrative, and a goal made you want to learn more. Was that a motivating factor." A: "Yes, for sure." [00:32:28.160] [AN = 4] [4,4,4,4,4/4,4,4]
Stu-F-8-12	"Like, it's interesting to learn all the information we're told, and you get the chills, and you get up, and you just want to, like, learn." [00:22:28.210] [AN = 5] [R = 4; AN for all responses = 5,5,5,5,5]
Affect Numbers	(CRE): [Organization AN = 2] (Neut): [Organization AN = 12] (CBE): [Organization AN = 57]
Theme [Personal motivations]	**Average Affect Number (AN) Score: 3.9***

Only 18 of the 19 subjects had responses on this theme.

Note: Affect numbers were calculated by taking the sum of each category. CREs: Restrictive experiences incurred a value of less than 3. Neutral is the sum of all responses warranting a 3. CBEs: AN values above 3 were associated with confidence-building experiences, and those are summed here as well.

Table 29

Saturated data from analysis of noncategorical uLearning criteria. Theme: Family interactions

Subject ID:	Comments [Interview time code] [R = Repetition of similar comments]
Stu-F-6-5	"There's like times where I want to get my homework done. It's like I think that my parents don't really care about my grades? I get home and it's like, now it's my job to take care of my little brother, clean my room, chores, and whatever. Make her [mom's] life easier, I guess. They both dropped out of high school, so, I don't know. Maybe

Subject ID:	**Comments** [Interview time code] [R = Repetition of similar comments]
	they don't like it when I do better in school than they did." [AN = 1] [00:024:08.590] [R = 2; AN for all responses = 1,1,1]
Stu-M-7-9	"As soon as I got home it was all about chores, helping my brother and sister … basically just helping around the house. It was all fine and whatever, but it meant that I had to do school stuff later. A lot of times I was tired, ya' know? Sometimes I didn't finish school stuff. I needed a break or just went to bed." [00:031:22.100] [AN = 2] [R = 4; AN for all responses = 2,2,2,2]
Stu-M-7-6	"My parents don't really speak English well. So don't talk to them about it. I wouldn't even know how to explain it." [00:32:02.870] [AN = 3] [R = 4; AN for all responses = 3,3,3,3,3]
Stu-F-8-11	"We were talking about, like, the alien thing that we went over in class. She's [mom] is really interested in that sort of stuff." [00:32:25.500] [AN = 4] [R = 4; AN for all responses = 4,4,4,4]
Stu-F-6-1	"I was talking to my dad, who is really into this sort of stuff, and he asked me if I could come to the class, too." [00:35:01.500] [AN = 5] [R = 2; AN for all responses = 5,5,5]
Affect Numbers	(CRE): [Organization AN = 11] (Neut): [Organization AN = 15] (CBE): [Organization AN = 31]
Theme [Family interactions]	**Average Affect Number (AN) Score: 3.0**

Note: Affect numbers were calculated by taking the sum of each category. CREs: Restrictive experiences incurred a value of less than 3. Neutral is the sum of all responses warranting a 3. CBEs: AN values above 3 were associated with confidence-building experiences, and those are summed here as well.

Table 30

Saturated data from the analysis of noncategorical criteria. Theme: External struggles

Subject ID:	**Comments** [Interview time code] [R = Repetition of similar comments]
Stu-M-8-19	"I was going through stuff. My whole world was upside down. Sometimes I had to leave class and walk. It was like … I can't even, right now." [AN = 1] [00:042:00.150] [R = 1; AN for all responses = 1,1]
Stu-F-8-11	"I think part of the problem is that I'm pretty lazy. I'm sure my struggles are kinda my own fault." [00:031:22.100] [AN = 2] [R = 4; AN for all responses = 2,2,2,2]
	Students had either indicated they had no struggles or had not stated that they had external struggles. [AN = 3] [R = 9; AN for all responses = 3,3,3,3,3/3,3,3,3]
Stu-F-7-10	"I was didn't want to do the work because I was like, what does this have to do with chemistry or anything? And then [the instructor] would show how all the stuff in the class goes back to chemistry. Pretty cool." [00:38:05.070] [AN = 4] [R = 2; AN for all responses = 4,4,4]

Subject ID:	**Comments** [Interview time code] [R = Repetition of similar comments]
Stu-F-6-1	A: "As you know, I struggled with some pretty bad social anxiety. It a strength and a weakness." Q: "How do you mean?" A: "The need to feel socially withdrawn, like, makes focusing easier. But only in some classes. This was one of them. I felt, like, I could relax a little and do my work and enjoy the crazy stuff we did in AREA154." [00:31:58.720] [AN = 5] [R = 0; AN for all responses = 5]
Affect Numbers	(CRE): [Organization AN = 10] (Neut): [Organization AN = 27] (CBE): [Organization AN = 17]
Theme [External struggles]	**Average Affect Number (AN) Score: 2.8**

Note: Affect numbers were calculated by taking the sum of each category. CREs: Restrictive experiences incurred a value of less than 3. Neutral is the sum of all responses warranting a 3. CBEs: AN values above 3 were associated with confidence-building experiences, and those are summed here as well.

The theme analysis for instructor influence will be approached a bit differently than the other affect number evaluations. As previously mentioned, these students' instructor was the originator, designer, and implementor of the AREA154: Apocalypse Division uLearning system. Additionally, the instructor has multiple national teaching awards, is a college professor who instructs educational technology, and has 24 years of in-classroom instructional experience. The instructor is highly skilled, and the abilities of an instructor can play a critical role in a program's success. This analysis category attempted to collect data concerning the system's viability without the person who built the program teaching the course. Is it possible that another person could lead students through the curriculum and still provide confidence-building experiences? Initially, the subjects responded with statements indicating that the system could not be run by another instructor. Such answers generated an affect number of 1. Conversely, an affect number of 5 was associated with student statements that seemed confident that with the right training and set of personal traits, the program could absolutely be replicated with similar CBEs.

Table 31

Saturated data from analysis of noncategorical uLearning criteria. Theme: Instructor influence

Subject ID:	**Comments** [Interview time code] [R = Repetition of similar comments]
Stu-M-8-18	"You created that website. But that doesn't mean it's not the same thing. You are the website. You have all the information. You are like the guru of it, like you have all the details." [AN = 1] [00:47:12.490] [R = 2; AN for all responses = 1,1,1,1]
Stu-M-7-14	Q: "Do you think that the Area 154 program Apocalypse Division could be taught successfully by a different teacher?" A: "No. Eh, not the same way." [01:05:15.880] [AN = 2] [R = 4; AN for all responses = 2,2,2,2,2/2,2]
Stu-M-4-3	"Our class was pretty, like, do it yourself. It wouldn't feel the same, that's for sure, but I don't know. I actually don't know if it would work." [AN = 3] [R = 2; AN for all responses = 3,3,3]
Stu-F-6-5	"I think so, because I think everything is there in the videos and, you know, like the PDS and everything. I think it would be possible." [00:35:25.680] [AN = 4] [R = 2; AN for all responses = 4,4,4]
Stu-F-9-7	Q: "Could the AREA154 experience be taught by another teacher?" Q: "Yes, however, you guys [current and any future teachers] need to have a very similar characteristics. And that is to be to make the ability to make it exciting, the way you talk about it, you put yourself in that actual situation. And it's someone that has like a sense of roleplay or someone has a sense of creativity or yeah." [00:52:44.440] [AN = 5] [R = 1; AN for all responses = 5,5]
Affect Numbers	(CRE): [Organization AN = 16] (Neut): [Organization AN = 9] (CBE): [Organization AN = 22]
Theme [Instructor influence]	**Average Affect Number (AN) Score: 2.5**

Note: Affect numbers were calculated by taking the sum of each category. CREs: Restrictive experiences incurred a value of less than 3. Neutral is the sum of all responses warranting a 3. CBEs: AN values above 3 were associated with confidence-building experiences, and those are summed here as well.

Phase III: Theory development

Subject area interest

Observational experience over the three-year implementation period pointed to several examples of students who did not care for the class content or how it was designed. Statements expressing such sentiments were rated with an affect number of 1. The phrase, "Science just isn't my thing," or other variations of this "mildly restrictive" statement, received an affect number of 2. Statements reflecting a favorable view of science or STEM classes were given affect numbers above 3 and up to 5.

Interestingly, no subjects indicated any values below 3. Observational data regarding some of these subjects (included in the student profiles in Phase IV) would suggest that they might have an interest in STEM, though that interest does not appear to be intense enough to inspire productivity. One of the revealing points of this theme centers on the observation that for this subject group, subject-area interest played a role in holding students' attention, and possibly engagement, but not the number of gradable artifacts. Three of the five subjects who responded in a way that warranted an affect number of 5 had some of the lowest overall grades in the class. While the overall theme AN was 4.0, this result is puzzling. It brings up the notion of learning and how learning is evaluated. Two of the subjects with an AN of 5 in this area actually demonstrated interest in the subject outside of class. One of them (Stu-M-4-3) not unexpectedly took an engineering elective the following year and also built a smelting pit to run the thermite reaction in his backyard, something he had learned in one of the AREA154 case files. This subject scored moderately well in the class but not at the top.

Similarly, the second student kept his ATN, finished course content that he had not completed during the school year, developed an interest in electronics, and has continued working with electronic devices since. However, subject Stu-M-7-17 had the third-lowest overall grade in the class. A caveat should be made on the calculation of this AN. Grades are determined by production, and production tendencies are considered to be a very linear-active trait. Lewis (2012) predicts that interest will influence grades in linear-active students because they are psycho-socially programmed to produce. That might explain the mixed results between subject grades (as seen in Phase IV) and indicated interest. The affect number for this theme is **4.0**.

Personal motivations.

Because personal motivations play an influential role in a student's success in school (Krapp, 1999), attention should be paid to how they may have influenced subjects' CBEs in AREA154. The following analysis of the subjects' personal motivations was calculated differently than the previous theme analysis examples. A student who is completely driven by grades would be demonstrating an affect number of 1, essentially signifying that the uLearning AREA154 experience was a lot of noise that got in the way of getting the work done for a grade. An affect number of 5 would be assigned to statements demonstrating that AREA154 and its subsequent uLearning components were the primary motivating force behind the subjects' level of perceived achievement. The following tables present the collective data that reflects the influence of each of these noncategorical characteristics. The affect number for this theme was **3.9**.

Family interactions.

In general, family interactions between the subjects in the study and their families did not appear to affect CBEs in any particular way. The determined affect number of this theme was neutral: AN = 3. Subjects' statements about interactions with their parents strongly suggested that family interactions restricted confidence. For example, evidence of either intentional or unintentional subversion of subjects' interests emerged in how they responded to questions about family interactions. As Stu-M-7-9 mentioned, he believes that his success might feel threatening to his parents. Alternatively, as mentioned in Chapter Two, restrictive behavior suggests that parents may subvert education because they start to feel detached from their children. Whether this holds true or not with Stu-M-7-9 is unknown. Not surprisingly, the language barrier played a role in subjects' willingness to share about their uLearning experiences with their family.

On the opposite end of the support spectrum, some subjects' parents demonstrated support for their AREA154 experience to the point of wanting to attend the class themselves. Interestingly, though, in regard to the subjects who responded to this topic with affect numbers of 5, there is no consistency in achievement for this value. The two subjects whose comments were assigned values of 5 were on polar opposite ends of the achievement spectrum. In contrast, subjects who indicated a restrictive experience with their family were all in the middle or toward the bottom of the overall class grade ranking. The affect number given to this theme was **3.0**.

External struggles.

All students struggle, some more than others. This theme arose from the data that noted codes associated with areas of struggle. The focus here will be to assess the role that the AREA154 uLearning system played in that struggle or how it potentially alleviates the struggle. The results indicated that a notable effect on the student's performance occurs when life outside the classroom applies emotional stress to the student. Almost half of the subjects did not overtly state that they were experiencing any external sources of struggle (beyond what they considered normal). They were therefore ascribed an affect number of 3, indicating that this category had no outside effect on their experience in class. However, about a third of the subject group stated that they were experiencing some form of stress. Two subjects, both male and both at the very bottom of the grade ranking, said they were in the middle of emotional issues that dominated their school experience. An argument could be made that this external factor is responsible for their poor performance. At the time of the interview, both of these subjects stated that they were now in "a better place" and were again enrolled in science classes, both with far better grades than they had earned in the previous year in AREA154. Overall, the analysis of the external factors theme provided a means of assessing the influence that uncontrollable life events could have on the overall affect number for building success and confidence. Though the AREA154 uLearning system did appear to help address some of these challenges, much of what the students experienced was beyond this study's scope. The affect number assigned to this theme was **2.8**.

Instructor's influence.

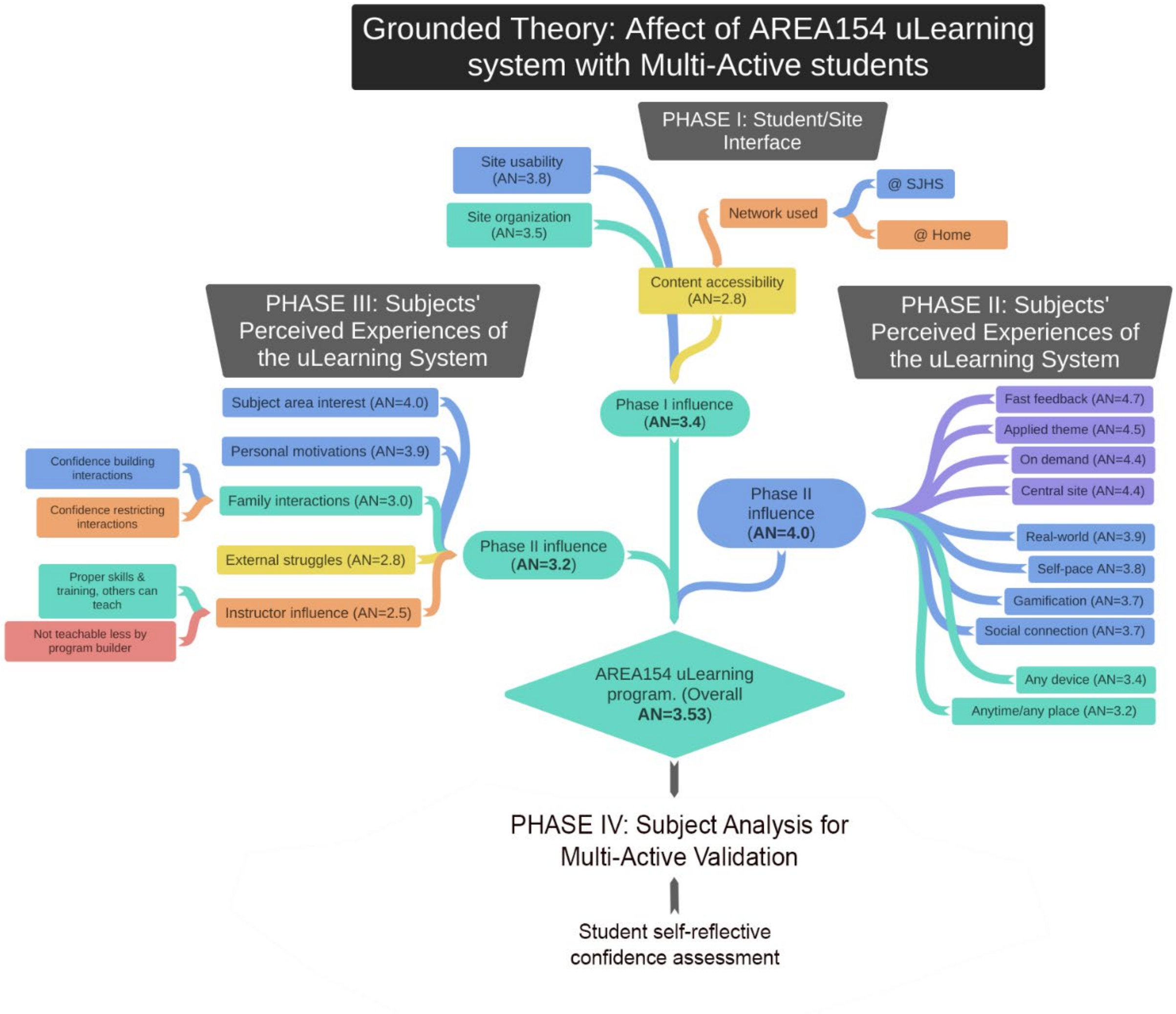
The instructor's impact reinforced previous notions about the teacher's influence on the classroom experience. The vast majority of the study subjects indicated either moderately or with some emphasis that the program could not be taught as well if someone else were leading it. Follow-up questions then probed further, asking subjects if practical training would be enough to allow another instructor to use the program effectively or at least acceptably well. Many of the subjects agreed that with effective training, this could be possible. In her testimony, Stu-F-7-10 stated that different highly skilled science or chemistry teachers who were willing to immerse themselves in the program theme and "explore it with the students" would stand a much better chance of succeeding.

Phase I, II, and III compilation for theory revision

After three phases of analytical cross-checking, the grounded theory took on a new shape. It now includes information concerning subjects' testimonies regarding noncategorical influences that affected their STEM learning experiences. Figure 4.7 below presents the current development of the grounded theory with three phases completed.

Figure 8

Grounded theory developmental evolution through three phases of results



Note: Factors labeled in purple (4.3 – 5.0) and blue (3.6 – 4.2) represent areas of higher confidence- and success-building. Factors in green (3.0 – 3.5) represent a medium-low or neutral degree of confidence- and success-building. Yellow (2.6 – 3.0) represents neutral to medium-low confidence- and success-restricting. Orange (1.8 – 2.5) and red (1.0 – 1.7) represent higher areas of confidence- and success-restriction.

Phase IV: Student profiles, individual experiences, and multi-active behaviors

The study's foundation rests upon the assumption that uLearning systems can prove beneficial to people who display multi-active psycho-social behaviors. Hispanics, according to Lewis (2012), are described as highly multi-active. Phase IV attempts to understand the subjects' identities, assess their multi-active behavioral traits, and present accessible transparent data to validate student testimony about their perceptions of success.

Previous observations of the AERA154 system implementations saw reductions in the student failure rate. Results in this analysis phase also indicated that the decrease of failing grades was not the only nor the most important benefit of the system for the subjects. Study participants had been purposefully selected to represent a wide variety of academic levels of achievement. Conceptual Application Proof – 1 and CAP - 3 aided in incorporating this data into the formulation of the developing grounded theory.

> ***Conceptual Application Proof (CAP) - 1 :*** Students at a variety of different achievement levels demonstrate the ability to experience confidence-building events and these events provide evidence of improved STEM area self-confidence. The theory must be able explain and predict situations where success is and is not experienced.

> ***Conceptual Application Proof (CAP) - 3:*** The students benefiting from the program were classified as Multi-Active through a variety of assessment tools.

Student profiles.

Nineteen students participated in the study. Eighteen were interviewed over Zoom and one responded via a question-and-answer format through district email. Phase IV aimed to validate the assumption that the students who self-identify as Hispanic (American Hispanic) still retain the multi-active psycho-social behavioral traits that Lewis (2012) observed. The subject profiles collected data on all of the following:

- The subjects' fall and spring grades for the 2019 and 2020 semesters.
- All progress report grades demonstrating a path of achievement.
- The final spring semester grade in comparison to spring semester grades for all of the core subject classes.
- Subjects' average login and usage time.

- Memos concerning the subjects' in-class performance and behavioral tendencies during the 2019–2020 school year.
- Data regarding subjects' enrollment in a STEM class the following year.
- Memos concerning the interview observations and context of the interview.
- A list of themes associated with the interview and subjects' experiences.

Student profile data

The student profile data are lengthy and detailed. Much thought and consideration were given about whether or not to maintain the existing continuity of the subjects' profile data. After reading and observing the structure of several other grounded theory dissertations (Clapham, 2012; Catherall, 2017; Greenhaus, 2014), keeping the data visible, transparent, and aligned with the theory development offered clear benefits for the reader. As described by Catherall (2017), GT provides a tour of evidence with twists and turns that let the readers discover the theory as it evolves. The subject profiles act as a sort of checkpoint that presents past and present STEM activity, encouraging the cross-checking of student interview data with their productivity history. In many ways, the two sets of information help complete the picture concerning the relationship between Lewis' multi-active profiles and how the AREA154 uLearning system appeared to promote CBEs. The following extensive list includes all 19 of the subjects' interview profiles. They are arranged in the order of the year-long average grade for the year in which the subjects were enrolled in AREA154.

Table 32

Sample participant performance profile — No. 1-ranking participant

Student ID	Fall Grade %	Spring Grade %	Year-Long Average	Year-Long Trend		Multi-Active Score (max = 11)	AREA154 vs. Other Core Subjects (2nd Sem)	
STU-F-4-1	101.5	105.5	102.3	1QF	A	2	STEM	A+
				2QF	A		Math	A+
				FSG	A+		English	A-

	1QS	A	History	A
	2QS	A+		
	SSG	A+	Previous STEM grade (freshman)	C
			Took STEM course the following year	Yes

	In-Class Login % Over Course Year	Login % at Home Over Course Year
AREA154 Backend Login Frequency (Data extrapolated based on usage across a one-month time frame using "Simple History" WordPress backend plug-in.)	99%	87%
AREA154 Daily Login Duration (Data extrapolated based on usage across a one-month time frame using "Simple History" WordPress backend plug-in.)	48 min/class period	17 min/day

Memos on participant's in-class behaviors: The student demonstrated an exceptional level of quiet and focus. She had one of these most disciplined routines of any of the students in her class, which supports her in-class frequency for class login. She would always arrive in class, open the ATN, and log into the site even if it was not a focal point of the day's activities. It should be noted that this student had an IEP for social anxiety. Apparently it had been worse during her freshman year, which may explain why her grade was so much lower than her grade in AREA154. There is no known official reason for her turnaround during her sophomore year. Her grade in the class was due to her diligence, OCD-type fixation on details for completing her ATN, and the application of achievement points at the end of the grading period. *(Observations recalled from 2019–2020 school year—9 months of class time.)*

Memos from interview & observations: The student has made great strides in gaining confidence within her ability to communicate. This could have occurred because the interview took place over Zoom rather than face-to-face. The subject's responses were clear but short and concise, not displaying much need or desire to expound upon her experience. She noted that the STEM class was one of her favorites and that she would frequently engage in extracurricular research on topics such as the Yellowstone caldera and the possibility of electromagnetically induced zombies. As a video game player, the zombie theme was one of her favorites. The topics of the uLearning program also (according to her mother) served as one of the stepping-stones that helped her learn how to reach out and speak to people around her. According to her mother, as noted in her IEP meeting, she would talk about the content in AREA154 more than anything else from any other class that year. What is rather remarkable is how many specific details she could recall about nuances in the case-file PDFs that I had forgotten about—things that clearly had made an impact on her. She noted that when we used professional material to block EM, it only worked if the phone was completely enveloped in it. Even the tiniest hole would cause the phone to ring. (*Interview time: 73 min.*)

Codes: *Attentive-focused, multi-linear non-conformant (MLNC), achiever-type, grade-motivated, science-minded, positive psycho-social integration (+PSS), curious, atypical, top grade (tied with one other classmate), family-share, better than frosh, 2ndS>1stS, confident, family-centered, routine-centered.*

Note: The student ID – Stu – gender – multi-active rating – STEM GPA ranking among participants.

Table 33

Participant performance profile – No. 2 Ranking Participant

Student ID	Fall Grade %	Spring Grade %	Year-long Average	Year-long trend		Multi-Active Score (max=11)	AREA154 vs. other core subjects (2nd Sem)	
STU-F-6-2	99.1	97.1	98.1	1QF	A	6	STEM	A+
				2QF	A		Math	A+
				FSG	A+		Adv English	A
				1QS	A		History	A
				2QS	A			
				SSG	A		Previous STEM Grade (Freshman)	A

		Took STEM course following year	Yes

AREA154 backend log-in frequency: (Data extrapolated based on usage across a one month time frame using "Simple History" WordPress backend plug-in.)	In-class Login % over course year	Login % at home over course year
	94%	88%
AREA154 Daily log-in duration: (Data extrapolated based on usage across a one month time frame using "Simple History" WordPress backend plug-in.)	38 min	25 min

Memos on participant's in-class behaviors: This subject demonstrated a high degree of focus on achievement. Much of that achievement drive seems to stem from the mother who works as a manager at a large company (somewhere in Corona, Ca – student was unclear on precisely what parent did for a living). I received several emails from the parent over the course of the year any time attendance or grades appeared to become an issue. Subject would be considered highly managed, but also provides a sensation that she longs for the social interaction that her home life seems to constrain. Often very talkative in class with peers. She seemed not to get as much done in class. Instead, she would complete most of her work at home – as evidence of the at-home logins and the timestamps provided by the SRTs taken across the year. (Observations recalled from 2019-2020 school year – 9 months of class time.)

Memos from interview & observations: Student was very talkative despite her statements to the contrary about "only talking when she felt she needed to do so. Her answers were honest and straight-forward. She did not appear to be a fan of the Examulations due to the shifting of the teams. She was quite comfortable with the table group she was placed with over the course of the year. As she had risen in rank to "Special Agent" she would always move her seat back to the location with one or more of her in-class social associates. Her social tendencies (she responded to her phone twice during the interview) seemed to only be curbed by the ridged influence her mother has in her life. She was also on a computer rather than the school-provided Chromebook. This indicates that this subject may be in a higher strata of socioeconomic influence than her peers. There did not appear to be any indication that she did any extracurricular research on the program topics. Subject is intelligent and socially savvy. Her recall, in my opinion, should be better given her "earned" grade. Her interview left me with the feeling that she was more involved with the sort of behavior associated with a term well-trained students use to pass classes they lack a specific interest in called "learn and burn". Learn it for when you need it, then burn it down forever, or something to that effect. (Interview time: 83 min)

Codes: *MomManaged, focused, Multi-Linear non-conformant (MLNC), SeeminglyIntelligent, Social, Multi-Linear non-conformant (MLNC), Forced- Positive Psycho-social Integration (F+PPI), Top Grade (Tied with one other class), Confidence, Routine-centered*

Note: The student ID – Stu – gender - Multi-Active rating – STEM GPA ranking among participants

Table 34

Participant performance profile – No. 3 Ranking Participant

Student ID	Fall Grade %	Spring Grade %	Year-long Average	Year-long trend		Multi-Active Score (max=11)	AREA154 vs. other core subjects (2nd Sem)	
STU-M-4-3	88.8	99.5	94.2	1QF	A-	4	STEM	A+
				2QF	A-		Math	A-
				FSG	B		English	A

	1QS	B	History	A-
	2QS	A		
	SSG	A+	Previous STEM Grade (Freshman)	B
			Took STEM course following year	Yes*

AREA154 backend log-in frequency: (Data extrapolated based on usage across a one month time frame using "Simple History" WordPress backend plug-in.)	In-class Login % over course year	Login % at home over course year
	84%	62%
AREA154 Daily log-in duration: (Data extrapolated based on usage across a one month time frame using "Simple History" WordPress backend plug-in.)	49 min	30 min

Memos on participant's in-class behaviors: Participant was highly respectful, largely quiet, would volunteer to get involved with class discussions however only when no one else was willing to do so. He was heavily involved with Air Force ROTC as was the rest of his table. They would often collaborate as a team. However, after significant observation time it became clear that this subject was the driving force behind the work. While he spend time talking about the random subject content offered up by peers at the table, he was usually the one that put everyone back on task, with a little help from the instructor. When the group was separated, the other two (also in AF ROTC) would suffer large drops in productivity. One of them would simply stop and engage in distracting activities during most of the period. It should be noted that the summer after class let out, subject requested the reactants to initiate the Thermite reaction, a reaction he learned about during the Alien invasion. He dug a two-foot by two-foot by two-foot hole and successfully ran the reaction. He recorded the process and sent me the images. His dedication and willingness to apply knowledge outside the classroom is rare – or it is at least rare for them to do it and then send pictures of their "achievements".(Observations recalled from 2019-2020 school year – 9 months of class time.)

Memos from interview & observations: The interview took place in what looked like a "study". Pictures of military aircraft hung on the walls and what appeared to be framed medals were on a bookshelf next to books that were too far away to see the title. After some pre-interview questioning, subject revealed that his family had been in the military in some form for the last 3 generations. The structure that is brought about by having a military family might explain why this subject scored so low on the Multi-Active scale. While his immediate and extended family appeared to identify with Hispanic psycho-social behaviors, the military appears to have provided some form of assimilation that is more synchronous with the school culture that is so prevalent in US schools. Subject discussed how he would often do work at home because he was comfortable with the AREA154 system and that may explain why he was able to converse in class yet appear to keep his grades up. (*Interview time: 65 min*)

Codes: *Managed, focused, SeeminglyIntelligent, disciplined, ROTC, Social, Multi-Linear non-conformant (MLNC), Forced-Positive Psycho-social Integration (+PSI), Routine-centered, Top Grade, Better than frosh, 2ndS>1stS, Extra-effort, Confidence, Atypical*

Note: The student ID – Stu – gender - Multi-Active rating – STEM GPA ranking among participants

* Chose to take physics and additional STEM engineering class

Table 36

Participant performance profile – No. 4 Ranking Participant

Student ID	Fall Grade %	Spring Grade %	Year-long Average	Year-long trend	Multi-Active Score (max=11)	AREA154 vs. other core subjects
STU-F-8-4	92.1	93.5	92.8	1QF A+ 2QF A FSG A- 1QS B+ 2QS A SSG A	8	STEM A Math A English B History A- Previous STEM Grade (Freshman) A Took STEM course following year Yes**

	In-class Login % over course year	Login % at home over course year
AREA154 backend log-in frequency: (Data extrapolated based on usage across a one month time frame using "Simple History" WordPress backend plug-in.)	89%	55%
AREA154 Daily log-in duration: (Data extrapolated based on usage across a one month time frame using "Simple History" WordPress backend plug-in.)	39 min	22 min

Memos on participant's in-class behaviors: Participant was notably social and had to be moved once during the course of the year, not for her own sake, but for the sake of others. She noted that she was skilled at catching up at home when she needed to do so. This was not so much the case with the other to students. The would get so caught up in the conversation that the socialization dominated their full attention. Subject was also a part of that, however, her rather disciplined nature proved to overcome that obstacle. Participant demonstrated well-developed coping mechanisms for home and school. *(Observations recalled from 2019-2020 school year – 9 months of class time.)*

Memos from interview & observations: Subject demonstrate some hesitance with the interview, maybe just nervous. She appeared to be honest but her very considerate nature may require me to go back and use that as a filter as coding of her comments about the uLearning system is completed. During the interview, it was noted that she was responsible for two younger siblings. Often times getting them taken care of and assisting her Mother would take priority and she would often be left to do school related business later at night. As the oldest of three she appears to have taken on a bit of a "sister mom" role. Both parents worked and as the oldest and assumed to be most capable, she was tasked to take on more responsibilities than her siblings. When asked, she said she didn't seem to mind, rather "It just is what it is." Reflecting on her statement, it seems to tightly align with Lewis' observations about Hispanic cultures, family priorities, and the easy-going nature when confronted with changes in plans. Subject demonstrated active recall of past casefile information with impressive accuracy and frequency. (*Interview time: 61 min*)

Codes: *Sister-mom, disciplined, Family-focused, Social, Positive Psycho-social Integration (+PSI), Achiever, First-born, Top Grade (tied with one other class), 2ndS>1stS, (~)Emotional Gratification.*

Note: The student ID – Stu – gender - Multi-Active rating – STEM GPA ranking among participants

** Student was in Bio-Med pathway and had to take Bio-Med II as part of the program

Table 37

Participant performance profile – No. 5 Ranking Participant

Student ID	Fall Grade %	Spring Grade %	Year-long Average	Year-long trend	Multi-Active Score (max=11)	AREA154 vs. other core subjects (2nd Sem)
STU-F-6-5	88.5	95.2	91.9	1QF B- 2QF B FSG A- 1QS C 2QS A SSG A	6	STEM A Math B- English C History D- Previous STEM Grade (Freshman) C Took STEM course following year Yes

	In-class Login % over course year	Login % at home over course year
AREA154 backend log-in frequency: (Data extrapolated based on usage across a one month time frame using “Simple History” WordPress backend plug-in.)	91%	25%
AREA154 Daily log-in duration: (Data extrapolated based on usage across a one month time frame using “Simple History” WordPress backend plug-in.)	51 min	5 min

Memos on participant’s in-class behaviors: Participant did not leave much of an impression across the year. Quiet, reserved, task-minded, she was not very conversational (perhaps due to some issue with her conversational English: No, just checked Aeries database and she was advanced for language development). There is no recollection of her talking with anyone, she was on task whenever she was observed in her table teams. Also, she would appear to work alone during Examulations. Though, this sort of action was normal among students that had a completed ATN and knew how to survive. Well-prepared students often refused to share. Other than these, recollections of this student are vague. *(Observations recalled from 2019-2020 school year – 9 months of class time.)*

Memos from interview & observations: Often times during the interview I would get the feeling that she would stop and rephrase or say something that wasn’t entirely the full response due to a cultural imperative to respect the feelings of others. She had an older brother that had moved out of the home. As she was the oldest sibling many of the chores that the mom would do were passed to her. As such, after school time was often dominated with family-related issues. The parents both appear to be in blue-collar type work (subject stated parents work at night – non-typical of white-collar work hours) He final grade in AREA154 was notably higher than her other subjects. Something – yet unclear – about this environment that promoted her success. Subject’s recall of events during the year lacked specific detail, however, she was clear about her interest in the class and how she felt about being a part of the class; it appeared to have a positive impact on her. (*Interview time: 55 min*)

Codes: *Sister-mom, Interest-driven(?), Family-focused, Non-social, Positive Psycho-social synchronization (+PSS), Achiever, Second born (oldest currently at home), Blue-collar parents, Top grade, (~)Multi-Linear Conformant ((~)MLC), Better than frosh, 2ndS>1stS*

Note: The student ID – Stu – gender - Multi-Active rating – STEM GPA ranking among participants

Table 38

Participant performance profile – No. 6 Ranking Participant

Student ID	Fall Grade %	Spring Grade %	Year-long Average	Year-long trend	Multi-Active Score (max=11)	AREA154 vs. other core subjects (2nd Sem)

STU-F-7-6	90.2	92.3	91.3	1QF B- 2QF B- FSG A- 1QS A+ 2QS B+ SSG A-	7	STEM A- Math C- English A+ History B- Previous STEM Grade (Soph. Bio Med I) B Took STEM course following year Yes**

	In-class Login % over course year	Login % at home over course year
AREA154 backend log-in frequency: (Data extrapolated based on usage across a one month time frame using "Simple History" WordPress backend plug-in.)	82%	15%
AREA154 Daily log-in duration: (Data extrapolated based on usage across a one month time frame using "Simple History" WordPress backend plug-in.)	33 min	23 min

Memos on participant's in-class behaviors: Participant demonstrated intermittent times of focus and attention to time-dependent tasks. She had a propensity to put off in class content in favor of socializing with the team at her table. She was a cooperative student and minded classroom authority. On every occasion where she was reminded that there was work to be completed, she responded. However, her peers were less cooperative and would tend to draw her out into discussion eventually. She was a year older (11th grade) than most of the students in the class (typically 10th graders), and perhaps that made her presence there a bit of novelty. She displayed above-average interest and curiosity about the AREA154 themes. She would often leave her table team and ask questions about the implications of the assumptions made within the case files. *(Observations recalled from 2019-2020 school year – 9 months of class time.)*

Memos from interview & observations: The interview was on her phone because the internet was not a solid connection. All her previous science experiences in high school were BioMed classes. Nothing else. She discussed how science classes were always overwhelming for her (a possible perception that she couldn't do well or lacked confidence). In general she spoke casually about being "bored" with traditional classes and asked about why teachers don't take applicability into account when planning curriculum. She assumed it was part of her job. I spoke to her about how most teachers teach how they learn and that over the last 15 years, the brain wiring has changed significantly due to growing up with the internet and the avalanche of media. Her older sister was in the room during the call and subject would often turn to her for approval (assumed) when she was answering questions about her own opinions about elements of the AREA154 program. (*Interview time: 72 min*)

Codes: *Family focused, Respectful, Social, Negative Psycho-social Synchronization, Second-Top Grade, Interest, Curiosity, Multi-Linear Conformant (MLC), Parents-Non English, Better than frosh, 2ndS>1stS, Emotional Gratification*

Note: The student ID – Stu – gender - Multi-Active rating – STEM GPA ranking among participants

** Student was in Bio-Med pathway and had to take Bio-Med II as part of the program

Table 39

Participant performance profile – No. 7 Ranking Participant

Student ID	Fall Grade %	Spring Grade %	Year-long Average	Year-long trend	Multi-Active Score (max=11)	AREA154 vs. other core subjects (2nd Sem)
STU-F-9-7	90.1	92.3	90.8	1QF B-	7	STEM A-

	2QF B- FSG A- 1QS A+ 2QS B+ SSG A-	Math A- English B+ History B- Previous STEM Grade (Soph. Bio Med I) B Took STEM course following year No***
AREA154 backend log-in frequency: (Data extrapolated based on usage across a one month time frame using “Simple History” WordPress backend plug-in.)	In-class Login % over course year 95%	Login % at home over course year 45%
AREA154 Daily log-in duration: (Data extrapolated based on usage across a one month time frame using “Simple History” WordPress backend plug-in.)	48 min	36 min
Memos on participant’s in-class behaviors: Participant entered the class after three weeks into the school year. It was recommended to her by her previous high school math teacher that she move to a school that offered more resources to match her potential academically. Subject displayed all of the model behaviors of a “good student.” She was cooperative and responsive to correction. The student was more motivated by the act of learning interesting information than she was interested in grades for the sake of getting good grades. She was a senior, the only senior in the class, and her level of maturity may have contributed to her rather Linear-Active behaviors, even though most of her family appeared to be very closely attenuated to Lewis’ assumptions about Hispanic psycho-social behavior. Parents worked blue-collar jobs – I recall something about her mom working odd hours at the post office and how she was often responsible for taking care of her younger sister. *(Observations recalled from 2019-2020 school year – 9 months of class time.)*		
Memos from interview & observations: After the cultural interview segment, both subject tended to show tendencies toward Linear behaviors. Subject stated in a follow-up to the cultural questions that she is considered “cold” by her family as she appears to present more logic than feelings. She additionally noted that she was the outlier in that sense from the rest of her family. She noted during the interview that she would take her phone with her on family picnics and work on AREA154 content. She stated it was for two reasons, she was highly interested in the content, and she enjoyed sharing it with an equally interested younger cousin who would frequently ask her about the course content. The very notion that she would take classwork to a family gathering would tend to suggest that she sees herself as a sort of cultural outsider. Her curiosity about the course content and her willingness to now question everything (which she stemmed from the AREA154 course). Teachers from her previous school Baypoint Academy (her math teacher specifically) stated that this particular student had an academic aptitude that far exceeded anyone in her class. For that reason, she was encouraged to transfer from Baypoint to San Jacinto High School. During the interview, subject demonstrated a rather impressive command over her recall of specific elements of the AREA154 program. She noted the content more specifically associate with casefiles that had a sort of “bigger than life” feel and induced a sense of anxiety. It appears the anxiety both drove her curiosity, and knowing more allowed her to gain command over that anxious feeling. This forced feedback loop seems to assist in giving rise to her attitude towards questioning everything, especially the mainstream media. (*Interview time: 80 min*)		
Codes: *Family-focused, Respectful, Social, Positive Psycho-social Integration (+PPI), Top Grade, Interest, High-Curiosity, Changed World-View, High Multi-Linear Conformant (HMLC), Family-Share, Better than frosh, 2ndS>1stS, Remote access, Atypical*		

Note: The student ID – Stu – gender - Multi-Active rating – STEM GPA ranking among participants
*** Subject was a Senior

Table 40

Participant performance profile – No. 8 Ranking Participant

Student ID	Fall Grade %	Spring Grade %	Year-long Average	Year-long trend	Multi-Active Score (max=11)	AREA154 vs. other core subjects (2nd Sem)
STU-M-9-8	82.1	90.8	86.5	1QF B+ 2QF B FSG B- 1QS A 2QS A- SSG A-	8	STEM A- Math D English A+ History A- Previous STEM Grade (Freshman) C Took STEM course following year Yes

	In-class Login % over course year	Login % at home over course year
AREA154 backend log-in frequency: (Data extrapolated based on usage across a one month time frame using “Simple History” WordPress backend plug-in.)	64%	44%
AREA154 Daily log-in duration: (Data extrapolated based on usage across a one month time frame using “Simple History” WordPress backend plug-in.)	36 min	25 min

Memos on participant’s in-class behaviors: Subject was a minimalist (as memory serves) when it came to achievement. He sat with a group of friends within the class and tended to fall back on some of them for work sometimes (maybe more often than was indicated in the interview). His ATN was often sloppy and had the condensed appearance of being summarized or possibly copied from someone else. He would often only write partial sentences as answers (despite being told many times not to do that). After his first Examulation – where he was killed within the first 4 months – it dawned on him that he ought to be more mindful of having a complete ATN. I think this was even noted in the interview recording. Despite the realization, he would default back to his prior lowest-possible-effort methodologies. He sat with one of the other participants in this study and was often seen attempting to coerce help from his fellow ROTC friends. According to the backend data on the AREA154 site, the only Examulation this subject passed was the one where he was partnered with one of his ROTC friends. II would imagine it was the same friend who was helping him during class so often. Behaviors often were swayed by what “felt good to do at the time” influenced by a need for instant gratification. This impulse usually led to heavily off-topic subjects of discussion. *(Observations recalled from 2019-2020 school year – 9 months of class time.)*

Memos from interview & observations: Subject indicated that he was pretty good with the examulations, and that would need to be verified with Aeries (Verified 2/7/21 he passed 2/3 examulations). He had distinct career goals with a focus on getting into the Air Force. There was no face recording on this interview. I do not think that will impact any of the findings. He did however, indicate that he had a willingness to please and keep the emotionally positive elements of the relationship in play. I have a feeling that there was some of that in this interview. After validating some of the statements made about the Examulation it does not appear that he had any intention to misrepresent any of the information he provided. From time to time when subject would speak during the interview loud voices of children and shouting parent could be heard in background. There may be a reason why subject appeared distant and agitated. Perhaps home is not the place of peace it is for many students. (*Interview time: 54 min*)

Codes: *(~) priorities, Respectful, ROTC, Social, Second Top Grade, Minimalist, User, High Multi-Linear conformant (HMLC), Feeling-based logic, Trouble@Home, Better than frosh, 2ndS>1stS, 2ndSemResurgence*

Note: The student ID – Stu – gender - Multi-Active rating – STEM GPA ranking among participants

Table 41

Participant performance profile – No. 9 Ranking Participant

Student ID	Fall Grade %	Spring Grade %	Year-long Average	Year-long trend	Multi-Active Score (max=11)	AREA154 vs. other core subjects (2nd Sem)	
STU-M-7-9	82.5	88.6	85.6	1QF A 2QF B FSG B 1QS A 2QS B SSG B	7	STEM Math English History Previous STEM Grade (Freshman) Took STEM course following year	B C B- C C- Yes

	In-class Login % over course year	Login % at home over course year
AREA154 backend log-in frequency: (Data extrapolated based on usage across a one month time frame using "Simple History" WordPress backend plug-in.)	79%	31%
AREA154 Daily log-in duration: (Data extrapolated based on usage across a one month time frame using "Simple History" WordPress backend plug-in.)	45 min	19 min

Memos on participant's in-class behaviors: Subject demonstrated a quiet and cooperative demeanor across the course of the year. He was not notable academically however, his curiosity was something to be admired. More than just about any other student subject would stay in at lunches and breaks to engage in conversation about class topics and topics connected to those covered in the AREA154 program. Even the following year he would come and find me from across campus to ask questions that he had come up with. The student appeared to be much more of a thinker than a doer. Not driven so much by the list-driven nature of typical classes, but more so driving by things that made him curious, content that created dissonance in his mind. Also of note, his use of retakes was a little higher than most and often had to be reminded of missing work. *(Observations recalled from 2019-2020 school year – 9 months of class time.)*

Memos from interview & observations: Subject is currently a senior and changed physically, as expected. His answers were straightforward and short. He was enthusiastic about participating in the interview process and when prompted to provide more information he did so without any hesitation. I think he nature is to be brief. His family does not appear to have the same characteristic. The interview was interrupted 3 times (once by mother and twice by younger sister). Guessing, I think the sister came in because as subject stated in his interview, he often spoke to his younger sister and older brother about the class and they would often times carry on lengthy discussions over various AREA154 and related topics. Additionally, the little sister waved at the camera, perhaps aware of who was on the other side. When asked about if he share with his parents,

he stated, “They don’t really speak English well, so as long as my grades look good. They are pretty hands-off with school.” (*Interview time: 78 min*)
Codes: *High Curiosity, Multi-Linear conformant (MLC), Parents-No English, Top Grade, Family-Share, Better than frosh, Emotional gratification*

Note: The student ID – Stu – gender - Multi-Active rating – STEM GPA ranking among participants

Table 42

Participant performance profile – No. 10 Ranking Participant

Student ID	Fall Grade %	Spring Grade %	Year-long Average	Year-long trend		Multi-Active Score (max=11)	AREA154 vs. other core subjects (2nd Sem)	
STU-F-7-10	77.1	92.2	84.9	1QF	D-	y	STEM	A-
				2QF	D-		Math	B
				FSG	C		English	B+
				1QS	A+		History	A-
				2QS	A-			
				SSG	A-		Previous STEM Grade (Freshman)	D+
							Took STEM course following year	Yes

	In-class Login % over course year	Login % at home over course year
AREA154 backend log-in frequency: (Data extrapolated based on usage across a one month time frame using “Simple History” WordPress backend plug-in.)	65%	15%
AREA154 Daily log-in duration: (Data extrapolated based on usage across a one month time frame using “Simple History” WordPress backend plug-in.)	32 min	11 min

Memos on participant’s in-class behaviors: Subject demonstrated highly social tendencies. She appeared to respond well to being redirected back to work, was pleasant about the interaction – all the time. However, her level of distractibility and impulse into engaging into emotionally rewarding activities (socialization) may be the reason why she displayed such poor grades. While she was interested in our conversations during class discussions. As long as there was a “story” to be heard, she was completely focused. During class discussions, she was one of the students with the greatest degree of interaction with the instructor. However, it is at the beginning of the program where one comes to understand how the system works. Miss out on that, and her comments about how the system was “hard to understand” may start to make sense. She demonstrated a high degree of interpersonal intelligence and was often the target of table partners who needed assistance. She did not demonstrate much of the traditional “success” behaviors that would be associated with students who demonstrate high marks. She seemed to want to learn for the sake of learning but had less interest in doing the work associated with proving she learned something. However, after the first Examulation she “died” because she was not prepared. She displayed visible signs of worry. That may have been the precursor that led to the performance turnaround during the second semester. *(Observations recalled from 2019-2020 school year – 9 months of class time.)*
Memos from interview & observations: Subject was very positive and accommodating during the interview. She appeared to demonstrate “respect reflex” and provide answers that might demonstrate answers that I would want to hear rather than the

blunt truth of the matter. On several occasions, she was able to identify areas of study and general topics but could not really identify much of the specifics. She stated that the course content and how it was presented encouraged her to look up and further study topics in a way that no class (especially STEM) had done before. It could be that her intense social behavior at the beginning of the year was due to her discomfort with her previous science experiences. She did not that she experienced some anxiety with taking chemistry because "everyone said it was super hard and boring." The interview went longer than expected due to being interrupted twice by mom that needed her for assistance with something. She's the oldest in the family of 3 kids, and it would be logical to suggest that she constantly gets pulled into being a sister-mom to help raise the younger siblings. Being busy with family affairs would explain why so little work appears to have been done at home. She also noted that she excitedly shared class content with mom. Dad worked nights and was not around much. (*Interview time: 92 min*)

Codes: *High Curiosity, Multi-Linear conformant (MLC), Sister-mom, Top Grade, Family-Share, Better than frosh, 2ndS>1stS, Emotional gratification, 2ndSemResurgence, Confidence, Family focused, Social*

Note: The student ID – Stu – gender - Multi-Active rating – STEM GPA ranking among participants

Table 43

Participant performance profile – No. 11 Ranking Participant

Student ID	Fall Grade %	Spring Grade %	Year-long Average	Year-long trend		Multi-Active Score (max=11)	AREA154 vs. other core subjects (2nd Sem)	
STU-F-7-11	78.8	88.4	83.6	1QF	F	8	STEM	B+
				2QF	C		Math	A
				FSG	C+		English	A-
				1QS	A+		History	B-
				2QS	B			
				SSG	B+		Previous STEM Grade (Freshman)	B
							Took STEM course following year	Yes

	In-class Login % over course year	Login % at home over course year
AREA154 backend log-in frequency: (Data extrapolated based on usage across a one month time frame using "Simple History" WordPress backend plug-in.)	98%	9%
AREA154 Daily log-in duration: (Data extrapolated based on usage across a one month time frame using "Simple History" WordPress backend plug-in.)	51 min	8 min

Memos on participant's in-class behaviors: Student presented what one might call "average social tendencies" for a sophomore at SJHS. She was on topic when asked, but very frequently was pulled off task but interactions with technology and table team members. Of note, she was always in class early (perhaps had a class nearby) and appeared to be prepped up and ready to go for the class period (logged into the site, ATN out). Additionally, she did very little at home. If there was any work to be done, then it was done during school. She was quiet about home life and opted to talk about current events, the topics of interest connected to the class, or video games. Also of note, subject was gone from class for about two weeks where she was able to keep up while on the road and at the airport. She noted once before class that she was at the airport in the back of her mom's car and needed to know what was due. *(Observations recalled from 2019-2020 school year – 9 months of class time.)*

Memos from interview & observations: Subject was verbose during the interview. While not confirmed, the conversation seemed to drag on in a manner befitting a person who was relieved to be in the interview and not somewhere else. Subject talked about issues with site organization at the beginning of the term, but once she, in her words, "actually started to pay attention" she noted that the organization of the site was quite easy to follow. No follow-up questions were used to discuss why she felt paying attention to the class at the beginning was difficult. Subject noted that her family had uprooted due to financial issues, though did not disclose when this happened or why it happened. (*Interview time: 88 min*)

Codes: *Social, Interested, Multi-Linear conformant (MLC), Parents-No English, Better than frosh, 2ndS>1stS, Trouble@Home, Remote access, Confidence, Family-focused*

Note: The student ID – Stu – gender - Multi-Active rating – STEM GPA ranking among participants

Table 44

Participant performance profile – No. 12 Ranking Participant

Student ID	Fall Grade %	Spring Grade %	Year-long Average	Year-long trend	Multi-Active Score (max=11)	AREA154 vs. other core subjects (2nd Sem)
STU-F-7-12	72.7	91.6	82.1	1QF D 2QF D- FSG C- 1QS A+ 2QS A- SSG A-	8	STEM A- Math A English C History B- Previous STEM Grade (Freshman) C- Took STEM course following year Yes

	In-class Login % over course year	Login % at home over course year
AREA154 backend log-in frequency: (Data extrapolated based on usage across a one month time frame using "Simple History" WordPress backend plug-in.)	75%	39%
AREA154 Daily log-in duration: (Data extrapolated based on usage across a one month time frame using "Simple History" WordPress backend plug-in.)	51 min	17 min

Memos on participant's in-class behaviors: This subject was unusually quiet when compared to her female peers in the room. She was easy to look over as she did not participate in open class discussions. If she had questions that were few to none in the first semester. There was no data regarding her stand-0ffish behavior. Judging by her first semester grades (not shown, as she displayed an anomalous behavior, her first semester grades were acquired) she appeared to have something going on at school or at home that seemed to decimate her ability to do work at school. Her ATN was usually in good order and indicative of someone who paid attention to directions (second semester), though it was unclear what was the source of the disturbance. Upon consulting the site backend data, subject never "survived" any of the Examulations. This could have been do to some issues with English, as I often found it necessary to repeat or restate information to make sure she understood the information at hand. The fact that she seemed to struggle with English sometimes could indicate that no one speaks it at home. It could also be that people who are under lots of emotional trauma have very limited short-term memories and cognitive process abilities. That could also explain her need to have things re-explained. *(Observations recalled from 2018-2019 school year – 9 months of class time.)*

Memos from interview & observations: Subject was more open and verbose than when she was enrolled in AREA154. She appeared genuine with her answers, though they were vague and lacked the sort of detail that one might know if they really did remember as much as they claim they did. She was very enthusiastic about the content and being interested in what was going on. However, her responses indicate that she may have "felt" she learned a lot emotionally, but when asked to articulate specifics, the details were very sparse. She also noted that during the Examulations she would not interact with the others in the group she felt that she did the work and did not want to share information when they did not earn it nor have anything to trade in return for her assistance during this "group" test. (*Interview time: 53 min*)

Codes: Non-s*ocial, Interested, Multi-Linear conformant (MLC), Parents-NoEnglish(?), Trouble@Home, Better than frosh, 2ndS>1stS, 2ndSemResurgence, Confidence, Family focused, Social*

Note: The student ID – Stu – gender - Multi-Active rating – STEM GPA ranking among participants

Table 45

Participant performance profile – No. 13 Ranking Participant

Student ID	Fall Grade %	Spring Grade %	Year-long Average	Year-long trend		Multi-Active Score (max=11)	AREA154 vs. other core subjects (2nd Sem)	
STU-F-7-13	91.1	72.8	82.0	1QF	A	7	STEM	C
				2QF	A-		Math	D-
				FSG	A-		English	A
				1QS	C		History	C
				2QS	C			
				SSG	C		Previous STEM Grade (Freshman)	A
							Took STEM course following year	No****

	In-class Login % over course year	Login % at home over course year
AREA154 backend log-in frequency: (Data extrapolated based on usage across a one month time frame using "Simple History" WordPress backend plug-in.)	UNK	UNK
AREA154 Daily log-in duration: (Data extrapolated based on usage across a one month time frame using "Simple History" WordPress backend plug-in.)	UNK min	UNK min

Memos on participant's in-class behaviors: The subject demonstrated some real potential cognitively. She was not only fluent in Spanish, truly seemed to enjoy her Hispanic roots, but had near-perfect Linear-Active integration socially. She was an achiever and been used to being the "teachers pet," as she would put it. She came into the school three weeks late and was acclimated as quickly as possible. Frankly, in 25 years of teaching, never has a student become so seemingly comfortable with her surroundings as she did. She displayed a high degree of comfort within the AREA154 environment. She enjoyed the topics and the intellectual challenge it posed to her. She liked to argue; it was fun for her. Not aggressively, but more like cognitive gymnastics. After spending many lunches in the AREA154 classroom with other students, she devolved that she had been "relocated" by her father from central California to live at her aunt's house in San Jacinto, over a weekend trip. Her and her little brother had to leave everything they owned behind. According to the subject, they would be able to get their stuff sent down later. She was never given a reason. Across many discussions with her, the details appeared to be very questionable

surrounding her father's "means of income." One could only speculate the sort of environment she was in on a daily basis. On her last day of school, she simply said I have to go. My father said I could come and say good-bye to anyone I wanted to. She deleted her AREA154 student account (losing all of the backend data.) I have been in email contact with her off and on over the last semester. She agreed to talk about her experiences with the AREA154 program. However, she couldn't be recorded or be on camera. The questions were sent to her, and she sent back a written document containing information used in lieu of the interview. *(Observations recalled from 2019-2020 school year – 8 months of class time.)*
Memos from interview & observations: Not a recorded interview, rather subject requested to not be on video or audio or be recorded. She was willing to share her thoughts in a written response. The document was coherent and well written. She did from time to time say that she loved to write – as demonstrated by her A in English. She did note that her experience in AREA154 was exceptional and beyond any learning experience she had ever had. She noted herself as "not a science-minded person"; however, due to the non-traditional nature of the class, she found it to be quite beneficial. (*Interview time: 0 min*)
Codes: *Attentive-focused, Interested, Multi-Linear conformant (MLC), Trouble@Home, Positive Psycho-social integration (+PPI), Family-focused, Respectful, Atypical, Seemingly-Intelligent, Mentor, Social*

Note: The student ID – Stu – gender - Multi-Active rating – STEM GPA ranking among participants
****Left school district for undisclosed reasons. Current schedule is unknown.

Table 46

Participant performance profile – No. 14 Ranking Participant

Student ID	Fall Grade %	Spring Grade %	Year-long Average	Year-long trend	Multi-Active Score (max=11)	AREA154 vs. other core subjects (2nd Sem)
STU-M-7-14	72.1	91.4	81.8	1QF D+ 2QF C- FSG C- 1QS A+ 2QS A- SSG A-	7	STEM A- Math A English B History B- Previous STEM Grade (Freshman) D Took STEM course following year Yes

	In-class Login % over course year	Login % at home over course year
AREA154 backend log-in frequency: (Data extrapolated based on usage across a one month time frame using "Simple History" WordPress backend plug-in.)	47% (1st sem = 21% 2nd sem = 79%)	35%
AREA154 Daily log-in duration: (Data extrapolated based on usage across a one month time frame using "Simple History" WordPress backend plug-in.)	45 min (1st sem = 38 min 2nd sem = 52 min)	10 min

Memos on participant's in-class behaviors: The subject is highly subject to motivation via his personal interests. If he isn't interested in the class or assignment, the work automatically is placed as a very low priority. In class subject demonstrated high levels of curiosity beyond the average student. Despite his curious nature and solid questioning abilities, he did not respond to his potential until the beginning of the second term at the beginning of the Alien invasion unit. After that, he demonstrated a completely different set of academic priorities. *(Observations recalled from 2019-2020 school year – 9 months of class time.)*

Memos from interview & observations: Subject demonstrated significant interest in music and made note that while they were very interested in the class, they were not so motivated to do the "work" part of school Subject appeared to be very interested in following "fun" things after school. He said "partying" and such. Typically, when the students would refer to these sorts of activities, it was a subtle way to convey a collection of people getting high together. This assertion is unconfirmed. However, anecdotal evidence would seem to suggest this to be true. During the interview, he noted that after fir first semester the Alien invasion case file caught his attention in a way that the other case files had not (for reasons that are not clear). At that point, he refocused his efforts and appeared to improve his level of success dramatically. Subject demonstrates behaviors more like that of a philosopher and tends to want to learn things because his curiosity has been peaked rather than being motivated by the productivity of getting things done. (*Interview time: 61 min*)
Codes: *Highly social, Interested, Multi-Linear conformant (MLC), Trouble@Home(?), Better than frosh, Emotional gratification, 2ndS>1stS, 2ndSemResurgence, Family focused*

Note: The student ID – Stu – gender - Multi-Active rating – STEM GPA ranking among participants

Table 47

Participant performance profile – No. 15 Ranking Participant

Student ID	Fall Grade %	Spring Grade %	Year-long Average	Year-long trend		Multi-Active Score (max=11)	AREA154 vs. other core subjects (2nd Sem)	
STU-M-7-15	81.1	78.6	80.6	1QF	F	9	STEM	C+
				2QF	D		Math	D-
				FSG	B-		English	D
				1QS	A		History	C
				2QS	B			
				SSG	C+		Previous STEM Grade (Freshman)	F
							Took STEM course following year	Yes

	In-class Login % over course year	Login % at home over course year
AREA154 backend log-in frequency: (Data extrapolated based on usage across a one month time frame using "Simple History" WordPress backend plug-in.)	76%	4%
AREA154 Daily log-in duration: (Data extrapolated based on usage across a one month time frame using "Simple History" WordPress backend plug-in.)	39 min (1st sem = 38 min 2nd sem = 52 min)	4 min

Memos on participant's in-class behaviors: Subject represents one of the more interesting outliers in the study. Student was unofficially ranked by the administrative team as one of the most troubled and difficult students in the school. He displayed behaviors consistent with someone who had violent oppositional defiance disorder and had been noted to get physical with anyone who pushed him. Teachers, coaches, other students, there was a general sense of unease when subject was in class. He came from a home where he lived with his mother and an in/out step-parent that (on word from one of his friends) was verbally abusive. Home was not a good place. After taking a special interest in the student, giving him responsibilities in class that centered around AREA154 content and class functions. His seat was placed near the location where I could observe him. Conversations were generally positive but short lived. I often provided him opportunities to help him with his SRTs and retake them when he got stuck. He didn't do much with his ATN – it was largely empty and disorganized. However, once his hit enough 100% on the SRTs to show up on the leaderboard, that changed the entire outlook and motivation for the class. Grades

no longer mattered. The only motivation the subject utilized was in the top 5 Agent list on the website. He took unparallel amount of pride in being in that position. He would come in at lunch and after school to work on SRTs to maintain that position. *(Observations recalled from 2018-2019 school year – 9 months of class time.)*
Memos from interview & observations: Subject was removed from school during his Senior year and transferred to a continuation school. The interview was done over the phone rather than Zoom. Subject appeared to be hardened by life. He had a noticeable number of tattoos and no longer played baseball (a passion of his while enrolled in AREA154). Life appears to not have been any easier for him. He recalled his intense drive to be on the leaderboard. Though he could not remember much of what he learned specifically, he felt that it was the class that he learned the most. He was specifically curious about the Alien invasion case file and brought up several current events ask if I had also seen them in the news. He talked a little about why he never did work at home. No specific details were provided about exactly what aversions existed other than he tried to avoid the place. He also mentioned that he felt chilled out as an adult and felt that he could work better with people. I am wondering if that was a side effect of the THC he was routinely ingesting (he would talk about getting high after school and how it help him stay calm. I do not think he knows I overheard that conversation. Throughout the call, subject maintained that he felt he learned a lot, though didn't appear that he could recall any specific details relating to the course curriculum. (*Interview time: 56 min*)
Codes: *Highly social, Interested, High Multi-Linear conformant (MLC), Trouble@Home(?), Better than frosh, Emotional gratification, Gamification, Mentor, Confidence, Atypical, Feelings-based-Logic, Family-Focused, User, Feelings-based-Logic, Top-Grade*

Note: The student ID – Stu – gender - Multi-Active rating – STEM GPA ranking among participants

Table 48

Participant performance profile – No. 16 Ranking Participant

Student ID	Fall Grade %	Spring Grade %	Year-long Average	Year-long trend		Multi-Active Score (max=11)	AREA154 vs. other core subjects (2nd Sem)	
STU-M-8-16	80.5	62.3	71.4	1QF	A	9	STEM	D-
				2QF	B-		Math	C-
				FSG	B-		English	C
				1QS	C		History	D
				2QS	D			
				SSG	D-		Previous STEM Grade (Freshman)	B
							Took STEM course following year	Yes

	In-class Login % over course year	Login % at home over course year
AREA154 backend log-in frequency: (Data extrapolated based on usage across a one month time frame using "Simple History" WordPress backend plug-in.)	86%	7%
AREA154 Daily log-in duration: (Data extrapolated based on usage across a one month time frame using "Simple History" WordPress backend plug-in.)	26 min (1st sem = 22 min 2nd sem = 31 min)	3 min

Memos on participant's in-class behaviors: Subject was highly social and yearned for the attention and interaction from his peers. He was curious and had the potential to be a very powerful student; however, his drive to engage in

emotionally gratifying activities such as socialization, phone communication (people outside of class), and game apps, got in the way. Subject would come back to class after school, lunch, before school to ask questions and converse about all sorts of topics. Many centered around AREA154 content. Others were more hypothetical. He demonstrated many of the physiological symptoms of someone with ADHD. The topic of his attention span never came up and, as a result, never addressed. He spent time lamenting the Top Agent Leaderboard, often saying, “I guess I don’t have what it takes.” This was not an uncommon feeling about the Leaderboard. Other subjects noted that it was motivating to get up on it but demotivating to be pulled off of it. *(Observations recalled from 2018-2019 school year – 9 months of class time.)*

Memos from interview & observations: During the interview I recalled that David had some pretty intense personal issues during that second semester. Perhaps he was on a downhill spiral all year. He stated he didn’t even recall the A-invasion and that’s the case file everyone remembers. He had a girlfriend (social issue) that was a big problem. Admittedly he stated that he was not in good shape. I recall him asking me for time to leave class and just walk the halls to cool off. I don’t think his assessed grade here is a true evaluation of his potential. He achieved a B in the science class the following year.

Additionally, some of his answers seem to contradict himself in terms of how he would search for information. He stated that he would usually find it on his own. However, in the interview, he stated that he would frequently come to the teacher or seek out peers to acquire information. I have a feeling this means “can I copy your work so I can get the signature on the ATN” He is a highly emotional and sensitive person. He displayed evidence that he struggles with how he feels about his actions and levels of personal success. Noteworthy observation, subject said on multiple occasions “Well, if I’m going to be honest, …” and then would answer the interview question in a way that felt incongruent with my observational experience with him. Like others he noted the class as his favorite in high school and that he learned far more in this class than any other STEM-related course. However, the depth of his answers didn’t seem to indicate that he retained much of that knowledge. He does, though, clearly recall how the class made him feel. (*Interview time: 56 min*)

Codes: *Highly social, Interested, Multi-Linear conformant (MLC), Trouble@Home(?), Better than frosh, Emotional gratification, (-)Gamification, Mentor, confidence, Family focused, Feelings-based-Logic, TopGrade*

Note: The student ID – Stu – gender - Multi-Active rating – STEM GPA ranking among participants

Table 49

Participant performance profile – No. 17 Ranking Participant

Student ID	Fall Grade %	Spring Grade %	Year-long Average	Year-long trend		Multi-Active Score (max=11)	AREA154 vs. other core subjects (2nd Sem)	
STU-M-7-17	58.2	82.8	70.5	1QF	C-	7	STEM	B
				2QF	D		Math	D
				FSG	F		English	D+
				1QS	A+		History	D-
				2QS	B+			
				SSG	B-		Previous STEM Grade (Freshman)	D-
							Took STEM course following year	Yes

AREA154 backend log-in frequency: (Data extrapolated based on usage across a one month time frame using “Simple History” WordPress backend plug-in.)	In-class Login % over course year	Login % at home over course year
	65% (1st sem = 45% 2nd sem = 85%)	9%

AREA154 Daily log-in duration: (Data extrapolated based on usage across a one month time frame using "Simple History" WordPress backend plug-in.)	40 min (1st sem = 29 min 2nd sem = 50 min)	9 min
Memos on participant's in-class behaviors: Subject displayed interesting behaviors during the course of the year. His tendency was to try and move off into a less occupied area of the room and be unnoticed. As he did participate in class discussions and would occasionally not attend his third-period class because he wanted to hear the AREA154 presentation again. Upon reviewing his Aeries records subject's scores are rather solid in the ATN. However, his performances in the Examulations appear to have been his downfall. He had a complete set of notes (or so it would seem) yet still managed to do terribly on the Examulations. He tends to exude a sort of "I know more than you" air about him. It is unknown if he actually worked with others or he was the one being shunned by the other members of the Examulation team. *(Observations recalled from 2018-2019 school year – 9 months of class time.)*		
Memos from interview & observations: Interview lasted a little more than an hour and provided some interesting anomalous behaviors. Subject did not display the traditional academic profile. He only engages in subjects he personally finds interesting or challenging. His parents work night shifts and do not appear to be largely enrolled in his academic behaviors. Subject retained his notebook (displayed it on camera – no other student was able to produce it or even offered to do so) and demonstrated on camera the notes he had completed it. He also noted that he would frequently use the AREA154 site on his phone - citing one (possibly more) time where he was in the parking lot of Walmart in the car waiting for his mom working on AREA154 content. After some consideration, a new realization arose. This was a student that has little regard for grades sitting unattended in a car. He could have his choice to do or play anything. Instead, he chose to work on AREA154 content and challenges. It should also be noted that he went on to talk about the "electronics case file" and how he continued to work with it and learn it after school was out. Very few other students mentioned this action. (*Interview time: 68 min*)		
Codes: *Non-social, Interested, Multi-Linear conformant (MLC), Trouble@Home(?), Better than frosh, Emotional gratification, RemoteAccess, Extra-effort, Emotional gratification, Top grade, 2ndS>1stS, 2ndSemResurgence, Confidence, Family focused, Feelings-based-Logic, Top-Grade*		

Note: The student ID – Stu – gender - Multi-Active rating – STEM GPA ranking among participants

Table 50

Participant performance profile – No. 18 Ranking Participant

Student ID	Fall Grade %	Spring Grade %	Year-long Average	Year-long trend		Multi-Active Score (max=11)	AREA154 vs. other core subjects (2nd Sem)	
STU-F-9-18	60.8	74.6	67.7	1QF	F	9	STEM	C
				2QF	F		Math	C+
				FSG	D-		English	D
				1QS	B		History	D-
				2QS	F			
				SSG	C		Previous STEM Grade (Freshman)	D
							Took STEM course following year	Yes

AREA154 backend log-in frequency: (Data extrapolated based on usage across a one month time frame using "Simple History" WordPress backend plug-in.)	In-class Login % over course year	Login % at home over course year
	55%	5%

AREA154 Daily log-in duration: (Data extrapolated based on usage across a one month time frame using "Simple History" WordPress backend plug-in.)	17 min	1 min
Memos on participant's in-class behaviors: Subject has a very small footprint in class. Quiet but social, she made it look like she may have been doing something productive while at the same time being engaged in activities (socialization with table team, phone, apps…). When encouraged to get back to work, she would comply for the time being. However, she would then go right back to what could be considered emotionally gratifying activities. The number of interactions with this subject was limited, as she never appeared to need help and would always appear very confident that things were under control. Aeries scores indicate that she "died" in every Examulation (approx. the 7-10 month mark). This usually indicates someone who is smart enough to do the work and remembers enough to cover some distance, but not nearly enough to save herself, nor did anyone else at the table feel it necessary to assist. *(Observations recalled from 2019-2020 school year – 9 months of class time.)*		
Memos from interview & observations: A pleasant person and an easy interview. She appears to have matured since my last contact with her. She appears to have more direction now. She noted on several occasions that she "felt the experience" in AREA154 was good, but there was something there that felt off. Perhaps she was sharing this because emotionally, this is what she recalls. It could be that she was surprised to hear from me and that I wanted to interview HER. We did not have a lot of contact. Perhaps the shock of being chosen was motivation to paint the experience in a way that is counterintuitive to past observations, her grades, and in-class actions. She made note that she wanted to be an art therapist for kids. STEM was never really part of the plan. Oddly, she also talked at length about the content she would bring up with her mom about the class. Apparently, they would talk about the controversial topics at home at great length. Her knowledge of scientific details was very low. However, her ability to recall the narrative associated with the content was above average. It was especially impressive, considering how much I felt she was not paying attention. After viewing her grades in other subjects, it would appear that there might some relative validity to her favorable statements towards her experience. Her grade was slightly higher than the next highest grade during her second semester. Subjects Lewis rating was exceptionally high and may posit a reason why "productivity" was never really on her agenda. (*Interview time: 63 min*)		
Codes: *Social, Interested(?), High Multi-Linear conformant (HMLC), Better than frosh, Emotional gratification, Top grade, 2ndS>1stS, 2ndSemResurgence, Confidence, Family-focused, Feeling-based-Logic*		

Note: The student ID – Stu – gender - Multi-Active rating – STEM GPA ranking among participants

Table 51

Participant performance profile – No. 19 Ranking Participant

Student ID	Fall Grade %	Spring Grade %	Year-long Average	Year-long trend		Multi-Active Score (max=11)	AREA154 vs. other core subjects (2nd Sem)	
STU-M-8-19	52.7	56.7	54.4	1QF	B	8	STEM	F
				2QF	F		Math	F
				FSG	F		English	D
				1QS	F		History	D
				2QS	F			
				SSG	F		Previous STEM Grade (Freshman)	C
							Took STEM course following year	Yes

	In-class Login % over course year	Login % at home over course year
AREA154 backend log-in frequency: (Data extrapolated based on usage across a one month time frame using "Simple History" WordPress backend plug-in.)	38%	3%
AREA154 Daily log-in duration: (Data extrapolated based on usage across a one month time frame using "Simple History" WordPress backend plug-in.)	8 min	0.5 min
Memos on participant's in-class behaviors: Subject has a unique demeanor. He comes across as just, angry. Interactions in class usually revolved around him coming into class breaking out his school-appointed Chromebook, and begin watching cartoons or playing games. At times he would get so angry when losing his game that he would slam the computer and storm out of the room or burst out profanities. That was the overall feeling of his time in the classroom. However, it wasn't like that during the first six weeks. Subject participated and seemed genuinely interested in what was going on. Then, something changed. His attendance records were consulted, and starting the 10th of October, each week has at least one unexcused absence and anywhere between two-three tardy notifications. Starting the Spring semester, the unexcused absences grew. He was regularly marked absent from two-five classes two-four times a week. Looking back on the experience, he was either physically or mentally not present in that room. It could be assumed that he was either unwilling to participate or unable to participate – as such the majority of his actions in class centered around emotionally gratifying activities, with rare occasions where he would be involved enough with the discussion that he contributed something unique and meaningful to the open conversation. It was rare, but it happened. *(Observations recalled from 2019-2020 school year – 9 months of class time.)*		
Memos from interview & observations: Again, the enigma arises. Twice during the interview, he stated that "your class was one of my favorites". It is unclear why that statement was made. He stated that he didn't really talk to family about the class, as he was the youngest of five children and the others were away from home. He did not appear to have many conversations with his parents. He may not even spend that much time at home. At the time of the interview, he was at a friend's house who had internet access. His was apparently not working well. Subject displayed a sort of fondness for the environment. He noted during the discussion of the AREA154 system that he thought it was "cool that you made your own stuff custom". Indicating that he valued the effort the instructor made towards their experience. One might assume that this was not a shared feeling with most of his classes. He had very general recall about the casefiles referring to them as "The volcano-one" and "The alien-one". When asked about his absences and why he was gone all the time, he said there was "stuff he had to do". At that point, his friend laughed – indicating that this was not the whole story. When pressed for more details, he was very hesitant to reply. When asked if he was at school or not during those absences, he said that he was sometimes, sometimes not. I asked if that something that he needed to deal with started in October. He thought that sounded accurate. So, whatever it was that he was "stuff" he was doing has a pretty heavy impact on his ability to succeed at school. Also curious, when we spoke about his confidence level in AREA154 vs. other programs, he was animate that he felt more successful in the AREA154 program than he did in his previous STEM class (biology). Enigmatic because his grade was higher in biology than it was in this program. (*Interview time: 63 min*)		
Codes: Non-s*ocial, Interested(?),Multi-Linear conformant (MLC), Emotional gratification, 2ndS>1stS, Trouble@home, Confidence, Atypical, Feeling-Based-Logic,*		

Note: The student ID – Stu – gender - Multi-Active rating – STEM GPA ranking among participants

Tabulation of codes vs. academic achievement level.

Table 52 tabulates the codes that resulted from the dynamic analysis of the uLearning system's users. As noted before, the subjects were selected from a wide range of achievement levels. Students from every grade (A–F) were solicited via email to participate. There is a heavier representation of A and B grades than C or D/F grades. One could argue that this makes sense given the nature of the students who are likely to respond to teachers, emails, and requests and those who are less likely to do so. One might posit that if the C or D/F students were more responsive to their school email and teacher requests, they would probably be A or B students. In any case, the data collected by the individuals who did respond to the interview request is presented below, showing the results of the code frequencies broken down by achievement level.

Table 52

Coding pass: Open coding of student profiles

Codes Used	Meaning	Frequency of Usage
2ndS>1stS	Achieved a better grade in the second term (spring).	AAAAA (5/7) BBBBBB (6/7) C (1/2) DD (2/2)
2ndSemResurgence	Demonstrated a 10% or greater increase in grade in the spring semester over the previous semester.	A BBB C D
Archiver-type	Has the ability to take exceptionally good notes, almost as if they were archiving information for posterity.	AAA (3/7) B (1/7)
Attention-focused	Is very rarely engaged in behaviors that are not the topic of focus in the class at the time.	AA (2/7) B (1/7)
Atypical	Demonstrated a notable trait or behavior that affected their AREA154 experience and is very rare among the subject pool.	AAA (3/7) B (1/7) C (1/3) D (1/2)
Better than frosh	Earned a higher grade in AREA154 than in freshman biology.	AAAAAA (6) BBBBB (5/7) CCC (3/3) D (1/2)
Confident	Displayed or overtly stated that they felt notably more confident in AREA154 than in other STEM programs.	AA (2/7) BBB (3/7) CCC (3/3) DD (2/2)

Curious	Demonstrated that curiosity is a driving factor in their engagement.	AAAA* (4/7) B*B* (2/7)
*Highly curious	Noted that curiosity was *the* defining motivating factor for their engagement.	
Delta worldview	Has overtly shown significant evidence that their worldview has changed due to their AREA154 experience.	A (1/7)
Disciplined	Displayed notable levels of self-discipline.	AAA (3/7)
Emotional gratification	Participated in emotionally gratifying activities at a notable rate.	AA (2/7) BBBB (4/7)
(~) Emotional gratification	Engaged in emotionally gratifying activities occasionally. (*Such activities are defined as game apps, social media, texting, online games, YouTube, or anything that is a non-thinking activity designed to raise serotonin levels.*)	CCC (2/3) D (1/2)
Exo-managed	Behavior is managed by an external influence from outside the family, like clubs, organizations, or sports.	A (2/7)
Extra-effort	Engaged in the AREA154 program on their own time doing content-related work inspired by the program.	A (1/7) C (1/3)
Family-focused	Has noted that they put family first, then school or career.	AAAAA (5/7) BBBBB (5/7) CCC (3/3) DD (2/2)
Family-sharing	Shares AREA154 learning content (scientific or narrative) with a family member.	A (1/7) BB (2/7)
Feeling-based logic	Demonstrated a propensity to make decisions almost entirely based on how a certain event or task made them feel.	A (1/7) CCC (3/3) DD (2/2)
Gamification	Was positively affected by the gamification enough to mention it during the interview.	A (1/7) BB (2/7)
(-) Gamification	Demonstrated de-motivating behaviors due to the gamification elements.	CC (2/3)
Grade-motivated	Indicated that grades are their primary motivation for success in school.	AA (2/7)

Interested	Demonstrated interest in the AREA154 program as the motivation for participating in class.	A (1/7) BBB (3/7) CCC (3/3) D (1/2)
Mentor	Received additional guidance from the instructor beyond the confines of the normal class day on a routine basis (after school, at lunch, before school).	B (1/7) CC (2/3)
Minimalist	Demonstrated in class or noted in the interview that they do the absolute minimum to meet the requirements of the task at hand.	A (1/7) D (1/2)
Mom-managed	Has overtly stated or shown evidence of having a mother who has a significant role in managing the student's academic career.	A (1/7)
Multi-linear conforming (MLC)	Has a score between 7 and 8 on the Lewis assessment.	AAAAA*A (6/7) BBBBBBB* (7/7)
High multi-linear conforming (HMLC)	Has a score of 9 or higher on the Lewis assessment.	CCC* (3/3) DD* (2/2)
(~) Multi-linear conforming [(~)MLC]	Has a score slightly higher than 50% on the Lewis assessment.	
Non-social	Demonstrates a tendency to not talk in class. Is introverted and tends not to speak out in class.	A (1/7) B (1/7) C (1/2)
Parents-no-English	Indicated that both parents do not speak English.	A (1/7) BBB (3/7)
(+) Psycho-social integration (+PPI)	Displayed significant skills in integrating into the linear-active social behavioral system (playing the game of school).	AAAAA* (5/7) B (1/7)
*Forced (+) psycho-social integration (F+PPI)	Was indoctrinated through some official program to learn how to be linear-active. This is likely due to membership in ROTC, AVID, or extensive parental management.	
Remote-access	Accessed the temple.area154.net website away from home and away from school.	A (1/7) B (1/7) C (1/3)
Respectful	Exhibited notable levels of respect during class.	AAAA (4/7) B (1/7)
ROTC	Belonged to the Air Force ROTC at San Jacinto High School.	AA (2/7)

Routine-centered	Stated or demonstrated that they base their day or actions around a strict routine.	AA (2/7)
Science-minded	Stated during the interview or through actions in class that they are looking for a career in science or a related field.	A (1/7)
Sister-mom	Specifically noted having mom-like responsibilities at home—responsibility over siblings that superseded academic obligations.	AA (2/7) B (1/7)
Social *Highly social	Demonstrated a notable amount of socialization in class. Demonstrated a much higher than normal socialization rate.	BBB (3/7) C*C* (2/3) D* (1/2)
Top-grade	AREA154 was the top grade on the final spring report card.	AAAA (4/7) BB (2/7) CC (2/3) D (1/2)
2nd-top-grade	AREA154 was the second-highest grade on the spring report card.	AA (2/7) C (1/3) D (1/2)
Trouble@home	At some point during the interview, there was overt evidence to suggest that the student was experiencing discord at home.	A (1/7) BB (2/7) CCC (1/3) D (1/2)
User	Demonstrated behaviors in class or noted actions during the interview that signal they used other people to acquire work or manipulate them to bypass doing the work in the program.	A (1/7) C (1/3)

Note: Several codes had been removed from the list due to lack of frequency or lack of relevance to the topic under study.

Trends revealed by code frequency analysis.

Interesting trends began to take shape when the codes were collected and code frequency was analyzed. The codes that resulted from the grade analysis, the observational summary, and the interview were posted at the bottom of each subject's profile. The accumulated codes present the student's experiences and personal representation both as a student and as someone who has experienced an entire academic year in a uLearning system. As the analysis continued, more of the same codes arose, demonstrating patterns among different academic achievement levels. The analysis includes the percentage of login frequency while in school and percentage of login frequency by the same user during the same day but outside of the school network. The assumption is that these logins are taking place either at home or on the go. Few of the subjects commented on using anything but their school-supplied Chromebook for accessing the site. Thus, the assumption that the logins are taking place at home could be considered a sound presumption. The frequency was determined by the number of logins between a specific range of dates. In this case, the frequency was measured across the fall semester of 2019, divided by the total number of school days during that period. The formula is as follows:

$$\textit{Average login frequency} = [\Sigma\ (\textit{No. of logins/total school days})]\ /\ \textit{number of subjects}$$

Table 53 presents the results from the segregation of codes by academic achievement level and backend login information on the AREA154 site.

Table 53

Results of code frequency by class grade, login frequency, and average session duration

Course Grade	Code	Frequency	Login Freq. @School	Login Freq. @Home
A – Top responses *Program-influenced*	Top grade Better than frosh 2ndSem>1stSem	5/7 6/7 5/7	Ave: 90.4% T_s = 43 min	Ave: 54% T_s = 24 min
A – Top responses *Multi-active conforming*	Social Family-focused Emotional-gratification Multi-active-conforming*	5/7 5/7 5/7 7/7		
A – Top responses *Active-linear adaptation skills*	(+) Psycho-social integration Self-disciplined	0/7 0/7		
A – Second-tier responses	Atypical Achiever-type	3/7 3/7		

Course Grade	Code	Frequency	Login Freq. @School	Login Freq. @Home
B – Top responses *Program-influenced*	Top grade	6/7	Ave: 71%	Ave: 28%
	Better than frosh	7/7	T_s = 42 min	T_s = 13 min
	2ndSem>1stSem	6/7		
B – Top responses *Multi-active conforming*	Social	5/7		
	Respectful	5/7		
	Family-focused	6/7		
	Multi-active-conforming*	6/7		
B – Top responses *Active-linear adaptation skills*	(+) Psycho-social	7/7		
	integration	5/7		
	Self-disciplined			
B – Second-tier responses	Parents-no-English	3/7		
	Confidence	3/7		
	Interest	3/7		
	2ndSem-resurgence	3/7		
C – Top responses *Program-influenced*	Top grade	3/3	Ave: 76%	Ave: 6%
	Better than frosh	3/3	T_s = 30 min	T_s = 5 min
	Interest-driven	3/3		
C – Top responses *Multi-active conforming*	Social	2/3		
	Family-focused	3/3		
	Emotional-gratification	3/3		
	Feelings-based-logic	3/3		
	Trouble@home	3/3		
	Mentor	2/3		
	Multi-active-conforming*	3/3		
C – Top responses *Active-linear adaptation skills*	(+) Psycho-social	0/7		
	integration	0/7		
	Self-disciplined			
C – Second-tier responses	Parents-no-English	1/7		
	User	1/3		
	Remote-access	1/3		
	Non-social	1/3		
	Atypical	1/3		
D/F – Top responses *Program-influenced*	Confidence	2/2	Ave: 47%	Ave: 4%
	2ndSem>1stSem	2/2	T_s = 13 min	T_s = 0.75 min
	Interest-driven	2/2		
	Top-grade	1/2		

Course Grade	Code	Frequency	Login Freq. @School	Login Freq. @Home
D/F – Top responses *Multi-active conforming*	Family-focused Emotional-gratification Feelings-based-logic High/multi-active-conforming* Trouble@home Atypical Social Non-social	2/2 2/2 2/2 2/2 1/2 1/2 1/2 1/2		
D/F – Top responses *Active-linear adaptation skills*	(+) Psycho-social integration Self-disciplined	0/7 0/7		

*This data resulted from a questionnaire developed explicitly from Lewis' (2012) descriptions of multi-active and linear-active psycho-social behaviors. Questions were modeled as a scenario wherein two options were provided. The subject would choose between the two options based on what they believed they would do in the given situation. One option was derived from the multi-active behavior list, and the other was derived from the linear-active behavior list.

Noteworthy observations about the users of the AREA154 uLearning system.

This analysis further groups code frequency and breaks the frequencies down, not by codes but by achievement level. Viewed this way, some clear trends arise, as follows.

Sections reflecting an interaction with the uLearning system:

- In every top-grade category between A and D, a minimum of 71% of the subjects reported AREA154 as their top grade of all core subjects.
- In every category, a minimum of 87% of the subjects said their grades in AREA154 were better than those for their freshman biology or Biomed I class.
- In the A and B categories, a minimum of 71% of the subjects stated that their grade improved in the second semester.

Sections reflecting multi-active behavioral traits:

- The multi-active interview Q&A confirmed that a minimum of 87% of the subjects in *all* categories self-ascribed multi-active behaviors.

- Only the A category self-ascribed behavioral traits that were linear-active, indicating a higher degree of cultural integration into the U.S. educational system.
- As the grades became lower, the number and frequency of multi-active traits increased, possibly reinforcing the supposition that the multi-active and linear-active cultures are instructionally incompatible.
- The indications that a student may be having trouble in the subjects becomes notable with the lower grades. There is some evidence to suggest that their low grade in the class may have resulted in part from domestic unrest.
- In the case of the one student who did not self-identify as multi-active, although his actions in class and the interview session would suggest strong multi-active influences at home, he was part of a military family. The subject was in his second year of ROTC during the time of the study.

Sections reflecting login and session time at school and at home:

- As the grades go from A to D/F, the login frequency and the duration of the login time both at home and at school drop, indicating that when at home, students are unwilling or unable to log into the class site.

Subject perceptions of success, confidence, and improvement

This study seeks to build a grounded theory that will provide insight into four primary Conceptual Application Proofs. Through phases I–III, the focus was on the system and its effects as well as the influence of other noncategorical themes on the students' confidence-building or -restricting experiences. Phase IV focuses specifically on the student and uses two sources of additional information (Aeries student data-managing software and backend login data from the AREA154 website) to further enhance the qualitative image and to determine whether the study's assumption about the psycho-social behaviors of the Hispanic students were congruent with Lewis's (2012) conclusions about multi-active cultures. As a final theme analysis, the study asked the subjects overtly about their perceptions. What were their perceptions of their success and their confidence in the AREA154 uLearning STEM program? That data would then be cross-referenced with their individual academic profiles for additional insight into the student experience.

Table 54 presents the themes developed from interview transcript-coding sequences. These themes collectively encompass elements that affected subjects while they were participating in the AREA154 uLearning experience.

Table 54

Themes, their meaning, and their effect on AREA154 experiences

Theme	Definition	AREA154 Impact Areas
Pre-program	Perceived STEM confidence during the year prior to the uLearning system. In most cases, this was freshman biology. However, for two of the subjects, BioMed I was their freshman science experience.	This theme seeks to identify examples where AREA154 is influential in students' perceptions. The analysis will focus more on whether the program did or did not have an impact and to what degree.
In-program	Perceived STEM confidence within the uLearning system.	This theme seeks to identify areas of the AREA154 construct in which subjects stated that they have higher levels of CBEs and those responsible for restricting their STEM confidence (CREs).
Specific-areas-confidence	Self-identified areas wherein subjects felt more confident and successful than others—identified areas of program strength. These strengths could be content-oriented or a particular section of the uLearning design construct.	This theme seeks to identify common areas of subject strength. This information could serve to help evolve the program in the direction that multi-active students seem to respond to best.

Table 55

Student-reported self-confidence before AREA154, contrasted with student records

Subject (Ranked by averaged course grade)	Interview Response	Affect Number	Top Grade (Spring 2020)	AREA154 > Bio (Average year-long grade)
Stu-F-6-1	"I was confident with the subject, I wasn't so much with myself." [00:18:52.250]	3	Tied for top	Higher
Stu-F-7-2	"Honestly, I was less confident at the start [of AREA154]. It's not normal. It took a while to get used to." [00:11:18.430]	2	Tied for top	Same as
Stu-M-4-3	"It would be fair to say that I did the work because I had to. It didn't really jump out at me, certainly not inspired by it. Huge difference between the two [bio and AREA154]." [00:8:51.400]	5	Top grade	Higher
Stu-F-8-4	"I wasn't confident in science [last year], I didn't really like it. Chemistry (AREA154) year was better for me." [*Response to follow-up question via text message.*]	4	Tied for top (A-)	Same as
Stu-F-6-5	*No recorded response from subject.*	N/A	N/A	N/A
Stu-F-7-6	"These are the first semester and then I just got hung up on that and it's just distracting me from the actual rest of the class. I think this is hard to do and I forget sometimes and I'm like, how do I do this now? And I definitely did struggle for sure last year." [00:32:10.190]	5	Top grade (A)	Higher
Stu-F-9-7	"I basically knew nothing. It was a system, you just regurgitate the information. Not really doing your own research, just doing what you're told. I	5	Tied for top (A-)	Higher

Subject (Ranked by averaged course grade)	Interview Response	Affect Number	Top Grade (Spring 2020)	AREA154 > Bio (Average year-long grade)
	needed more. AREA154 was more, it was like being the researcher!" [*Response to follow-up question via email.*]			
Stu-M-9-8	"I wasn't really that good at it, like, it was hard for me to understand. Not that year [enrollment year], that was easy." [*Response to follow-up question via email.*]	4	Second-top (A-)	Higher
Stu-M7-9	"I did pretty well in biology. I wasn't all that interested in it though. But not, like, not confident I couldn't do well. Because I was into the class I felt much more confident." [*Response to follow-up question via email.*]	5	Top grade (B+)	Higher
Stu-F-7-10	"I liked my teacher, but honestly, I had no idea what I was doing in biology. I felt I was never really good at science. That changed the next year." [00:00:51.740]	4	Tied for top (A-)	Higher
Stu-F-8-11	"Biomed was career-oriented; it had a purpose. It wasn't like a normal biology class. I was worried about chemistry. People said it was hard and it was going to be different from biomed. Coming into chemistry, my confidence was shaky." [00:00:44.470]	4	No	Higher
Stu-F-8-12	"I don't remember biology or any of my middle school science classes. Those classes were difficult compared to AREA154 stuff." [00:06:43.340]	4	Top grade (A-)	Higher
Stu-F-7-13	"It [previous experiences] were nothing like this [uLearning].	4	No (C)	Lower

Subject (Ranked by averaged course grade)	Interview Response	Affect Number	Top Grade (Spring 2020)	AREA154 > Bio (Average year-long grade)
	Was never much of a science person."			
Stu-M-7-14	"I got taking science when I was seventh grade but never started taking it seriously until sophomore year."	4	Top grade (A-)	Higher
Stu-M-9-15	"I had no confidence in school at all. Especially science. This class was the first science-like class I've ever passed, I think, I'm pretty sure." [00:00:32.321]	5	Top grade (C)	Higher
Stu-M-8-16	"I was okay at science; I liked it. Not into books or notes, or you know, the same stuff over and over. One of the best thing about [AREA154] was it was so different."	4	Second-top (D-)	Lower
Stu-M-7-17	"I was bad at math, science, things like that. Teachers didn't know how to teach us the right way. Straight out of the book, just read out of the book. Kills my drive, kills my grade." [00:11:18.430]	4	Top grade (B)	Higher
Stu-F-9-18	I wasn't so confident." [00:01:04.010]	4	Top grade (C)	Higher
Stu-M-8-19	"I didn't care about school so much. I've never been good at it or really interested in science much. This class [AREA154] was cooler than the last. I could do it, just didn't, you know?" [00:00:10.356]	4	(F)	Lower
Theme: [Pre-program] Total Affect Number		**AN = 4.2**	8/18 = Top grade 5/18 = Tied w/top 5/18 = Second-top	13/18 = Higher 3/18 = Same as 2/18 = Lower

Note: Student Stu-F-6-5 did not have interview data that addressed this topic. Either the question was not asked, or the data were not found.

The following table assesses student confidence after having experienced the system for one academic year. Essentially, subject confidence ascribed to the program will be assigned an affect number like before. Subjects who indicated a high number of CREs will be represented by 1. Conversely, subjects who reflected a high amount of CBEs will be assigned a value of 5. In addition to the confidence data (any subject data that indicated an experience of high confidence), the corresponding subject area or uLearning feature was added to the subjects' confidence statements. The table's data represents the student's general perceptions of how the AREA154 uLearning program affected their STEM experiences.

Table 56

Student-reported self-confidence before AREA154 contrasted with student records

Subject (Ranked by averaged course grade)	Interview Response	Affect Number	Specific Confidence Area
Stu-F-6-1	"The idea that I could be able to save someone's life. That was both confidence-building and scary. But it was a good thing." [00:18:52.250]	4	Subject strength: Reactions, naming compounds (alien invasion, caldera). uLearning: Central site, SRTs, ATN.
Stu-F-7-2	"At the end of the year, felt pretty successful and confident." [00:36:45.450]	4	uLearning: Central site.
Stu-M-4-3	"I would still do the work at home and I still have that confidence, but I wish I had more confidence from what I was writing down in class. But at the end, best science class I've ever had." [00:12:57.900]	5	Subject strength: Exothermic reactions, compounds, making formulas (alien invasion). uLearning: Central site, thematic application—caldera, alien invasion, fast feedback.
Stu-F-8-4	"Yeah, when I took one of the first SRTs because I knew I believed there was going to be a lot easier. But it wasn't also because I wasn't using my notes, but once I started using the notes [ATN] and actually taking notes of the presentations and everything else, it was a lot easier, like the second time I took it [SRT] I did way better. It was an easy system after that." [00:16:46.090]	4	Subject strength: Magnetic waves (zombie invasion). uLearning: Central site, thematic application—caldera, alien invasion, fast feedback.

Subject (Ranked by averaged course grade)	Interview Response	Affect Number	Specific Confidence Area
Stu-F-6-5	"Once you got in the program. I feel like I think I caught on to the lessons faster, and I'm not sure why, I think because the way it was presented made it more interesting to pay attention. I think." [00:01:19.070]	4	uLearning: Central site.
Stu-F-7-6	"There was some struggle at first, because … it's new, not normal, like, at all … once I figured out the system, I felt like with some effort I could get the grade I need." [00:05:00.870]	5	*None specified.*
Stu-F-9-7	"You gave us a list of things to find a way to find it, but you didn't make it super easy … And those added to your level of confidence of like, hey, I can do this and I don't need anybody else to help or I feel like I'm independent and I could do this on my own." [00:18:10.460]	5	Subject strength: Atoms, bonding, compounds (alien invasion). uLearning: Thematic application—alien invasion, caldera, central site.
Stu-M-9-8	"I think it is because the way that you're teaching it, because you were like actually engaging in what we were doing and like just like the platform that you had everything on, because since everything was on one website and everything." [00:13:47.100]	4	Subject strength: Caldera. uLearning: Central site.
Stu-M-7-9	"I felt better at science at the end of the year. I've never had a class that made me think so much. My grade could have been better, but what mattered was how it opened my eyes to how, you know, like the bigger picture, stuff that I've felt for a long time. But this class made me think. Wasted a lot of hours staring at my ceiling thinking about stuff from that class." [00:25:10.990]	5	uLearning: Thematic application—alien invasion.
Stu-F-7-10	Q: "Would it be fair to say, that you feel more confident and successful in STEM subjects now?" A: "Yeah, absolutely, but I can say at the end, like I had the hang of it and what to do."	5	Content: ATN—notebook feedback.

Subject (Ranked by averaged course grade)	Interview Response	Affect Number	Specific Confidence Area
Stu-F-8-11	Q: "It sounds like you say you feel pretty confident when you compare that [AREA154] to, let's say, previous experiences?" A: "Yeah, for sure."	4	Subject strength: Earth science Antarctica (alien invasion). uLearning: Central site, thematic application—caldera, alien invasion, fast feedback.
Stu-F-8-12	"A lot of confidence, especially when, okay, you would look at it and you would think, 'I don't know any of this and I don't know how I'm going to learn it, and it's complicated,' but then when you just sit down and listen and you get the hang of things, you know, you do it for yourself and then you get it right. You just have a lot of confidence and then want to do it again and you wait for the next one." [00:07:11.140]	5	Content: Alien invasion (chemistry).
Stu-F-7-13	"All in all, I would say my confidence in science skyrocketed throughout the year - especially since everyone always has a chemistry horror story to tell." [*Written response.*]	5	uLearning: Central site, self-paced, fast feedback.
Stu-M-7-14	"Then looking back, you're like, do I feel more confident, like I can do this stuff? There for me, and I feel more confident and I feel more curious about other things, chemistry, biology, I feel more curious."	4	uLearning: Central site, self-paced, fast feedback.
Stu-M-9-15	"This was the best grade I had all year. I think it was the best grade I had in all of high school, except for maybe, like, PE."	5	*None specified.*
Stu-M-8-16	Q: "Okay, so would you say that once you started with the program that your confidence changed?" A: "Yeah, definitely."	4	uLearning: Central site, self-paced, fast feedback.
Stu-M-7-17	A: "I think I did pretty good in there." Q: "And in terms of confidence level, you felt like there wasn't anything that you couldn't do given the environment and the tools available?" A: "If I wanted to do it, I could absolutely do it." [00:12:21.630]	4	Content: Examulations.

Subject (Ranked by averaged course grade)	Interview Response	Affect Number	Specific Confidence Area
Stu-F-9-18	Q: "Okay, so if I'm understanding this right, your experience in the AREA154 program and because of some of the hands-on things, you felt like you had a better grasp of what was going on in that class or in that system than you have in the past?" A: "I would say that. Yeah. I feel I learned a lot."	4	Content: Caldera (hands-on).
Stu-M-8-19	"I don't know. You know I just sort of gave up at the end. Was like, I can't catch up now. I guess it was what it was."	3	*None specified.*
Theme: [Program] Total Affect Number		**AN = 4.4**	

Note: Student Stu-F-6-5 did not have interview data that addressed this topic. Either the question was not asked, or the data were not found.

Theory development and plausible validation

Through four phases, the AREA154 uLearning STEM program underwent a high degree of scrutiny and cross-validation to arrive at a grounded theory that could explain the system's success. The circumstantial evidence broken down into categorical influences suggests that specific aspects of this uLearning system do influence and predict personal growth by imparting confidence-building experiences to multi-active (Hispanic) students. The last section asks the subject directly about the type of impact the AREA154 system had on their sense of confidence in STEM subjects.

Pre-program and program **themes**. Interview data compiled through the pre-program and program themes demonstrates clearly that the subjects' perception of their growth as a group was substantial. The majority of students expressed that they felt a sense of uneasiness with their freshman science classes; one subject stated that she had trouble even recalling what science class she had freshman year. The reasons for the relative uneasiness are unknown and would require further study. It could have been that they only viewed themselves as having previously lacked confidence in contrast to the robust level of confidence they felt after experiencing a full

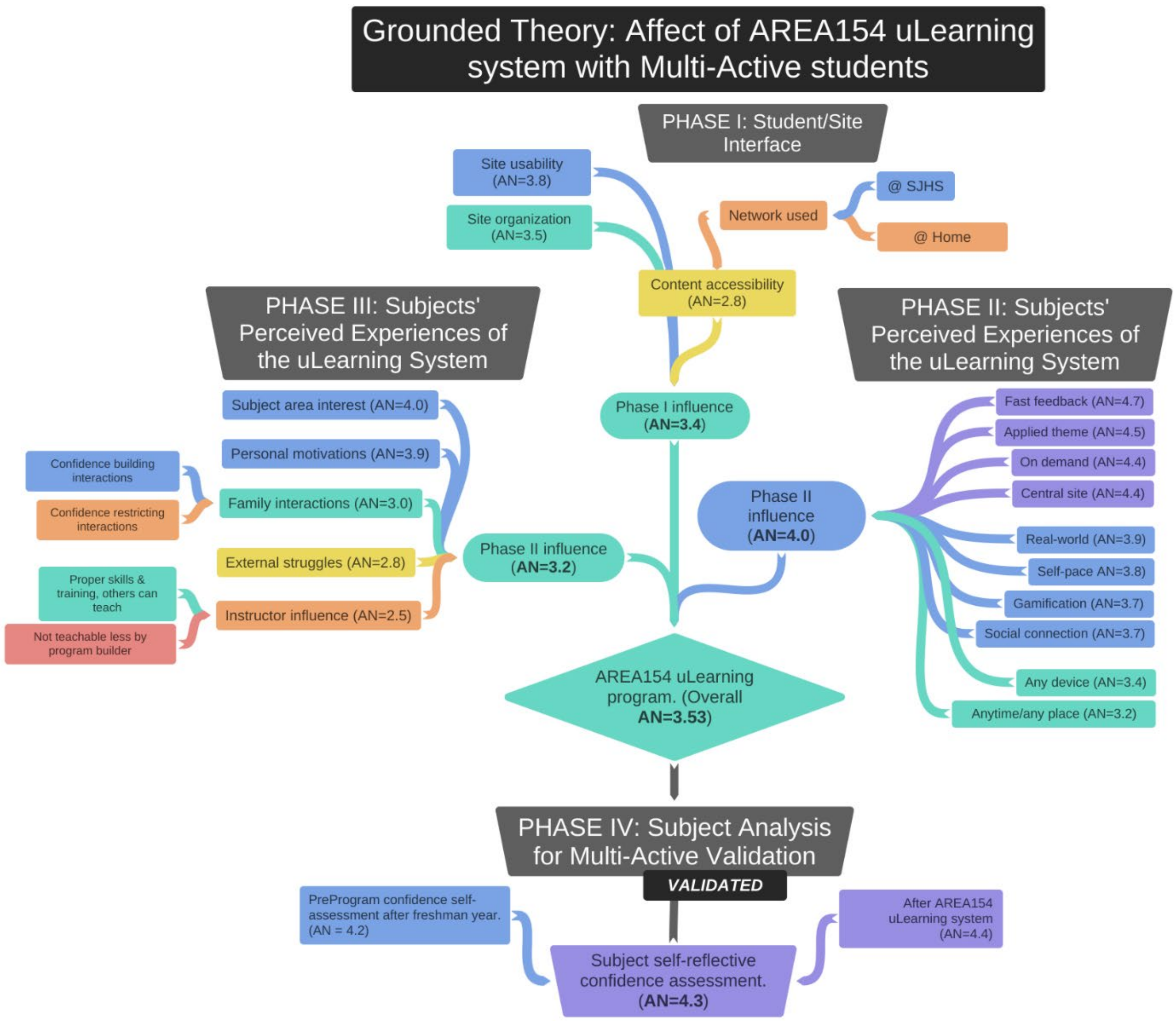
AREA154 curriculum. Given the high affect numbers, it could be that had these same subjects been asked about their confidence at the end of freshman year, they may have replied differently. The interview data and the comments made by the subjects appear to validate the data presented earlier in phases I, II, and III. The system is effective at increasing STEM confidence. However, a systematic breakdown of subject profile data begins to explain the program's influence on multi-active student populations. The affect number for the theme pre-program was **4.2** (indicating that subjects felt far more confident in AREA154 than in their freshman STEM class), and the affect number for the program theme was **4.4** (indicating an increase in CBEs at the end of the 2020 school year).

Phase I, II, III, and IV final theory revision: A summary of findings

All four phases have been gruelingly analyzed to validate cultural assumptions and generate a clear understanding of the subjects who participated in the research. Phases I and II analyzed the structural features of the technology and the influence of the uLearning design philosophy. Moreover, subjects' perceptions of noncategorical data provided data on external influencing factors that could enhance or derail educational efforts. The four reflective phases served as a categorical cross-check to validate findings discovered by coding and theming subjects' recalled experiences. Finally, subjects' self-assessments about their lived experiences were coded and compiled. The results presented information regarding the impact that AREA154 had made on their CBEs. Figure 4.8 represents the most current version of the grounded theory, which explains the effects on multi-active students. In the conclusions section, the theory will also be used to identify, describe, predict, and answer the four Grounded Theory CAPs in this study.

Figure 9

Grounded theory: Affect of AREA154 uLearning system with multi-active students



Note: Factors labeled in purple (4.3 – 5.0) and blue (3.6 – 4.2) represent areas of higher confidence- and success-building. Factors in green (3.0 – 3.5) represent medium-low or neutral confidence- and success-building. Yellow (2.6 – 3.0) represents neutral to medium-low confidence- and success-restricting. Orange (1.8 – 2.5) and red (1.0 – 1.7) represent higher areas of confidence and success restriction.

Discussion

Theoretical contributions of the study

uLearning technological designs date back almost 30 years. The idea is not new. Nor is the technology used to conceive, design, build, and deploy the AREA154 uLearning experience. All of the tools and programs are relatively commonplace. WordPress is not new, Sensei LMS was published in 2009, and the Adobe media software updates versions of software that first came out fifteen to twenty years ago. However, the design is novel. The lens by which the technology, the instructor, and the curriculum work together, that is new.

Theoretical contributions to the field of education.

Also uncommon was the remarkably varied training the designer underwent to both conceptualize the environment, and attain the technical capacity to materialize the idea. An unexpected, though not surprising, theoretical contributions to education is the training used to build such systems. The type of training discussed in Phase III addresses on a crucial point. The overall Affect Number for the AREA154 experience could have been higher if the technical training prognosis was available, meaning, the subjects in the study respectfully noted the relative lack of creative technical skill in most teachers. They were aware of the possibility of someone possessing the skill-sets for evolving and maintaining such a system were rare, not impossible, but unlikely. The implication being, that if this system could be implemented, more frequent and in-depth technical training would be needed for the teachers.

The staff training trends in the San Jacinto Unified School district (Pre-COVID) centered around Google Suite, Pre-built corporate LMS sites like PowerSchool, Haiku, and gadget sites like Kahoot. Communication with teachers in surrounding districts is infrequent, but communications indicate educational technology exposure is limited. Granted, Google Suite offers a wide range of simple and highly integrated media production tools; it could be a good jumping-off point. However, these suites lack the creative power to produce anything as interactive or immersive as AREA154. That being said, maybe it doesn't have to be.

As previously noted, this study points out the importance of the unification of design, instructor, and technology. This realization was product independent. One does not need to use the same tool set to accomplish similar, not exactly, but workable facsimiles of uLearning environments. The study emphasized the need for an entire a systemic phase-shift in teacher technology training.

Anecdotal observations suggest that districts' edtech training panders to teachers pleading for them to try, possibly invest, into anything that leads to better classroom results. Typically, Little is learned, less is applied, and things go on as they were. Consider the implications of the findings in this study. A research-backed solution that can and has made a notable difference. A more effective approach might be to offer the best teachers everything, rather than offering somethings to everyone. In other words, offer hungry motivated teachers rigorous high-end training on-site generation, Adobe production software, and SQL databases. Then provide a venue to openly create a the new iteration of their curriculum with uLearning as the axial design guide. Follow their progress publicly, open it to others to watch and follow as well. Upon completion celebrate those teachers like rock stars. Their success seeds the motivation that pulls others into the program. New participants are selectively chose to maintain the training rigor and manage the quality of the output.

The scope of the study does not include topics like edtech training nor the distinct methodology by which the program was built. If success is found in the product, so is it also in the means that delivered it. The implication of expanded teacher training may, theoretically, be one of the most important implications of the study.

***Contributions to STEM for Multi-Active students*.**

Hispanic students have been failing STEM subjects and dropping out of high school at a rather phenomenal pace, and it does not appear to be slowing down. This study developed a grounded theory, a blueprint, that demonstrates a way to improve the situation. The theory is complicated with many technical moving parts. The elements to the theory are not traditional. They tend not to follow a five-step lesson plan, there's no traditional homework cycle, nor does it depend on the typical instructional resources. Implementing any high school STEM program would require change, but perhaps AREA154 may require them to change too much. This study developed a uLearning theory which delineated skills requiring future teachers to embrace additional professional philosophies their traditional educational training is likely to reject. More optimistically, the AREA154 program has the best chance of thriving if planted in a STEM classroom where the teacher is either new to the teaching field, new to the subject matter, or perhaps an instructional experimentalist. In any case, the theory was clear on the importance of the teacher. Like planting a tropical bush in the desert, if AREA154 isn't seeded in the right environment it will die and possibly cause confusion, increase confidence-restricting experiences, and push students further away from STEM areas rather than pull them in to it.

Reflections as primary researcher / designer / instructor

***Burned to the ground, but rose from the ashes*.**

Before *AREA154: Apocalypse Division*, there existed a less-developed iteration called *AREA154: BlackOps*, which possessed glimmers of uLearning potential. BlackOps was themed around alleged conspiracy theories, and hypothetical CSI-like scenarios which introduced the chemistry but with a built-in theme. BlackOps was built on an version of WordPress and lacked the integrated backend sophistication of Apocalypse Division. They were similar curriculums but with one significant difference… the clientele. BlackOps was deployed at Mesa High School in Murrieta, the second most affluent city in Riverside County. The town had money, the kids (for the most part) had money, and consequently a larger population of Liner-Active students and parents.

The majority of students demonstrated great affinity for the stylized chemistry class, likely due to the pervasive feeling among Mesa students concerning the traditional chemistry course. Meetings among the chemistry teachers often let to lamented the high failure rate as it was the highest in all sciences. However, many of the parents and type-A high-achiever students balked at the BlackOps design and scoffed that it was not chemistry and would damage their child's chances of succeeding in college. Not too long after the parent emails, the administration arrived to attempt to squash the controversy, which usually involves an attempt to please the parent by strong-arming the instructor. After years administrative headaches and overly-involved Linear-Active parents, the decision was made to accept a recruiting offer to go to San Jacinto, a far less glamorous location with poorer students, unlavish surroundings, but district ripe with title one technology money.

A new type of student meant a new flavor of problem. These students made choices that were confounding and the first few months offered time to seek solutions though none came quickly. In fall semester of the Boise State University Doctoral program, in a class called "Culture and technology," the Lewis Cultural Triangle sparked insight into an answer. It was the ignition point that lead to retooling and rebuilding BlackOps into the *AREA154: Apocalypse Division*. During the first two years of its implementation both content from the doctoral program and students' (users) experience-based feedback, the system was built, torn down, rebuilt, and forged. The district cabinet visited the room four times during that period. According to then principal Luke Smith, was highly irregular but impressive. Three different SJHS administrators commented during teacher evaluation debriefings on the high concentration of students actively engaged. It is assumed that other classes performed differently based on the reaction of those who have been in other chemistry classes? Allegedly, it was a rare sight to witness.

Past production experiences working to maintain integrity

Transparency in analysis is one of the more essential merits for a qualitative to allow reader of the research to see the experiences, biases, and previous experiences that lead up to the completed research. Transparency provides the means for the reader to see the evidence and derive the conclusion for themselves, much like a juror in a court case. The researcher for this study is no stranger project involvement, much of which demands direct involvement. One of the most important lessons learned while building and implementing educational technology platforms involves learning how to remove oneself from the development equation. If the product is going to get better it needs to be critically evaluated. For the product to work, the evaluations must be the truth, regardless of one's personal feelings about the matter.

An illustration on the effect of self-removal, take a video of someone, anyone. When shown back to them, they may demonstrate some emotional reaction reflecting a narcissistic as the image reflects them incongruently with their elevated self-image. Perhaps the reaction feigns some shock at how "bad" they look or sound. People have a sensitivity about how they appear to others. This emotional reaction applies to video, audio, one's writing, painting, or anything else that reflects a sense of identity. Bias stems from this notion, and can skew data aligning results with one's identity reinforcing a previously held self-image. For this reason, all industry-sponsored research tends to be more heavily scrutinized. Any research for truth that closely incorporates the researcher, the subjects, and the study should face higher scrutiny.

The question of how one separates the work from personal emotions takes work and practice. The lead research in this study has participated in many multi-year self-driving projects that have both succeeded and failed. Failure is a hard lesson to learn, though tends to be the most meaningful. Many early projects failed due to the designers' resistance to outside criticism and despite the truth being share, shrugged it off to build something that endorsed self-recognition rather than self-gratification for designing a working product. Letting go of 'self' became part of the failure lessons that lead to the development of other successful large projects.

Design flexibility and only the fly system-wide adaptation.

Distinct advantages arise when one is the site administrator, curriculum designer, and the instructor. If something goes wrong, or some part of the site or downloadable PDF does not function as it should, the fix can be implemented almost immediately. For example, this happened on many occasions. The first-period class demonstrates a need for an additional feature on the PDF. In recognition that the new feature's addition could improve the students' experience, that feature could be added to the PDF in Adobe InDesign, saved to the PDF, and then uploaded to the media cache online. Before the second-period starts, that new feature is already loaded and ready. A more specifically noted by Stu-F-9-7, she indicated that calculator links were added to the PDF, and felt the additional steps saved by opening a calculator in a new tab were far better than trying to find one on her phone.

What she did not realizes was the calculator link was added two periods prior because first period appeared to need one and not having one caused a large number of students to stop working. Moreover, the calculator used on the PDF trainings was the same calculator used on the district math assessments providing practice and familiarity. This story tells how instructional technology and curricular cross training can sever the students' needs when they need them served, while emphasizing future staff technology integration training options.

Adaptation and possible implementation

Current deployments of AREA154.

Prior to this investigation, principals and school directors who had witnessed the system's design inquired about the possibility of implementing the AREA154: Apocalypse Division program in their schools. Curiously, neither of these schools represented the same demographic as SJHS, the initial pilot school. The director noted the system was not intentionally designed for other populations. However, there is a strong likelihood that, if deployed correctly, the system could potentially provide some very valuable STEM experiences. Some went better than others, but every example falls within the parameters of theory expectations.

At Springs Charter Schools, Riverside, CA.

Springs Charter, specifically the Flabob Airport Campus within the Springs system, implemented the system at a list minute's notice. The school hired a new science teacher, and she was not well prepared in chemistry. The principal, having heard about this system, asked to use it to help supplement the instruction. The new teacher was on the system, how to use it, the uLearning design ideology and the thematic narrative's importance to sustain engagement. That was the limit of the teacher's exposure. As a result, the implementation failed. Upon further investigation, the teacher never used the website that was set up for her. She downloaded the PDFs and then uploaded them to the school's Canvas-based courses. Based on an interview with one of the students who was very confused about the nature of the course, the teacher provided absolutely no background on the thematic integration and did not use the website, nor did she use the pre-made SRTs. Soon after some time was spent on the phone with the student. Some developer-type insights were provided to the student about the program. After which, the student began to respond much more like the students in this study. Interest went up, engagement went up, and for a short while. The teacher made no attempt to pursue further training.

At SJHS – adopted as NGSS chemistry curriculum.

A teacher who used to be in the math department at SJHS was placed in the physics class because she had a physical science supplemental. Due to that supplemental, she was also asked to teach chemistry as well. With little to no chemistry background, AREA154 was offered up as a possible solution. Same high school, same subject, but very different teachers teaching it. Each time a new training came up, both the designer and the new "director" met and ironed out questions concerning the curriculum and what each part of the curriculum meant. Over time, the new director noted that the students did not seem engaged, and the designer investigated for an explanation. The problem was discussed and after some examination, the cause appeared to be the lack of thematic narrative inclusion. This study indicated the theme played a very influential role for the students' confidence-building experiences, and lacking narrative exposed, context to the real-world applications, the students were very neutral towards the program. The new director demonstrated all of the fundamentals of a good STEM teacher. There was nothing notably wrong with her methodology. She was, however, lacking the sense of adventure and play – a willingness to lose herself to the director's role. Which, among science teachers, is arguably a scarce commodity.

The solution for the theme implementation issue involved inviting her classes to come along and listen to the case file briefings. These class days are spent creating the setting for the case file, research, professional testimonies about the reality of the case files was not uncommon. These were big, in-your-face, dramatic, hard-hitting presentations that drove the thematic narrative home. Several days after the first group briefing, the new director noted the improvement in engagement and the increase in spontaneous conversations about “what if” scenarios and conversations they had with family and friends. The new director is not so new anymore. As her abilities grew with the chemistry, the AREA154 site was used less and less, SRTs replaced with paper-based tests, and a greater focus on mathematical applications of the curriculum. She did what any good teacher does with a curriculum. She evolved the material to match her personal and intellectual strengths. While *AREA154: Apocalypse Division* served as a starting point, it is unclear how much of the original system has remained over the last three years of use and modification.

At Hope Academy Bishkek, Kyrgyzstan.

The third installation of AREA154 was deployed in a private school run by Randall Gwin. As in the previous examples, Mr. Gwin had to take on teaching a STEM chemistry course. Not being a chemistry specialist or even a science major, the AREA154 system provided a pre-built, semi-proven platform that could function as a starting point. Mr. Gwin, a doctoral student at Boise State University and a cohort member of the program designer, was familiar with the AREA154 concept. It came up and been discussed several times in a variety of classes. The students' pictures, who by profile appeared to be very bright and highly self-motivated, blazed through the curriculum. Pictures of their labs, comments about the curriculum were sent back occasionally to share their experiences. Reactions among the students and parents were positive, and the curriculum as delivered by Mr. Gwin was well received. Mr. Gwin also went so far as to arrange an “Ask the Director” day where the students who finished the program could ask the

Director, the program designer, any question they wanted. This conversation took place 14 time zones apart but was the highlight of the experience, according to Gwin. The program was implemented the following year but with a different teacher. Feedback on the new year has been limited.

Possible future deployments and variations

As of February 2021, conversations between Noel Quinones creator of *Operacion Exito* (operacionexcito.com), are leading to the development of a hybrid version of the uLearning system. Rather than case-files that last for months, small packet-sized missions would be the focus. Completing the mission packets raises the “Agent’s” Status among the group of individuals enrolled in the program. In essence, they are operating like the gamified curriculum in the AREA154 uLearning system. *Operacion Exito* currently has 50,000+ plus participants across 5 South American countries and is based in Puerto Rico. Mr. Quinones was referred by someone who had attended a presentation covering the preliminary research on the *AREA154: Apocalypse Division* uLearning design concept and its impact on Hispanic youth.

VROsmosis – Christophe Gomez, a former video game producer and now head of the Video Game Design College at The Art Center, caught wind of the AREA154 concept through a conversation at the SIGGRAPH conference where he met with the designer, instruction, and educational researcher behind AREA154. After several lengthy discussions about virtual reality and its potential for next-level science instruction, a team of four highly trained professionals formed VROsmosis. Over the year, a VR experience directly influenced uLearning principles, and inspired by the *AREA154: Apocalypse Division* theme, a demo was produced. The working title of the project is called *ARK Agent: Project Apollo*. The term “ARK Agent” is directly based on the role that students play while enrolled in the *AREA154: Apocalypse Division* classroom experience. The current Apollo Project narrative was based on the "Zombie" Case file found in the AREA154 curriculum. Development is in its beginning stages. Further development will likely build from this research and offer additional opportunities to research the CBEs provided through the virtual reality interface.

Limits on implementation. Based on prior experiences with schools that are highly Linear-Active, well-funded, and exist in affluent communities (or think they do) are likely to not respond well to this curriculum. I think, a graduate student from National University put it best. He said, "It's a wild system. But it would NEVER fly at my school." He had a point. Competitive high schools know that to succeed in college and do well in college-level science, one must have a solid, highly factual, and gritty foundation to survive what is, unarguably, a far more intense Linear-Active system while at university. The AREA154 methodologies would likely be seen as more of an impediment or an unnecessary hindrance to students that need to have as much hard dry science delivered to them as possible. The Grounded Theory developed in this study would concur with this observation. Which, interestingly, leads to something of an enigma.

Is the AREA154 program actually harming students' chances to survive in college or take advanced science classes? The argument is a valid one. Metaphorically, a thematic uLearning curriculum provides the "spoon full of sugar to make the medicine go down." Essentially, the experience reduces the grit students need to develop to survive higher-level courses. SJHS addressed this challenge by providing a two-tiered choice for students. If students were not so science-minded and needed a course to satisfy the A-G requirements for lab science, the AREA154 uLearning program severed the purpose. However, if students wished to pursue higher levels of science, IB and AP courses were provided for them. Though transitions between

AREA154 and higher chemistry levels do not happen often, the results are surprisingly positive. In the last three years, four students made the transition. All of them kept pace and thrived in the class. The answers were interestingly similar when asked what contributed to their success in a much more challenging chemistry curriculum. In short, they succeeded because they had solid, relatable, and meaningful ways in which to apply the dry science. They made it real for themselves.

Application to other high school subjects. According to the designer of AREA154, math would be the Holy Grail, so to speak, for program implementations. Initial efforts to begin talks on creating a math-oriented AREA154 stalled as the Math department demonstrated resistance to the idea of a thematically directed math class. The idea was foreign to them, and the idea of becoming thematically involved in the class themselves was even more foreign and less likely to happen.

Another attempted to broaden the uLearning ideology was made with the Language department. The department head was all for the concept and felt that the narrative would fit well within the class. Additionally, the idea of having the uLearning systems in place would sell well to the rest of the department. However, talks stalled when talking about the skills needed to make the system function properly was introduced. One could posit that the department is not very tech-savvy and was off-put by the type of technology required to build the system and sustain it.

Limitations to the study

Covid-19:

The pandemic and the havoc brought upon the public schools stands as the single most limiting feature to the study. The changes in protocols and students' absence from the campus drastically changed the original data collection methods for this investigation. When the original proposal was presented, there was a potential that schools would come back to the site in at least some form in the Fall. Unfortunately, that was not what ultimately panned out. As a result, several complications arose that may have impeded the study.

Access to students. Had students been at school, reaching potential subjects would have been far less labor-intensive. One could simply find the student, look up their schedule, and drop in on the class if needed to deliver the request by hand. Due to pandemic protocols, access to former students became almost entirely dependent on email. This fact may have a built-in bias that explains why more students at the lower end of the achievement scale didn't reply to be interviewed. While seeking subjects, a group of students were selected based on the criteria described in the Methods section on participant selection. There was a group of twenty-five students that were emailed. Zero students replied. Another set of emails were sent out. Again, no replies. The email philosophy was altered somewhat and shortened to basically, "Are you still enrolled at SJHS?" Curiously, this got students' attention and encouraged them to open up a conversation about being a part of the investigation. In total, 78 different students were emailed, many of them three or four times.

First to respond were the students who would be considered higher achievers, followed by the students in the middle and upper-middle of the grade spectrum. The students at the lower end of the spectrum were far more difficult to recruit. One could argue that students who respond to teachers in class are more likely to respond to an email. That possibility, though untested, is still plausible. Additionally, it does posit an explanation for the higher concentration of 'A's and 'B's than 'C's, 'D's, and 'F's in the subject pool. The condition behind finding participants and the struggles to sequester interviews were quite real. An official reason for it would have to be explicitly investigated to cast potential shadows on the study results officially.

Access to the original classroom. The interviews were initially slated to have taken place in the same class that hosted their experience. The recall of the facts would have been far more detailed, having the AREA154 realia in their hands and sitting in the seat they sat in a while enrolled. An argument could be made that the data may have come out differently had the subjects been interviewed on the campus and in that room. However, the direction of that influence would be impossible to assess. The lack of access to the original classroom led to the creation of a 15-minute long video. It highlighted a variety of different case files and classroom experiences to help the subjects reclaim lost memories and answer the interview questions as accurately as possible.

Perceptions of success

Subjects were asked towards the end of the interviews about their perceptions regarding personal levels of confidence and success in STEM subjects. Regardless of their class grade, the students appeared to recall very positive memories consistently and testified to how much they felt they learned. These Affect Numbers were presented in Phase IV as a reality check between actual student achievement and what they felt they achieved. When students were asked to compare AREA154 to all their other classes, science or otherwise, how much would they say was learned in each. The majority of the students responded without hesitation. Replies stating AREA154 experiences represented one of, if not the most, intense learning experience of their high school career up to that point. Yet, most of the subjects that replied this way were not the ‘A’ caliber students. Some of the students in the higher levels of achievement responded in the affirmative. Still, the most fervent responses came from the middle and lower-middle achievement levels of the subject pool.

Are the students not recalling how much they learned? Are they comparing AREA154 to other classes where they did not learn as much? Are the student's responses based more on nostalgic emotional memory than on facts? According to Lewis (2010) the latter is entirely possible. Multi-Active people display a strong propensity to focus primarily on how situations feel. This Multi-Active trait may explain the discrepancy between what the subjects felt they learned and what their earned posted grades. However, in defense of the subjects' self-assessments, one of the primary Multi-Active psycho-social tendencies is deprioritizing the need to "produce" for the sake of producing something. Frequently, students who have moderate to low grades in the class will be the same students who introduce the most exciting discussion topics or participate in group discussions. These same students could sit and talk about the course content in various ways, yet, get a 'C' or lower on their SRTs or killed during the Examulations. School grades are acquired by producing work, essentially, "earn" a grade not "learn" a grade. The legitimacy of the grading system to measure learning is beyond the scope of the study. Though, it should be noted that it is very likely that students' Multi-Active psycho-social behaviors played a role in how their grades turned out, yet not how they felt about the learning experience.

Formative assessments as "slot machines"

Anecdotal observational recall a specific SRT-taking technique that may influence some reported results. The practice was referred to as "slotting" and recalls efforts of students who did not prepare for formative assessments randomly guess on quiz answers only to fail and take the test randomly again. An unknown but theoretically sizable quality of students used "slotting" to take their SRTs. Normally students were encouraged to take the SRT and go through their notes to find answers. Slotters would ignore this and "play" SRT again. Slotters do not prepare or often forgetting to even put their ATN on the desk. After receiving a score usually somewhere in the 40%-55% range, they would try again. Much in the same way a slot machine might give a person lots of money without having to work for it, these students would make attempts over and over to “win” a good grade without having to study or do classwork. This practice rarely paid off, and more importantly, it reduced the meaning of the data when reviewing it to see what students know and what they do not. Unfortunately, Sensei, the LMS software for WordPress, does not keep track of SRT attempts. Therefore, an 80% after one attempt looks the same as an 80% after 20 attempts when looking at the student scores. This discrepancy can lead to erroneous assumptions about what students actually learned and ultimately present a possible limitation to the students' grades assessed in this study.

Procedural inconsistencies

Some subjects did not respond to all of the questions. In some cases, the data could be inferred through replaying the interview and discussion transcripts. Still, in other situations insignificant quantities of circumstantial data to in habited presuming an answer. Some of the questions were just left unasked. This missing data is sure to have an impact on the final results. However, the impact should be minimal.

The Law of diminishing returns and the need for stimulation

The link between interest in a subject and motivation has been long established by educational research. Schiefle (2011) writes, intrinsically motivated interest as “a content-specific motivation composed of intrinsic feeling-related and value-related valences” (p.299). Earlier in chapter 3 the notion of engagement and the results that “theme” had on the level of emotional focus a student was willing to provide to a specific topic. The difference here lies, perhaps, in the type of emotional and feeling-related stimuli is provide. The theme appeared to give a very general sense of existential emotional feedback. The class's subjects experienced dissonance that their life, their family, and their way of life could be at risk. This emotional interest is not content-centered but merely a “shoe-horn” so to speak. The theme provided the emotional hook to expose the subject area. However, all of that also has a limit.

The Law of Diminishing Returns famously predicts variances in economic markets, perhaps because it also describes general human behavior quite well. AREA154: Apocalypse Division experiences the same thing very much and has done so every year for the past four years. Interest level at the beginning of the year was observed to be very high, almost anxiety-inducingly high because the experience is new and nothing like the students have ever seen. A ticking-timebomb of a mega-volcano sits in their very backyard and is said to be over 40,000 years overdue for a massive world-altering eruption. After about four weeks, the immenseness of the situation dies down. From the outside, looking in, the class now has the appearance of a very oddly designed science facility. By week seven or eight, the routine has set in, and there are few emotionally energizing events anymore. Granted, news articles about the famed “Yellowstone Super-volcano” are pretty free-flowing. They can be used to stoke interest only so long before the routine becomes, well, routine. The phones come out, and the social media-induced attention deficit disorder kicks in, and students look for the next hit of dopamine from the easiest place to find it. Things change a little when the Examulation starts and the students are shuffled up into disaster teams. They must now use their notes, resources, and each other to survive a simulated eruption. The narrative fires are stoked again as the next case file starts and a different world-altering apocalyptic event spools up.

After several cycles of this, by mid-Spring, after three or four case files, the students demonstrated sever signs of diminishing returns. At this point, as the designer of the program, asking what can be done to stoke the fires of attention becomes a weekly question. Perhaps there is some sort of balance between feeding into the modern student's constant need for stimulation and training them to be patient and wait for the payoff that comes from diligence and hard work. This enigma of oppositional priorities continues to be investigated as new versions of AREA154 are deployed.

Integrity of student grades.

Student experiential testimony is hard to debunk. It's what they think. Grades are different and result of assessed tangible work. However, limitations exist when examining the grade's validity and questioning the how much of the grade was completed the subject. During the interview process, a pattern began to emerge connecting how much a student could recall and the grade. Subjects with higher marks were known to do the work in the ATN. In interviews, they spoke with a certain speed and confidence about the subject. This pattern persisted through the interview process until subject Stu-M-9-8 was interviewed. The student was ranked ninth in overall class grade. However, as noted in the student observation memos, he provided shockingly little in terms of a specific course and program details. Observationally, the memos noted that subject Stu-M-9-8 frequently requested help from Stu-M-4-3, a fellow ROTC member and friend. The requested support was often not assistance, but the other student's ATN so that he could copy the section as quickly as possible with as little effort as possible to get credit for finishing. Usually, this sort of activity is filtered by Examulation, meaning that those who did not put some effort into completing the ATN were all but sure to "die" early (fail) the summative assessment. As it turns out, Stu-M-9-8 passed. Though, it also turns out that Stu-M-4-3 was in the same group during the Examulation as Stu-M-9-8 . In total, this sort of example was rare but not unheard of throughout the general population of students. The Examulation did weed out those who tried to take short-cuts, mostly. This example suggests there are some limitations to the cross-validation of student testimony. While also exposing why using student grades to determine the Affect Numbers helped catch bias, deception, or just a bad memory on the part of the subject.

Conclusion

Applying the theory

Phase I: Student/Site Interface

> ***Conceptual Application Proof (CAP) - 1 :*** Students at a variety of different achievement levels demonstrate the ability to experience confidence-building events and these events provide evidence of improved STEM area self-confidence. The theory must be able explain and predict situations where succuss is and is not experienced.
>
> ***Conceptual Application Proof (CAP) - 2:*** The AREA154: Apocalypse Division program has identifiable elements of uLearning included and demonstrates these criteria as contributors in student confidence-building experiences.

The system-human interface, if designed poorly, can impede the utilization of any system. Phase I collected information on the subjects' experiences and provided them with carefully considered qualitative ratings. These values helped evaluate each category's impact on subjects' perceptions of success and confidence (self-efficacy) in STEM course. Affect Numbers over three indicated the measured values contributed to the subjects' confidence-building experiences and an overall more rewarding STEM learning experience.

In the area of site usability, students maintained the interface was mildly challenging, while systematically understandable. The Affect Number for site usability was 3.8, indicating the site was usable, accessible, and contributed to the overall CBE. Lingering questions about content placement contributed to a slightly lower Affect Number of 3.5 for the site's organizational impact. Most of the subjects' comments were quite positive about the overall organization, noting that it was easy to use, once they were aware of its overall design structure.

Some of the design complications users noted were not over looked by the site designer. Attempts to adjust the menu locations and content accessibility helped, but were limited. The WordPress theme used for the site was called "MyStyle" and in conjunction with the Sensei LMS plugin, WordPress did not provide clear means by which to change the site organization, though attempts were made. Overall, site organization was not a hindrance to the subjects' confidence building. Further compounding issues with content access, subjects' Wi-Fi instability at home or away from school. At school, subject data reflected very positive experiences.

Phase II: Subjects' Perceived Experiences of uLearning System

The educational technology design paradigm called uLearning operated as the "solution" for delivering STEM content to Multi-Active Hispanic students. The multi-facetted ideology was the developmental axis for building the *AREA154: Apocalypse division*. Subjects' collectively provided an overall Affect Number of 4.0. It was the highest Affect Number of the first three analysis phases, possibly confirming the assumption that uLearning was solvent with the Multi-Active students. While other cultural populations may present benefit from uLearning, perhaps even produce similar Affect Numbers. The evidence collected indicates to potential designers these results may only be applicable to learners who occupy the same cultural profiles as the students in the subject group.

Huang (2018) presented the criteria that comprise a uLearning system. The definitions were succinct, but the inclusionary criteria for each were broad. The broad nature of these defining characteristics leaves wiggle room for designers. As a curriculum or technology designer, Phases I and II represented factors be controlled or manipulated to build stronger, more robust learning experiences. The results concerning the each category of uLearning can be broken down in to three layers. The subjects' interview feedback pointed to positive (numbers over three) CBE for each category. Though some were higher than others.

High impact areas. The areas with the highest impact included fast-feedback on SRTs and other assessments 4.7. Also, the apocalyptic theme encasing the room, the website, the examulations, and the ATN 4.5 here highly valued. The on-demand features built into the downloadable PDF (Director icon and Media icons) suppling instruction and directions for the content forgotten or missed 4.4 was valued the same level as the centralization of all of the STEM course content on a centralized server that was the hub for all the educational experiences 4.4. The Affect Number of 4.4 for central site is much higher than the evaluation given to the site organization and content accessibility values. This could indicate that if the site had a more student-solvent design or was even designed as an site-app combination, the Phase I value could rise further.

Medium impact areas. The real-world application of the class information collected an Affect Number of 3.9, self-pacing and flexible deadlines 3.8, the gamification of learning including the Top Agent Leader board and use of achievement points for ranking was 3.7, Social connections provided by the daily site posts and class interactivity also received a value of 3.7. The relatively high impact of self-pacing and flexible deadlines may be more than just procrastination.

Richard Lewis wrote an article for the *Business Insider* called, “How different cultures understand time” (2014). In the article he calls back to the various behavior sets and notes that the Multi-Active peoples do not see time as a measure of respect as Linear-Active cultures do. The Linear-Active psycho-social profile link time and the ability to produce, make, and strive for more. To negate the time structure is to negate productivity, one of the core axial behaviors for Linear-Active people. Multi-Active priorities put productivity, for the sake of productivity, much lower on the list cultural values. As such, making time or being efficient with time for the sake of getting work checked off a production list holds little value. The endorsement of the flexible work schedule and self-pacing could be a subconscious endorsement of the Multi-Active disregard for time.

Mild impact areas. Interestingly, the idea that a student could use nearly any internet-connected device anywhere on the planet to interact with the program only provided a very mild CBE Affect Number. This finding, does, however, make more sense when considering the student Multi-Active profiles and backend showing low afterhours engagement numbers.

Phase III: Non-categorical influences

No system stands in a vacuum. Outside forces influences the individual using the system. The same could be said for classroom students at any learning institution. A theory must identify, explain, and predict the influence of variables associated with the phenomenon under study. The learner is a complex composite of fluctuating unknows. Some of which can be controlled by skilled teachers and some by skilled instructional design. Some outside influences are out of the control of both, but still have an impact on the learners' experience. The developing theory would be incomplete if these non-categorical factors weren't included. For the curriculum or technology designer, this answers the question, "What sort of effect would these additional influences have on the overall Affect Number of the program?"

Non-categorical CBEs and outside influences. Areas of higher impact included the subjects' inherent interest in science 4.0. This category reflects the subjects' view on science after their AREA154 experience and therefore could be skewed, not truly representative of the their inherent interest in science. The personal motivations for learning had a wide range of codes ranging from the entertainment value of the AREA154 theme to just being interested in the grade. Motivations varied greatly. Those who indicated an intrinsic motivational theme collectively created an Affect Number of positive CBE value of 3.9 while enrolled.

Non-categorical CREs and outside influences. The result for family interactions could be considered a bit misleading. The Affect Number value of 3.0 indicates that it had no influence in either direction. Knowing that Multi-Active cultures put family as a very high priority, this result does not appear congruent with the Multi-Active profile. The result began to make more sense when the sources of the value were considered. Subject data indicated that the students either had relatively positive CBE interactions with family, which included frequent conversations about class, supporting study time and the like.

Unfortunately, not everyone's experiences were as supportive. Some of the students insinuated that there were "troubles at home," but never went into details. The one very evident commonality here was the connection between students with trouble at home and the CRE impact it made on the subjects' school experiences. Every subject coded this way was either at the bottom of the achievement list of operation far below their academic potential.

Intense emotional drama and cognitively derailing events are not limited to the home. For example, Stu-7-17, remarked how his "crazy girlfriend" in the spring represented a very large CRE. The social distraction caused a two-letter grade drop in his STEM grade. Only through some heavy mentoring did the subject even pass the class—events similar to this happen infrequently but devastating when they do. Three of the subjects experienced some form of "trouble" that was out of anyone's ability to control, yet hugely impacted their academic performance. The collective Affect Number for external struggles was 2.8. One could argue that a different set of students may not have warranted the same collective score resulting in a higher Phase III average. Conversely, the opposite argument could be made. This section attempted to get a "flavor" of the impact. Larger sample studies involving non-categorical traumas would need to be done to assess if the external struggles theme was represented with statistical accuracy.

The final theme analyzed was the instructor had on the course. Note the Affect Number has a low value of 2.5. The low value is not to say that the teacher detracted from the experiences, quite the opposite. According to subject interview data, the course could very likely not be taught well by anyone else, not tallied officially, a rough estimate would put the CRE values for this down around 1.2. Many subject repeated the notion that the person who created the curriculum would be the best at teaching it. The subjects' consensus pointed to the possibility that AREA154 was, as one subject stated, a “one pony show”. After discussions with the subjects about teachers’ personality traits, instructional habits, personalities, some subjects agreed that with training and the right sort of teacher, similar results could be attained.

These results tend to point to an inherent weakness to the implementation of AREA154 in other classrooms. Such examples of failed attempts are detailed in the Discussion chapter. One of the more revealing findings from theory development centered on the teacher’s willingness to invest into the theme. Those to factors more than any other appear to be directly correlated when successful iterations of AREA154 were launched. That is not to suggest that teachers that deploy a uLearning system need to follow the curriculum Narrative exactly, in fact, quite the opposite. A teacher who uses the AREA154 system as a start could branch out on their own, develop new case files, adjust the existing cases, and write their own SRTs, as long as the narrative grows with it. Actually, this example might be the most ideal possible outcome. AREA154 is not just a product or just design, it is a seed. A kernel that when planted in the right place could grow in to something spectacular. The developing theory actually predicts it.

Phase IV: Subject analysis for Multi-Active validation

> ***Conceptual Application Proof (CAP) - 3:*** The students benefiting from the program were classified as Multi-Active through a variety of assessment tools.
>
> ***Conceptual Application Proof (CAP) - 4:*** In their own words, uLearning participants indicated the experience provided confidence-building experiences resulting in an increased level of self-confidence in STEM subjects.

The Multi-Active confirmation came from a variety of different sources of data. Establishing the psycho-social connection to the students' self-perceptions underpinned the investigation. As noted earlier, Hispanics have the highest failure and high school dropout rate of any ethnic minority in the United Stated. They are in trouble. This study hinges on the ability to demonstrate the subjects of the study (the students of SJHS) identify as Multi-Active.

Multi-Active validation through question and answer

The data collection on Multi-Active behavioral confirmation took the form of a question-and-answer session during the interview. A situation would be provided where two options for actions would be provided to the subject. One option reflected the sort of actions associated with Multi-Active inclinations. The second would be oriented towards Linear-Active type behaviors. The questions allowed the subject to analyze the situation and make the choice they felt was more akin to who they would react in the situation. On average, the students chose Multi-Active traits 7.7 times out of ten questions. Four of the subjects rated as a nine (9), which was the highest recorded value.

Oddly one subject, Stu-M-4-3, reported with a score of four (4) out of ten, clearly more Linear-Active than Multi-Active. The result was puzzling as the student actively described himself and his family as Hispanic, yet, he scores as Linear-Active. Two interesting observations contribute to understanding this response. During the interview, pictures of Air Force paraphernalia were cluttered on a shelf with metals and photos of people in uniform. It turns out that subject Stu-M-4-3 is the product of a military family. This observation would likely describe the Linearity in his thinking and decision making. Also curious was the subject's behavior at school. Noted on many occasions (and in subject profile memos under observations) subject would engage in social conversations with fellow ROTC associates during class. When asked about their productivity, the subject would often state that he would have it done but would later.

This reaction, the notion to favor emotionally gratifying or engage in feeling-based logic, is hallmark psycho-social behavior for multi-Active people. Stu-M-4-3 has done what several other high-achieving members of the study have done. According to the interview results, this particular trait can only be accomplished by a powerful outside influence capable of overcoming their primary psycho-social tendencies.

Student profiles add to the data pool, validation for growth.

Phase IV shifted to focus on the subjects of the study. Student profiles included observational data collected to summarize actions in class and memos that reflect soft-data observed during interviews. Aeries student grading system provided a graded history tracking the subject's progress throughout the academic year and with additional access to freshman STEM grades. The data could be used to analyze evidence of STEM progress. Grade comparisons indicated thirteen of the eighteen (one of the subject’s data was not accessible) subjects received higher grades in AREA154 than their freshman STEM class. Overall grade comparisons demonstrated seventeen of the subjects’ AREA154 STEM grade was in the top two of the four core subjects. For thirteen of the subjects AREA154 STEM grade was the highest or tied for the highest of the core subjects. The numbers here tend to point towards an increase in STEM self-efficacy through the CBEs in AREA154. A full freshman year core subject grade analysis would be needed to conform this, which would require administrative clearance beyond the limit of the study. Furthermore, fifteen of the students presented an even greater command over the content posting grades higher than fall semester. Results from Table 4.X and 4. X is below.

Subject grades compared to other core classes:
(Code = Top-grade)

- Subjects who's highest grade was in STEM: 8 of 19
- Subjects who's STEM grade was tied with another: 5 of 19
- Subjects who's second highest grade was in STEM: 5 of 19
- Subjects who's STEM grade was lowest among core classes: 1 of 19

Subject grades in AREA154 (soph. year) vs. freshman biology
(Code = Better-than-frosh)

- Subjects who's AREA154 grade was higher than freshman Bio: 13 of 19
- Subjects who's AREA154 grade was the same as freshman Bio: 3 of 19
- Subjects who's AREA154 grade was lower than freshman Bio: 2 of 19

Subjects who's grade improved in the second semester

- Subjects who's AREA154 grade was higher second semester: 15 of 19
  (code= 2ndSem>1stSem)
- Subjects who's spring grade improved by over 10%: 6 of 19
  (code = 2ndSemResurgence)

In both categories, 68% of the AREA154 uLearning subjects demonstrated grade superiority over their other subjects (top or tied) and grades higher than freshman-level biology (or BioMed I). As a side note, one student who's AREA154 grade was the lowest among core subjects failed all of his spring semester classes, though, he was one of the three or four subjects that rated highest for potential domestic struggle (*Code = Trouble@home*).

Positive Linear-Active integration, rare examples.

One code was used for subjects demonstrating the ability to integrate into the Linear-Active U.S. school system's psycho-social profile. Three of the group's top achievers demonstrated behavioral traits indicating a dual behavior pattern. At home, they were Multi-Active. However, at school they operated under and prioritized their in-class and school-based activities in a way that aligned them to a Linear-Active mindset. Previously noted, Stu-M-4-3 was born into a military family and the member of a military class on campus. Stu-F-6-1 appeared to be forced into a Linear-Active behavior set by her anxiety disorder. According to the subject, a lot of her success in school was correlated with retreating from other people. Subject Stu-F-7-2 was the oldest in her family, and she indicated signs of being highly managed by her mother. Schedules were managed, diet, after-school activities, grades, even school attendance under the watchful eye of the students maternal influence.

The results here present a bit of a dichotomy, an irregularity. These subjects demonstrate cultural integration is possible. So, the question remains, why does this cultural integration happen more often? The answer may be speculative, on the brink of just guessing. In the introduction where the socioeconomic status of the community listed San Jacinto in the lowest echelon of prosperous towns. The assumption might be that everyone shares the same level of affluency. It is likely that cities fiscal status is distributed across a bell-curve, meaning there are people that exist above and well-above the mean. While this next assumption could be verified through tax document analysis, having a higher family income could explain the subjects' apparent Linear-Active integration. Typically having money requires having a form of production mindset. For these subjects' the family's economic status could be playing a role in their ability to integrate behaviorally.

Self-reflective assessments on the AREA154 CBE impact. A

At the end of the interview process and, in some cases, through follow-up emails, subjects were asked to talk about the overall AREA154 confidence-building experience. They were explicitly asked how experiences within AREA154 (Phases 1-III) built their confidence since freshman year. The results delineated a strong affective response with an average AN of

4.3. According to the subjects, the system, the experience, and all the factors both systematic and not provided a large quantity of STEM confidence-building. In contrast, every subject that was asked (and not all were) about taking STEM classes after AREA154 and the responses were variations of the same response. Ranging from “Horrible” to “I’m not liking it all that much.” some reactions were more extreme than others. Across the 19 subjects the message was clear. The transition back into a Linear-Active classroom was not a pleasurable experience.

Overall, the findings demonstrate that these students possess the same cultural psycho-social behaviors as initially ascribed to Multi-Active people by Lewis in his book, *When Cultures Collide* (2010). Additionally, subjects’ grades reflected noticeable improvement not only over their Linear-Active freshman STEM class, but from the fall semester to the spring. Moreover, when students were asked to reflect on their own CBEs and self-efficacy the Affect Numbers were higher than the overall AN value for the system. The student data trends in Phase IV appear to demonstrate AREA154 and uLearning design concepts address concerns expressed by Saw and Chan in 2018 having observed STEM performance and confidence issues in Hispanic students.

Implication of research findings

A theory for Hispanic STEM education.

The question of, “Can Hispanic students have confidence-building experiences in an environment that is psycho-socially not built for them?” now has data to form a theoretical answer. The theory’s current flowchart-like shape resulted from extensive multi-phased evaluations of technology, learning content, and behavioral profiling. Multi-Active students respond to an environment that allows them to feel their way through it, improvise, facilitate options and move at a pace that works for them. Lewis (2010) noted that Multi-Active people are not planners nor respond to overly stringent unforgiving deadlines. This study found, very clearly, that every subject wanted to be successful and confident. Even those who were not "successful" displayed lament wished they could have been. AREA154 as a program, guided and designed by uLearning principles produced an overall Affect Number of 3.53. This value included the negative variables of life experiences as well as attempted to negate the influence of a highly trained national-award willing instructor. Remove those and the Affect Number jumps to 3.8, a more impressive number, but not realistic. The evolving theory provides a map to place programs against and identify areas of improvement. AREA154 has areas to improve, for sure, and lacking this theory making high-impact improvements is reduced sophisticated guessing and checking.

Lewis' cultural triangle applied to education.

The results of this study show Lewis' findings regarding culture to be an accurate identifier, explainer, and predictor of Hispanic cultural fluences on behavior. The results and should become a guiding instructional paradigm for schools with high numbers of Hispanic Students. Additionally, schools of teacher education in regions with a large enrollment of Hispanic students would likely benefit from observing the stark psycho-social differences between U.S. Schools and Hispanic students and families.

However, further research in this area would be advised. Lewis' trope on cultural behaviors was designed originally for business applications. This study found that the model also applied to high school students, but more examples in education would likely enhance the credibility of Lewis' assumptions applied to education.

The economic future of the United States.

In 2007 Borjas and Katz, two Harvard economists, published a paper that can be summed up in the following passage,

> "The continued migration of Mexican workers into the United States and the inevitable rapid growth of the group of native-born workers of Mexican ancestry suggest that the economic consequences of this low-skill migration influx are only beginning to be felt." (p.53)

The article titled, "Evolution of the Mexican-born Workforce in the United States" faced criticism about its alleged racial profiling of Hispanic people. However, the statistical application of Hispanic (Mexican-born) wages, birth rates, the economic impact of low-wage earners, high school drop-out rates, and the impact low wages on the local, state, and national tax revenue, the analysis appears to be quite sound.

Thomas Edsall of the New York Times summarized the Borjas and Katz article this way in an opinion piece called, "What Does Immigration Actually Cost Us?":

> "The effects of immigration in general are swamped by the impacts the Mexican-born workforce has on the slowdown of U.S. education supplies, technological change, and eroding labor market institutions (unions, minimum wages, rising outsourcing/fissuring of the workplace)." (https://www.nytimes.com/2016/09/29/opinion/campaign-stops/what-does-immigration-actually-cost-us.html)

The census numbers from 2016 support these notions, but what does this mean? In short, it means that if a solution cannot be found that encourages Hispanic students (especially Mexican-born) to stay in school and embrace math, science, technology and engineering subjects, their collective inability to acquire technology-based higher paying jobs will contribute to the increasing wage gaps, reinforce the poverty cycle, and drain local and state tax revenues (which are based on income – lower income means lower tax revenue). Lower tax revenue means less support for regional infrastructure and a diminished ability to support local education.

Various U.S. presidents have gone on record and softly touched on the problem, but with no real solutions. Clinton motioned a hard work ethic, and a need to contribute to the country you love. As expected President Trump's response was similar but far more hard stating that they should shape up or ship out.

As preposterous as it sounds, the grounded theory delineated in this study demonstrates that the ability to pull Hispanic Multi-Active students into STEM programs is possible. The literature review on the Hispanic achievement gap clearly indicates that the problem is not getting better, but far worse and faster. Whatever the nation's educational leaders are doing is clearly and emphatically not working, largely because they are either ignorant of the cultural differences and how to address them or understand them and refuse to address the issue. AREA154 itself may not be the answer, but this evolving theory is not so much about it manifested in the AREA154 program, but the design methodology behind it. THAT is the theory and THAT may just save the financial future of the United States.

Borjas and Katz (2007) were clear on how we are all irreversibly economically, interwoven with the fate of the Hispanic immigrants. We are all in this together now. Something different needs to be done to lead them to success because if they fail, we will all fail.

Suggestions for future research

More data and the inclusion of various research methods.

One of the noted weak spots in qualitative research is the small sample size. The sample size of this study was notably larger than many comparable Grounded Theory examples read prior to the start of this study. The call for a larger, more diversified sample pool is always needed. The diversification should come from inside and outside the school, inside and outside San Jacinto, and various places in California and the Southwest United States. Moreover, the larger pools of subjects will necessitate the inclusion of more quantitative methods to gain the support of statistical analysis.

Socioeconomic overlap.

The subject pool of students all reside and attend school in San Jacinto, CA. This is not an affluent town. According to the 2016 Riverside County demographics report, San Jacinto lists the 3rd lowest per capita income of all 21 cities in Riverside County over the population of 35,000. Lewis (2010) presented a list of psycho-social behaviors associated with Hispanic people. As it turns out, the same sorts of psycho-social behaviors are attributed to people who occupy the lower strata of the income ladder. The scope of socio-economically disadvantaged students was beyond the scope of this study. However, additional research including both a Hispanic group and low-income groups may provide insight into additional areas of theory application. Perhaps, a study with a variety of low-income “white” students or African American students would provide more inclusive data and potential opportunities to ascribe Lewis’ Multi-Active behaviors with low-income students. The results could provide a greater range of students that the AREA154 uLearning program or programs designed like it could be of great benefit.

Translations into various new platforms.

As mentioned earlier, the AREA154 uLearning design has already undergone some level of transformation to other platforms. The area of learning in virtual reality is notably limited. After a thorough scanning of applications available on the Oculus and Vive stores, very little exists in the content development area the ARK Agent project seeks to address. Perhaps that market segment is not profitable, or there is a need, and the skill sets required to produce such a VR app are so rare the segment remains unfilled simply by a lack of qualified people to build the software. In any case, the research opportunities to investigate STEM learning in virtual reality are immense and continue to develop.

New forms of educational technology training for teachers.

One can make the argument that there is a one-dollar and a ten-dollar way to do anything. The technical skill involved in making AREA154: Apocalypse Division is diverse and likely not something that can replicated in an afternoon Zoom call. That being said, there are more ways to utilize the uLearning axial paradigm, but with technology, that is far less complicated. Investigations into simplified versions of uLearning systems could mark an important starting point for teachers or an addition to a current technology instructional program. Research opportunities exist both for investigating less complicated means of uLearning deployment as well as researching how uLearning environments could impact younger students who are in middle school or possibly as far down as upper elementary grades.

Pandemic readiness.

Certainly, a research topic that would have been highly unlikely even two years ago would be the pandemic readiness of an educational content delivery system. The current iteration of AREA154 was specifically built to be a hybrid experience. The students would come into class, immerse themselves in the thematic simulation, and then extend it to the outside world. The system was built for ubiquitous access. One could access the learning content from anywhere, and the PDFs were equipped to deliver automated instructional experiences so students could continue moving forward without a classroom. As such, the transition into distance learning was, on the surface, was rather seamless.

Interesting research areas might begin with comparative studies between AREA154 students who were in class and those isolated in distance learning. What sort of tole did distance learning have on Multi-Active learners within the uLearning system. Additionally, research could be done to isolate differences between AREA154 STEM students and other STEM students whose teachers did not use a uLearning-based approach. These studies might highlight the elements that promoted student success at a distance and highlight areas that could be added, removed, improved, or enhanced.

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Appendix A – AREA154: Apocalypse Division Overview

(Documents following this page)

OVERVIEW & INTRODUCTION

A curricular breakdown of all the content deliver PDFs, topics, pacing, and other information needed to train new agents enrolled in the **AREA154: Apocalypse Division**.

Josh C. Sophomore	*"This was the greatest chemistry experience ever! Words cannot express how I feel about this class."*
Cesar Q. Junior (ELD)	*"The best class in the world. The best class that I have had."*
Annon (male)	*"The experiences I had felt in this class were the most fun, crazy, and life lesson (filled) of all my classes. I will take these skills with me to use in the world if ever there is a catastrophe."*
Georgia M. Junior	*"I had no idea any of this was even a thing! An amazing class."*
Annon (Female)	*"This class is the best class I ever had. This environment is very creative, the lights, the notebooks, the tech and a whole lot of things."*
Anthony M. Sophomore	*"This was my best class! To those coming next year, if you think you are ready for this... You are NOT READY! This stuff is crazy!"*
Natalie S. Sophomore	*"I wasn't expecting my science class to be this amazing. I learned so many things that made me think about what can happen in the world."*
Laelanie I. Sophomore	*"You have opened my eyes to so many things that I would have never thought of. Chemistry was not boring at all even though I didn't really talk much."*
Brandon C. Sophomore	*"Keep teaching this way because it makes learning fun and actually interesting. This was my most fun class; it opened my eyes to the real world."*
Ryan O. Sophomore (SpEd)	*"This is the world's best science class."*
Annon (Male)	*"I really enjoyed this class. I don't normally like science but this class made me enjoy it. This was my favorite class this year. I learned so much because you were teaching what actually grabbed my attention. I felt included even though I don't talk a lot."*

About the student feedback: *Students were told that I (the researcher) would not be reading any feedback forms until 2-days after school was out for the summer. At the time of the feedback grades, finals, and all work had been completed. Students knew their grades . Students were not encouraged to put their names on the feedback form, however some did so on their own accord. The course feedback was completely voluntary, done on paper, and students were encouraged to be honest.*

John O.
Sophomore

"It didn't take long to realize that this was going to be my favorite class. I would always come home and tell my family what we were learning. They think you're nuts, but every one of them would sign up to be in here if they could. You taught me to have an open mind set and always ask questions. That will always help me."

Shailah W.
Sophomore

"This was a once in a life time experience."

Annon (Male)

"I would take this class again. I learned chemistry and lots of stuff that wasn't chemistry."

Emelina M.
Junior

"Science is my favorite subject and you made me love it even more. I feel accomplished having finished the program."

Annon (Male)

"Krav Maga in a chemistry class! That's crazy! You for real opened my eyes to everything I thought I knew. This was my favorite class of my whole life."

Emiliy G.
Sophomore

"I've never had a class like this. I felt supported and helped. Even my parents wanted to take the class.

Zach L.
Sophomore

"I was challenged by the projects but understood the notes better in this class."

Ariana H.
Sophomore

"I thought this class (chemistry) was going to be a pointless class. After I started learning, I realized this was the only class that was going to teach me how to function in a crisis. I feel stronger knowing this."

Annon (Male).
Sophomore

"My other classes were very dull and just worksheets but this class was very fun I wish I could have it again! This class made me feel like I could maybe be some-one and actually learn and not feel dumb."

Leslie S.
Sophomore

"This class taught me how to work with others and bond as a team."

Staciah M.
Sophomore

"People said chemistry was hard. The feeling of success in chemistry was great because it was easier for me to learn and I actually have know how to do some actual chemistry."

Lindsay J.
Sophomore

"I thought the Examulations were really cool, because they tested us under a real simulated disaster. The test was like trying to survive in real life and not just a test with paper and pencil."

Stephanie T.
Sophomore

"Knowing this survival science makes me feel powerful. Like, people need me."

Robert S.
Junior

"If there were an AREA154 class of any other subject, I'd totally sign up for it."

Annon (Male)

"Thank you for pushing us and telling us about the REAL world. Though half of that stuff scared the crap out of me."

Leo R.

"I had in interest in some of these conspiracies theory, but this class put the science to the stories. The survival part has more importance when the conspiracies have some validity."

Maria V.
Sophomore

"I don't mind hard if the subject is interesting. This class was both!"

Angel L.
Sophomore

"An incredible year that was full of surprises and lots of fun. I will certainly neve forget this class."

Jasmine G.
Sophomore

"Everyday I can't wait to go to your class. The crazy stuff in this class always turns my day around."

Michael L.
Sophomore

"I had a great experience in this class. I wish I could have this class next year!"

Azul C..
Sophomore

"Chemistry was way easier to learn when there was a point to learning it."

Deliliah M.
Sophomore

"The AREA154 system helped me catch up when I had to spend time dealing with family stuff. The flexibility to work at my pace made it so I didn't fail out of the class. Retakes and achievements helped save my grade."

UNIT I ____

Evidence Statement PS-1: Use Mathematical representations to support the claims that atoms, and therefore mass, are conserved during a chemical reaction.

NGSS Performance Clarification: ***HS-PS1-7 Matter and its Interactions***
Emphasis is on using mathematical ideas to communicate the proportional relationships between masses of atoms in the reactants and the products, and the translation of these relationships to the macroscopic scale using the mole as the conversion from the atomic to the macroscopic scale. Emphasis is on assessing students' use of mathematical thinking and not on memorization and rote application of problem-solving techniques.

Essential Outcomes: Students will:
Conduct an investigation to generate circumference and volume data for modeling the amount of ash deposited on North America.

Laboratory Exercises / Activities: Calculating the volume of ash deposited on North America using Google earth to obtain circumference of different ash layers, assuming mass is conserved, the volume of magma in the chamber should equal the volume of ash deposited.

Evidence statement PS-2: Construct and revise an explanation for the outcome of a simple chemical reaction based on the outer-most electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.

NGSS Performance Clarification: ***HS-PS1-2 Matter and its Interactions***
Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen.

Essential Outcomes: Students will:
Conduct an investigation to generate circumference and volume data for modeling the amount of ash deposited on North America.

Laboratory Exercises / Activities: Calculating the volume of ash deposited on North America using Google earth to obtain circumference of different ash layers, assuming mass is conserved, the volume of magma in the chamber should equal the volume of ash deposited.

Evidence statement ESS1-5: Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.

NGSS Performance Clarification: ***HS-ESS1-5 Earth's Place in the Universe***
Emphasis is on the ability of plate tectonics to explain the ages of crustal rocks. Examples include evidence of the ages oceanic crust increasing with distance from mid-ocean ridges (a result of plate spreading) and the ages of North American continental crust decreasing with distance away from a central ancient core of the continental plate (a result of past plate interactions

Essential Outcomes: Students will:
Research tectonic movement of magmatic hots pots to predict the direction of movement and estimated time line of the Yellowstone Caldera eruption cycle to generate a model that predicts the potential threat of an eruption in the near future.

Laboratory Exercises / Activities: Not assigned.

Text Source(s):
California Science Framework http://www.cde.ca.gov/ci/sc/cf/scifwprepubversion.asp
Preliminary California Next Generation Science Standards Core Content Connectors
http://www.cde.ca.gov/ta/tg/ca/documents/ngssaltconnectors.pdf

UNIT I (Cont.)

Evidence Statement ETS1-2:	Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. (STEM application).
NGSS Performance Clarification:	***HS-ETS1-2 Engineering and Design*** Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade-off considerations.
Essential Outcomes:	Students will: Use the engineering designs and eventually choose one to use as a guide for building devices that will produce fresh drinking able water from water that has been compromised by acid rain and physical contaminants.
Laboratory Exercises / Activities:	Design and build a device that can eliminate dissolved NaCl (a product from the neutralization reaction) to make pure drinking water.

UNIT 2 ____________________________________

Evidence statement PS-1:	Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.
NGSS Performance Clarification:	***HS-PS1-1 Matter and its Interactions*** Examples of properties that could be predicted from patterns could include reactivity of metals, types of bonds formed, numbers of bonds formed, and reactions with oxygen.] [Assessment Boundary: Assessment is limited to main group elements. Assessment does not include quantitative understanding of ionization energy beyond relative trends.
Essential Outcomes:	Students will: Use the trends on the periodic table to create reactions that will produce vast amounts of heat.
Laboratory Exercises / Activities:	Not assigned.

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Evidence statement PS1-2:	Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
NGSS Performance Clarification:	***HS-PS1-2 Matter and its interactions*** Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen
Essential Outcomes:	Students will: Use the trends on the periodic table to create reactions that will produce vast amounts of heat.
Laboratory Exercises / Activities:	Not assigned.

Text Source(s):
California Science Framework http://www.cde.ca.gov/ci/sc/cf/scifwprepubversion.asp
Preliminary California Next Generation Science Standards Core Content Connectors
http://www.cde.ca.gov/ta/tg/ca/documents/ngssaltconnectors.pdf

UNIT 2 (Cont)

Evidence statement ESS3-1: Constructing Explanations and Designing Solutions that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories of the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

NGSS Performance Clarification: ***HS-ESS3-1 Earth and Human Activities***
Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised.

Essential Outcomes: Students will:
Use local and national data to assess the community's decision to support continued usage of local soil and mineral resources that will lead to a key information that will determine if the land is workable or does the community need to move on to areas in other parts of the country.

Laboratory Exercises / Activities: Create and use a simple soil texture analyze and analyze soil from three different areas of the local community. Based on the findings, students make decisions about staying in the area or going elsewhere.

Evidence statement ESS3-4: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems

NGSS Performance Clarification: ***HS-ESS3-4 Earth and Human Activities***
Examples for limiting future impacts could range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geo-engineering design solutions

Essential Outcomes: Students will:
Analyze the chemical production processes of organic fuels to acquire efficient means of refining fuels that will serve as sources of fuel in the event of a large scale shortage.

Laboratory Exercises / Activities: Create a simple still out of thick sport bottles, straws and some warm water. Corn can be catalyzed using alpha-amylase into ethanol and recovered to provide a source of fuel.

UNIT 3

Evidence statement PS1-4: Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.

NGSS Performance Clarification: ***HS-PS1-4 Matter and its interactions***
Emphasis is on the idea that a chemical reaction is a system that affects the energy change. Examples of models could include molecular-level drawings and diagrams of reactions, graphs showing the relative energies of reactants and products, and representations showing energy is conserved.

Essential Outcomes: Students will:
Present calculations showing the breaking of bonds in reactants and the difference in the bond energy of the products to illustrate which alkali or earth alkali metals would best fit the desired function for the reaction.

Laboratory Exercises / Activities: Not assigned.

Evidence statement PS1-5: Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.

NGSS Performance Clarification: ***HS-PS1-5 Matter and its Interactions***
Emphasis is on student reasoning that focuses on the number and energy of collisions between molecules.

Essential Outcomes: Students will:
Apply Le Chatelier's Principle to Their own physical trials that will provide physical feedback on how their body's carbon dioxide and oxygen equilibrium are affected by changing concentrations of each.

Laboratory Exercises / Activities: Using students, a bluetooth heart rate monitor, students can establish insight into their own CO_2 / O_2 equilibrium.

UNIT 3 (Cont)

Evidence statement PS1-6: Constructing Explanations and Designing Solutions that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories of the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

NGSS Performance Clarification: ***HS-PS1-6 Matter and its Interactions***
Emphasis is on the application of Le Chatelier's Principle and on refining designs of chemical reaction systems, including descriptions of the connection between changes made at the macroscopic level and what happens at the molecular level. Examples of designs could include different ways to increase product formation including adding reactants or removing products.

Essential Outcomes: Students will:
Apply Le Chatelier's Principle to Their own physical trials that will provide physical feedback on how their body's carbon dioxide and oxygen equilibrium are affected by changing concentrations of each.

Laboratory Exercises / Activities: Using students, a bluetooth heart rate monitor, students can establish insight into their own CO_2 / O_2 equilibrium.

Evidence statement PS4-1: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems

NGSS Performance Clarification: ***HS-PS4-1 Waves and Their Applications in Technologies for Information Transfer.***
Examples of data could include electromagnetic radiation traveling in a vacuum and glass, sound waves traveling through air and water, and seismic waves traveling through the Earth.

Essential Outcomes: Students will:
Test electromagnetic signal energy to acquire information about the transmissibility of different materials so that will key decisions can be made about which materials to use for reflecting an EM signals and which to be used for blocking them.

Laboratory Exercises / Activities: Students evaluate the penetrability of different types of materials by putting their cell phones inside each one and then trying to call it. The results indicate which materials can be used to protect yourself from a prion activation signal.

Evidence statement PS4-2: Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.

NGSS Performance Clarification: ***HS-PS4-1 Waves and Their Applications in Technologies for Information Transfer.***
Examples of advantages could include that digital information is stable because it can be stored reliably in computer memory, transferred easily, and copied and shared rapidly. Disadvantages could include issues of easy deletion, security, and theft.]

Essential Outcomes: Students will:
Test electromagnetic signal energy to acquire information about the transmissibility of different materials so that will key decisions can be made about which materials to use for reflecting an EM signals and which to be used for blocking them.

Laboratory Exercises / Activities: Students use the data from the prior experiment to construct a helmet or structure using the ascribed materials that could protect themselves.

Materials must be proven to block 3G signals 4G would be even better, but considered a bonus.

Text Source(s):
California Science Framework http://www.cde.ca.gov/ci/sc/cf/scifwprepubversion.asp
Preliminary California Next Generation Science Standards Core Content Connectors
http://www.cde.ca.gov/ta/tg/ca/documents/ngssaltconnectors.pdf

UNIT 4 (Cont)

Evidence statement PS1-3:	Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles
NGSS Performance Clarification:	***HS-PS1-3 Matter and its Interactions*** Emphasis is on understanding the strengths of forces between particles, not on naming specific intermolecular forces (such as dipole-dipole). Examples of particles could include ions, atoms, molecules, and networked materials (such as graphite). Examples of bulk properties of substances could include the melting point and boiling point, vapor pressure, and surface tension
Essential Outcomes:	Students will: Use different methods for calculating density to acquire the density of objects that have oddly shaped structures that will provide given information about specific qualities of a given material because of its unique density.
Laboratory Exercises / Activities:	Students are presented with a wide collection of materials of different masses, shapes, and densities. Students use measurements and volumetric analysis to rank the materials that are both real and theoretical.

Evidence statement PS1-2:	Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.
NGSS Performance Clarification:	***HS-PS1-2 Matter and its Interactions*** Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen
Essential Outcomes:	Students will: Use a cutting edge nuclear synthesis concept called “Island of Stability” to make predictions about the atomic and nuclear attributes of the much larger engineered atoms.
Laboratory Exercises / Activities:	Students are presented with a wide collection of materials of different masses, shapes, and densities. Students use measurements and volumetric analysis to rank the materials that are both real and theoretical.

UNIT 5

Evidence statement PS1-8:	Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.
NGSS Performance Clarification:	***HS-PS1-8 Matter and its Interactions*** Emphasis is on simple qualitative models, such as pictures or diagrams, and on the scale of energy released in nuclear processes relative to other kinds of transformations.
Essential Outcomes:	Students will: Use computer simulation software to analyze the degradation of nuclear material over time to provide a risk assessment for remaining in a specific area that has been soaked with various types of radiation.
Laboratory Exercises / Activities:	Not assigned.

Evidence statement PS2-3:	Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.
NGSS Performance Clarification:	***HS-PS1-2 Matter and its Interactions*** Examples of evaluation and refinement could include determining the success of the device at protecting an object from damage and modifying the design to improve it. Examples of a device could include a football helmet or a parachute.
Essential Outcomes:	Students will: Adapt the energy of kinetic motion to that of the energy of sub-nuclear radioactive particles to procure a potential solution for preventing prolonged exposure and increasing protection from nuclear radiation.
Laboratory Exercises / Activities:	Optionally assigned.

UNIT 5 (Cont)

Evidence statement PS3-1: Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known

NGSS Performance Clarification: ***HS-PS3-1 Energy***
Emphasis is on explaining the meaning of mathematical expressions used in the model.

Essential Outcomes: Students will:
Utilize a computer simulation on nuclear impact zones to calculate the amount of destruction at varying levels of yield to acquire an understanding of the impact of "height of detonation" can have on a target of nuclear attack.

Laboratory Exercises / Activities: To visit the online simulator for nuclear yield testing, visit nukemap.com.

Evidence statement ETS1-4: Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.

NGSS Performance Clarification: ***HS-ETS1-4 Engineering Design***
Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponential and logarithmic, in conjunction with computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems

Essential Outcomes: Students will:
Utilize a computer simulation on nuclear impact zones to calculate the amount of destruction at varying levels of yield to acquire an understanding of the impact of "height of detonation" can have on a target of nuclear attack.

Laboratory Exercises / Activities: To visit the online simulator for nuclear yield testing, visit nukemap.com.

Evidence statement PS2-5: Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current. (STEM Applications).

NGSS Performance Clarification: ***HS-PS2-5 Forces and Interactions***
Assessment is limited to designing and conducting investigations with provided materials and tools.

Essential Outcomes: Students will:
Use basic instruction on electrochemical batteries to create a electromagnetically driven motor to achieve a small amount of work when only using spare metallic sources routinely found around the house.

Laboratory Exercises / Activities: Using only simple metallic components to create an electric current, students will build a galvanic battery which would involve making judgements about the E-cell value for the anodes and cathodes to maximize cell voltage. A successful electrochemical cell system outputs more than 2.0v and easily lights an LED.

OPTIONAL ADDITIONAL UNIT
(Currently added to AS:02)

Evidence statement PS2-1: Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration

NGSS Performance Clarification: ***HS-PS2-1 Motion and Stability: Forces and Interactions***
Examples of data could include tables or graphs of position or velocity as a function of time for objects subject to a net unbalanced force, such as a falling object, an object sliding down a ramp, or a moving object being pulled by a constant force.

Essential Outcomes: Students will:
Use basic instructions on newton's laws of motion, drag aerodynamics, and the ideal gas law to design through experimentation a rocket that is maximized for distance to provide a physical model that can minimize drag and maximize the force generated by a compressed gas.

Laboratory Exercises / Activities: Optionally assigned.

OPTIONAL ADDITIONAL UNIT
(Currently added to AS:02)

Evidence statement PS2-1: Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration

NGSS Performance Clarification: ***HS-PS2-1 Motion and Stability: Forces and Interactions***
Examples of data could include tables or graphs of position or velocity as a function of time for objects subject to a net unbalanced force, such as a falling object, an object sliding down a ramp, or a moving object being pulled by a constant force.

Essential Outcomes: Students will:
Use basic instructions on newton's laws of motion, drag aerodynamics, and the ideal gas law to design through experimentation a rocket that is maximized for distance to provide a physical model that can minimize drag and maximize the force generated by a compressed gas.

Laboratory Exercises / Activities: Students pressurize rockets and study the application of the basic gas laws to maximize the distance a rocket travels while also minimizing the drag.

Additional help with building and predicting rocket distances, this online simulation could be used to help.

Evidence statement ETS1-4: Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

NGSS Performance Clarification: ***HS-PS2-5 Forces and Interactions***
Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

Essential Outcomes: Students will:
Same as above

Laboratory Exercises / Activities: *Same as above*

Evidence statement PS2-3: Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision

NGSS Performance Clarification: ***HS-PS2-3 Motion and Stability: Forces and Interactions***
Examples of evaluation and refinement could include determining the success of the device at protecting an object from damage and modifying the design to improve it. Examples of a device could include a football helmet or a parachute.

Essential Outcomes: Students will:
Same as above

Laboratory Exercises / Activities: *Same as above*

Assessment of Standards:

Unit 1 (Summative): Examulation (A simulation that assess knowledge through simulation) / Teaining SRTs 1-4 (Formative)
Unit 2 (S): Examulation (A simulation that assess knowledge through simulation) / Teaining SRTs 1-4 (Formative)
Unit 3 (S):Examulation (A simulation that assess knowledge through simulation) / Teaining SRTs 1-4 (Formative)
Unit 4 (S): Examulation (A simulation that assess knowledge through simulation) / Teaining SRTs 1-4 (Formative)
Unit 5 (S): Examulation (A simulation that assess knowledge through simulation) / Teaining SRTs 1-4 (Formative)
Summative (1): Fall Semester Final - Digitally deployed through the website
Summative (2): Spring Semester Final - Digitally deployed through the website.

Rigorous, Relevant & Relational Curriculum

Rigor, relevance and relational, (the three - R’s of the Common Core philosophy)are also at the root of the NGSS design principles. These come to life through the use of advanced web-based technology that empowers the students to have a sense of control over the distribution of the content and the rate at which they traverse the learning material... All while learning how to survive the end of everything!

The Three R’s Applied

The AREA154: Apocalypse Division curriculum provides access to researched based real-world situations that require the students to utilize a wide range of analytical skills and internet search techniques to acquire the key pieces of support information. In turn, this information then becomes important cognitive scaffolding for learning and remembering chemical and physical science curriculum. “An impression may be so exciting emotionally as almost to leave a scar upon the cerebral tissue” (James, 1890. p670). James wrote this quote some 120 years ago, and this statement still applies to our own experiences today. While the science classroom may not present the same level of emotional excitement as a car accident, being robbed, winning the lottery or a first kiss, experimental evidence strongly suggests that emotional impact affects memory and recall.

Experiments conducted by Leventon (2005) on the impact of emotional, sensory input and memory provided evidence that not only does emotionally intense input increase recall, but children of different ages are affected differently. In an experiment conducted for his dissertation, children between the ages of 7 and 11 and another group between 9 and 12 years-old. Both groups experienced a series of emotionally intense emotionally neutral images. The researchers then split the emotionally intense images into negative and positive emotional stimuli. Upon exposure to those images, at the fMRI module upon the students head would register the electromagnetic signal produced by the temporal lobe. The intense of the electrical signal, which occurs very close to 300 milliseconds after exposure. This signal was designated the p300 peak, and it was used as a reference to indicate the intense it of any emotional impact felt by the viewer (Hajcak, MacNamara, & Olvet, 2010). The results of these experiments indicated a statistically significant connection between negative images and older students and positive emotional images and younger students.

Leventon did not provide any experimental data to explain the results, however, hypothesized about the cause. The suggestion centered around the maturity of the brain’s neural wiring. Younger students do not have the advanced neural brain wiring that older students possess (2010). High school students, being at the older end of the experimental data pool, would most likely appear more sensitive to emotionally negative (fear, anxiety, threats to safety) than they would other stimuli represent more positive emotions (love, comfort, joy).

A New Kind of Student:

The volume of studies done on the affect of lower income on academic performance has always produced the same conclusion. Lower income students are far less likely to succeed in school. The research on identifying a cause or causes for this result are far less conclusive. Laccor and Tissington (2011) revealed that among the members of a low SES student's family the mother has the most impact on the students perceptions and success academically. Furthermore, the study also indicated that students from wealthier homes participated in far more experience building activities than low income peers. This data, along with other studies that have linked learning with life experiences, the operational philosophy in AREA154 is to build the educational experience around the experiential schemata that Hollywood has produced for the students.

There is nothing inherently broken about "traditional" science curriculum. However, several factors stand in the way of student engagement. The list provided here is a short view into some engagement blocks that derail students' ability to engage in a more traditional curriculum:

"Life experience"

The life experiences encourage and promote new neural connections that open the brain up to new possibilities, new information, and making new connections. As the brain will do this automatically if there is enough information for the student to solve the dissonance, low SES students will resist this task. The resistance doesn't come out of spite or oppositional defiance, it originates from not thinking one has the capacity to make the connections and have the information stick. More life experiences mean more neurosensory data to attach academic learning to and be able to retain it.

"Stimulus competition"

In wildly increasing numbers, students are diverted from classroom learning by activities on their personal devices of Chromebook that have a far greater emotional return. Traditional curriculum is just hopelessly outgunned and without a significant emotional stimulus at home (i.e. parents) willing to make school success more emotionally gratifying than Instagram. The 'drama' of this program was designed to help give learning a new dramatic edge to keep learners engaged.

"Comfort forces forgetting"

The AREA154: Apocalypse Division curriculum design attempts to destabilize ones sense of comfort in an attempt to use that dissonance to motivate students to want to know how to survive. Beyond race, religion, language, gender, or species the drive to survive is very strong. The program then attempts to utilize situational emotion to help embed factual information.

The following list provides a summative analysis of each segment of the AREA154: Apocalypse Division curriculum. Additionally, each content area will have specific examples of course rigor, relevance, and social collaboration with peers both inside the class and outside the class.

THE YELLOWSTONE CALDERA (SUPER VOLCANO)

AGENT TRAINING: AS:01
Case File: "Apocalypse By Caldera (Super Volcano)

Case Summary:

Over the last ten million years or so, the Yellowstone caldera has erupted every 600,000 years or so. As it stands currently, the United States is about 64,000 years over due. As the class begins the study, we explore what would happen if it erupts. We compare the energy release to that of many of the most immense nuclear explosions ever recorded. From there the United States, primarily the East coast erodes into chaos. The training covers the impact of inhaling micro particles of volcanic ash and the concrete-like substances that forms in the lungs. Then the water supply is compromised, and only the few know how to tell the good water from the water that might kill thousands of survivors. Finally, learn how to develop devices to neutralize and clean the water for the good of all.

STEM Experiences:

The caldera (super volcano) scenario has been played out in movies, comics, and video games for decades. However, large cognitive gaps remain about what volcanic ash is and how it differs from ash produced from a fire. In this case file, students build a set of simulatory lungs and expose these moist tissues to concrete ash (compositionally very close to volcanic ash) to observe the chemical influence volcanic ash has on animal lungs.

Additionally, the agents are faced with fresh water shortages due to the volcanic gasses disrupting the availability of drinking water. Agents design and build distillation devices that demonstrate how to not only neutralize acidified volcanic water, but separate the fresh water from the resulting saltwater. This skill could save lives in a number of different scenarios.

This list represents the key topics delivered to the students:

Chemical Focus Points
Thermodynamics
Units of energy / unit analysis
Structural analysis
Thermochemical reactions
Phase changes of matter
Hydration reactions of concrete
Metric analysis of energy units

Additional Focus Points
Volumetric analysis
Ratios and unit comparison
Google Earth - measurement tools

AGENT TRAINING: AS:02

Analysis of Case: “The Economic Collapse”

“The bill comes due, always.”
- Mordo (Dr. Strange, 2017, Marvel Cinematic Universe)

Case Summary:

Marvel Studios, aside from its obvious entertainment value, has moments where universal truths fall from the mouths of the characters. This quote from the movie represents the intensely fragile nature of the US economy. For decades the United States government has used the Federal Reserve to write checks for currency that was not backed by anything material. Only our faith in the US Dollar and the idea that the US can pay it’s bills keeps the US currency alive. However, less obviously, the US has managed influenced the OPEC nations to only see oil in US Dollars in exchange for military support. This, along with several moves by British Banks made in 1934 to suggest that the US Dollar be used as the world reserve currency, created the foundation for the “Petro-Dollar”. In this world altering scenario, an technology known as ground penetrating sonography, or seismic topography, discovers that the world’s oil reserves have been dramatically over estimated and nearly depleted. As a result, the world panics, the US Dollar becomes worthless, the economy crashes, and the money under the mattress isn’t worth the paper it’s printed on. So, now what?

This case file begins with the understanding that no one is at because no one can be paid, gasoline is $400 a gallon, and it’s only a matter of weeks before panic sets in and the common person starts to become desperate. As emergency services are tasked to exhaustion, the one additional bonus disaster begins to rear it’s head: Viral outbreak! In the final training of the case file the students are tasked with using their knowledge of chemical gas laws, pressure, forces, and aeronautical engineering skills to design a pressurized water rocket capable of delivering anti-viral medication into the “Hot Zone”.

STEM Experiences:

This case file requires the most materials and hands on time to complete. The students understanding of gas laws, pressure, forces of flight and other integrated sciences comes from students generated theory, student-lead design and building, student-lead testing, and student-lead revision, rebuilding, and retesting.

This list represents the key topics delivered to the students:

Science Focus Points

Identification of alkali metals on periodic table
Properties of alkali metals
Thermochemical reactions
Ideal Gas Law
Gay-Lussac Law
Boyles Law
Aeronautical forces of flight
Scientific experimental process
Engineering designing principles

Additional Focus Points

Math process - Percent composition
Basic principles in aeronautical forces
Read soil composition triangle diagrams
Distance acquisition using digital tools

AGENT TRAINING: AS:03

ANALYSIS OF CASE FILE: HYPER-INFECTIOUS PATHOGEN (PRION INFESTATION)

AKA: *THE ZOMBIE APOCALYPSE - and yes, it could happen.*

Case Summary:

Beginning as far back as the 1960s the US government has been playing with the idea of mind control as evident by the now declassified documents found online about the MK-ULTRA program. As the program was de-funded, MI-6 in conjunction with the CIA developed a nanometer sized tool that was susceptible to microwave and radio wave electromagnetic energy. The hope was to use this Barium - Strontium complex peizo crystal to create an electrical current into a protein substrate. The electrical current then creates changes in the proteins tertiary structure. According to the study, a specific and still unclassified electromagnetic wave (radio wave most likely) triggered the piezo crystal to induce the altered state of these brain proteins. Proteins are a lot like keys to a door. When the shape is altered, so is their function. This nanotechnology became known as a *the prion*, and the effect it had on the livestock was eventually dubbed the “Mad Cow” disease.

The mythology of the “zombie” is physiolocially impossible, as modern medical science understands the phenomenon. There is, however, an alternative adaptation to this story that is plausible, in fact we see spongiform ecephalopathy in the general public all the time in the form of brain wasting conditions like Alzheimerz. The prions and the attached atomic sized peizo crystal appear to leach the copper ions from the cerebral cortex of the brain. Over time, the brain would lose its thinking functions and resort to the more impulsive and torrential uncontrolled rat-brain. This deterioration was constitute zombie-like behavior. Not exactly like the mythology, but still frightfully possible. In the 1980s world wide propagation of such a radio wave would be impossible. However, in our modern era of cellular and satellite communication a world wide radio signal could be broad cast to nearly every person on the planet.

STEM Experiences:

The search: Divided into teams of 2-3 students used a smart phone app to collectinformation about the EMF signals surrounding materials commonly found in construction materials. Students form assumptions and theories about the electromagnetic permeability of each material and whether or not a signal can be received by the phone inside. Agents then begin to see that materials are not all created equal when electromagnetic waves are concerned. Using this information, agents begin to formulate plans to keep their own cerebral cortex safe from prion activation.

This list represents the key topics delivered to the students:

Chemical Focus Points

The electromagnetic spectrum

Wavelength, frequency, energy of EM waves

Chemical equilibrium

Le Chatelier’s Principles of equilibrium

E = ln calculationsof energy, frequency, wavelengths of EM radiation.

Additional Focus Points

Active participation in learning Krav Maga

Metric unit analysis

Algebraic calculations

THE FALSE FLAG ALIEN INVASION

AGENT TRAINING: AS:04

CASE FILE: "ALIEN INVASION" - A FALSE FLAG OPERATION.

Case Summary:

In 2005 During a joint mission between NASA and the ESA (European Space Agency) a pair of satelites called the GRACE TWINS were lauched to analyze gravitational oddities on Earth. What was found was quickly classified and only released recently to the public. The gravitational analysis suggest there was an impact in the south pole about 13-14,000 years ago. Normally, impacts of this type vaporize the meteorite. Not in this case. Whatever made that impact creator is still there! The evidence suggests the presence of a material far more dense than anything on the current periodic table; Something stong enough and dense enough to survive interstellar travel. The supposition of this advanced material sets the backdrop for the analysis of atoms, chemical structures, and the nature of mater on this planet. Sumerian, Egyptian, Mayan tablets and enscriptsions all point to the same thing. We are not alone and have not been for a very long time and someone is planning their return.

Dr. Steven Green, researcher, has spent the last 30 years diving into the depths of compartmentalized government projects. In his assessment, the real threat won't be actual "extra-terresterial Biological Entities" or EBNS (eee-bins). The threat would likely come from, us?? For years, dating back to Pres. Reagan's address to the United Nations back in 1983 may have worried about the possibility of a false-flag operation in order to pull all of the feuding political factions together under one roof. Whether the threat comes from above or originates from our own backyard, the effects will be devastating.

The STEM Experience:

In the event of an "invasion" the first step is to gather information. Agents collect a wide variety of unique materials and utilize STEM tools to determine the density of these newly found objects. Eventually, students locate very specific types of exothermic and endothermic reactions that could be used to help defend humanity from any sort of invasion.

This list represents the key topics delivered to the students:

Chemical Focus Points

Avogadro's number
Conversions between mole and particle
Chemical formulation & Naming
Writing names from formulation
Group ions - names & formulas
Ionization
Atomic structure
Periodic table organization
"Island of Stability" - Theory
Chemical reaction applications

Additional Focus Points

Dr. Steven Greer - Military ind. complex
Sumerian & Egyptian archeological history
Aztec & Mayan archeological history
Geographical & gravitational analysis of Antarctica
Crust displacement theory & tectonics

AGENT TRAINING: AS:05

CASE FILE: “GLOBAL THERMONUCLEAR WAR”

Case Summary:

Since the initial detonation at the Trinity test site at White Sands New Mexico, the world learned to tremble at the feet of the most devastating weapon the world had ever seen. To this day, the threat of a global thermonuclear event looms over everyone. In this case, the phenomenological story line begins with an extremist group called Al-Gebra (yes, like the math and done on purpose - because math seems to terrorize a lot of people!) acquires a multitude of nuclear weapons and intends to use them to “reset” humanity. This “situation” was chosen due to it being far more likely than to become come a threat than any nation-state such as Russia or China.

This case file analyzes the nature of radioactive fallout, nuclear radiation, and the biological effects that would likely be experiences in the event one was present in a nuclear debris field.

However, there is one more threat that we were not as vulnerable to back in the cold war as we are now. The threat of an EMP (electromagnetic pulse) looms to wreck untold havoc on electronic devices everywhere. As the last high-altitude nuclear test was during Operation Fishbowl where “Starfish Prime” was detonated off the coast of Hawaii 57 years ago. In addition to the radiation, our agents also have the burden of finding ways to protect key electronic components that would give them an edge in an apocalypse level event.

The STEM Experience:

Nearly every home in America has the materials needed to create a mask that could keep fine particles of dust and nuclear radiation out of one’s lungs long enough to get out of the effected area. Agents design and build this key tool. Additionally, agents design and build devices (some of which are callbacks to AS:03) to shield phones and computers prior to class one, two, or three EMP events. These Agents will have applicable skills to apply in times of intense need.

This list represents the key topics delivered to the students:

Chemical Focus Points
Nuclear decay cycles
Manipulation of the half-life equation
The role of the proton in nuclear stability
Identification of types of nuclear decay
The ^{238}U nuclear decay series
Gamma radiation
Beta radiation
Alpha radiation
E electromagnetic Pulses (EMPs)

Additional Focus Points
Algebraic calculations
Measuring and comparing atomic yields
Analyzing simulated EMP attacks
Coronal mass ejections (solar EMPs)

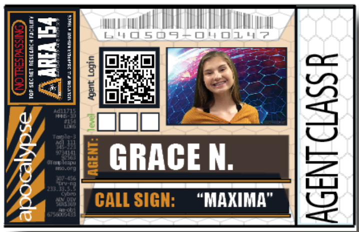
ACHIEVEMENTS & THE LEADER BOARD

Achievement Points: Experimental Motivation System
Designed and built by: Torrence Temple

Summary: Not all students are motivated by the utterance of a teacher to complete work. Telling a low SES student to simply “try harder” will often fall on deaf ears. Implementing modern gameification theory into a classroom curriculum has often been talked about but rarely implemented, especially in something as dry and clinical as chemistry. This section presents a web-based achievement system that was used to encourage students (agents-in-training) to increase their “rank” by accomplishing challenges above and beyond the expectations of the prescribed curriculum.

ACHIEVEMENTS, RANK, & MOTIVATION

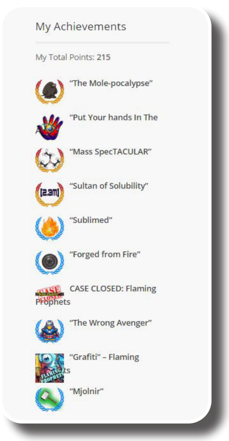
AGENT RANKING



Special Access "Rookie Agent" ID Badge - Used for achievements, rank, & attendance.

At the beginning of the year each student's picture was taken and put on a custom made Access Badge ID card (an optional add-on for the program). That they would acquire at the beginning of every class and keep on them until the class was over and they would return the badge to the class hanging area. Each student began at the beginning stages of the agent ranking program, which was simply defined as, "Agent".

The students could move up their ranking by accomplishing any number of activities during the course of the training year. Some of these areas of achievement



Included:

Achievement Type Point Value
100% Achievements (For SRTs -quizzes) 15 pts
Completion of a case file 10 pts
Graffiti Achievements 30 pts
Spec-Ops Achievements 40 pts
Q - Gadget Achievements 40 pts
Truth Achievements 20 pts
Hands-up Achievements 5 pts
Team Player Achievements 5 pts
The achievements expand as opportunities for building creative and engaging projects and challenges arises.

Below is a basic description of each category of achievement:

100% Achievements: Awarded to any student that had completed a SRT, stands for "Survival Readiness Test". SRTs are like quizzes and can be taken as many times as the student has the will to learn from their mistakes. A time period of 3 days is set on each SRT to encourage students not to put this off. In many cases, agents-in-training will elect to take these at home.

Completion Achievements: Any time an agent-in-training has passed (80% or higher) for every SRT in a case file and has completed the case file analysis, that agent is awarded achievement points for keeping to the high standards of the AREA154 training.

Graffiti Achievements: An odd category of achievements that encourage students / agents to take dry erase markers and declare their chemical brilliance on a mirror or window at home by doing a designated chemistry challenge at home. They have to have photographic evidence of the mission's completion and post it to the AREA154 website.

Spec-Ops Achievements: This category of achievement is rare and often times comes with some investment. The student / agent accepts a mission that involves observation, recon, extraction, or elimination of a target in real-life. The actual danger level is way less than is sounds. These operations work a lot like "Geocaching". The localation is predetermined and students use GPS coordinates and team work to find the drops and figure out the puzzles inside.

TYPES OF ACHIEVEMENTS ARE ALWAYS EXPANDING

Q- Gadget Achievements: Anytime a case file arises or an analysis presents itself, or a current event wit in the realm of chemistry hits the press, the opportunity for the students / agents to induce some STEM power is at hand. Students identify the problem presented and then design, engineer, build a solution to the designated challenge. A solution that is not unlike the gadgets developed by Q - Division in James Bond.

Truth Achievements: As civilians, we are not always privy to the truth of any given political, social, or economic situation. Any time a student / agent can provide evidence that what we see out in the popular press isn't what we have been told achievement points are awarded. Sometimes secret documents are embedded in classified locations on the downloadable trainings. Students / agents search these documents for clues to the links where these secret declassified documents can be read and secrets of our Government are revealed.

Hands Up! Achievements: Active anticipation is critical to building capable student / agents. For each time a student raises their and contributes to the discussions at hand the student can earn up to 3 of these Hands Up! Achievements per instructional period.

Teamwork Achievements: This category of achievement is presented by nomination. At the end of a training section, each table team has the ability to nominate someone at the table who has been the example of a collaborative team player. Agents can win this over and over for as long as their team feels that they have been the best team agent they can be.

Distribution of Achievement Points: Each student / Agent has his or her own profile on the AREA 154 website that they create upon registering with AREA 154. Every time the students get access to content or SRTs they must first log into the site. The site then remembers all of the events that can lead up to being given achievements. Some achievements would be automatic, such as getting a 100% on a SRT. At which point the site automatically awards the points and the "badge" to the agent. That badge is then posted on the bottom of the site and visible to the student every time they log into the site. Some of the achievements need to be presented manually by the director of AREA 154. At which time the points are applied to their total and the achievement badge is posted to their profile.

And... Totally Customizable: Each installation of AREA154 is totally customizable by the instructors using the system. Add achievements that are specific to your school and population! The sky is the limit with the number of achievements schools could add.

Feedback from the students on AREA154's Gameification element:

Since the inception of the program, simple data metrics were collected to reflect the impact of the achievement system (gameification) and how its impact on student motivation towards content mastery. AREA154: Black Ops was developed first in 2014 and was implemented for two years. In 2016 - 2019 AREA154 Apocalypse Division was build on the same operational foundation as Black Ops only more specifically gearerd towards NGSS content standards and building curriculum that would specifically address the cultural needs of the community. The Black Ops progam was run in a more affluent higher achieving community, Murrieta Mesa High School. The Apocalypse Division was implemented at San Jacinto High School in a lower achieving less affluent population.

Q: Did the AREA 154 achievement system encouraged you to want to work harder in order to advance your 'rank' within the class?

	Yes, Definitely	Occasionally	No impact
2014-2015 (BLACK OPS - MMHS, n=156)	34%	52%	14%
2015-2016 (BLACK OPS - MMHS, n=182)	28%	55%	18%
2016-2017 (APOC. DIV - SJHS, n=149)	26%	45%	29%
2017-2018 (APOC. DIV - SJHS, n=151)	31%	40%	29%
2018-2019 (APOC. DIV - SJHS, n=167)*	42%	30%	28%

Q: When you earned an achievement did you feel more successful as a student?

	Yes, Definitely	Occasionally	No impact
2014-2015 (BLACK OPS - MMHS, n=156)	85%	11%	18%
2015-2016 (BLACK OPS - MMHS, n=182)	76%	16%	8%
2016-2017 (APOC. DIV - SJHS, n=149)	71%	25%	4%
2017-2018 (APOC. DIV - SJHS, n=151)	62%	14%	24%
2018-2019 (APOC. DIV - SJHS, n=167)*	73%	18%	9%

Q: Was the possibility of earning achievement points, badges and promotions the most significant reason you pushed yourself to achieve 100% on the SRT assessments?

	Yes, Definitely	Occasionally	No impact
2014-2015 (BLACK OPS - MMHS, n=156)	81%	15%	4%
2015-2016 (BLACK OPS - MMHS, n=182)	77%	20%	3%
2016-2017 (APOC. DIV - SJHS, n=149)	72%	15%	13%
2017-2018 (APOC. DIV - SJHS, n=149)	74%	10%	16%
2018-2019 (APOC. DIV - SJHS, n=167)*	88%	10%	2%

Q: Did your participation in this achievement program influence your willingness to work harder in chemistry?

	Yes, Definitely	Occasionally	No impact
2014-2015 (BLACK OPS - MMHS, n=156)	20%	34%	46%
2015-2016 (BLACK OPS - MMHS, n=182)	24%	41%	35%
2016-2017 (APOC. DIV - SJHS, n=149)	54%	33%	13%
2017-2018 (APOC. DIV - SJHS, n=151)	57%	27%	16%
2018-2019 (APOC. DIV - SJHS, n=167)*	61%	28%	11%

** During this year an more attention was put into expanding achievments,attention to the learder board, and student recognition for their promotions and achievments.*

Summarization of the feedback:

Though the analysis of the achievement system was not exhaustive, several trends can be extracted from the data:

- The students tend to put more effort into attaining the 100% score necessary to attain the achievement points.
- The achievement system had an impact on the majority of the classes to work harder either an occasional or more regular bases to demonstrate skill mastery.
- The achievement points played an influential role in the students' decision to retake quizzes to get 100%.
- Students who are normally considered 'high achievers' participate in the gameification more frequently, however, students who tend not to classify themselves as 'good at school' benefitted the most from the achievements and the leaderboad - *(This observation comes is both connected to the quantitative results of the survey and observational experience over 5 years of implementation.)*
- Supported by both quantitative results and anecdotal observations, the achievements provided a notable sense of achievement in both groups that were high-achieveing and low-achieving.

Additional insights after having implemented this system over the course of an academic year. These are observations of student behavior in association with the achievement system.

- **Students require immediate feedback for the achievement system to have it's maximum effect.** Towards the middle to the end of the second semester the achievements were not immediately connected to the SRTs and students didn't receive their points immediately after the necessary score had been achieved. This caused students to not feel the sense of satisfaction of the achievement. The number of achievements reached by students during this time dropped substantially.
- **The icon list on the students profile page has an impact on the sense of achievement and motivation associated with this system.** In the occasions when the icon was not placed on the students' profile pages, the students would complain about the icon not being located on their profile and insist that it be corrected as soon as possible. When these problems were not addressed with in a relatively short period of time, the number of students that tried to reach the NEXT achievement dropped.
- **The type 'A' achiever students and students that had a history with video game type achievements benefited more from the achievement system than most of the other types of students.** After an analysis of the leaderboard, the students on the to 50 fit this profile of being achievement oriented in school to begin with, or achievement oriented from a video game perspective. Students that were neither gamers or scholastic achiever types did not benefit as much from the achievement system. Though, when asked, these students still enjoyed the fact that they had achievements posted on their profile. They we simply not motivated by the achievement prior to having acquired it.
- **The amount of effort and importance the instructor put into the leader board and the achievements directly affected the influence the gameification had on the students.** If the teacher thought it was important and provided even passing attention to student ranks, achievements, or bragged upon students in other classes who recently acquired achievements experienced higher levels of student in engagement than those who did paid little attention to the system.

This collection of research played validated and helped form the design philosophies behind the AREA154 content delivery and classroom experiences. The reference list is constantly growing and the research done on the subject of student learning will play a significant role in any updates or redesignes of AREA154 in the future.

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Appendix B – AREA154: Apocalypse Division HyperDoc PDFs

(Documents following this page)

AREA 154 :APOCALYPSE

ADVANCED RESEARCH & EVIDENCE ANALYSIS: CHEMISTRY DIVISION

CASE FILE:

[AS:01] CALDERA

Achievement Points: Experimental Motivation System
Designed and built by: Torrence Temple

Summary:

All of the curriculum is delivered to the student in the form of an interactive PDF. The next pages exemplify the PDF user interface and explain the iconography of the documents. In addition, comments made “from the director” are tips and lessons learned about implementing the content.

Video walk throughs are also available upon request.

Following the visual walkthrough is an example a suggested implementation time line for the Fall semester, thought implementation timelines can vary greatly among different instructors.

The Examulation - an assessment like no other.

CASE FILE COVER

Cover art from ***2012,*** the movie.

THE IMAGE

This scene takes place as the protagonists (the good guys) land in Yellowstone National Park realizing that the kooky conspiracy guy was dead on with his prediction about the caldera on the brink of exploding. The super volcano exploded in fantastic glory. This is a frame from that scene. As spectacular as this is, the explosion is still not big enough.

THE CONTENT

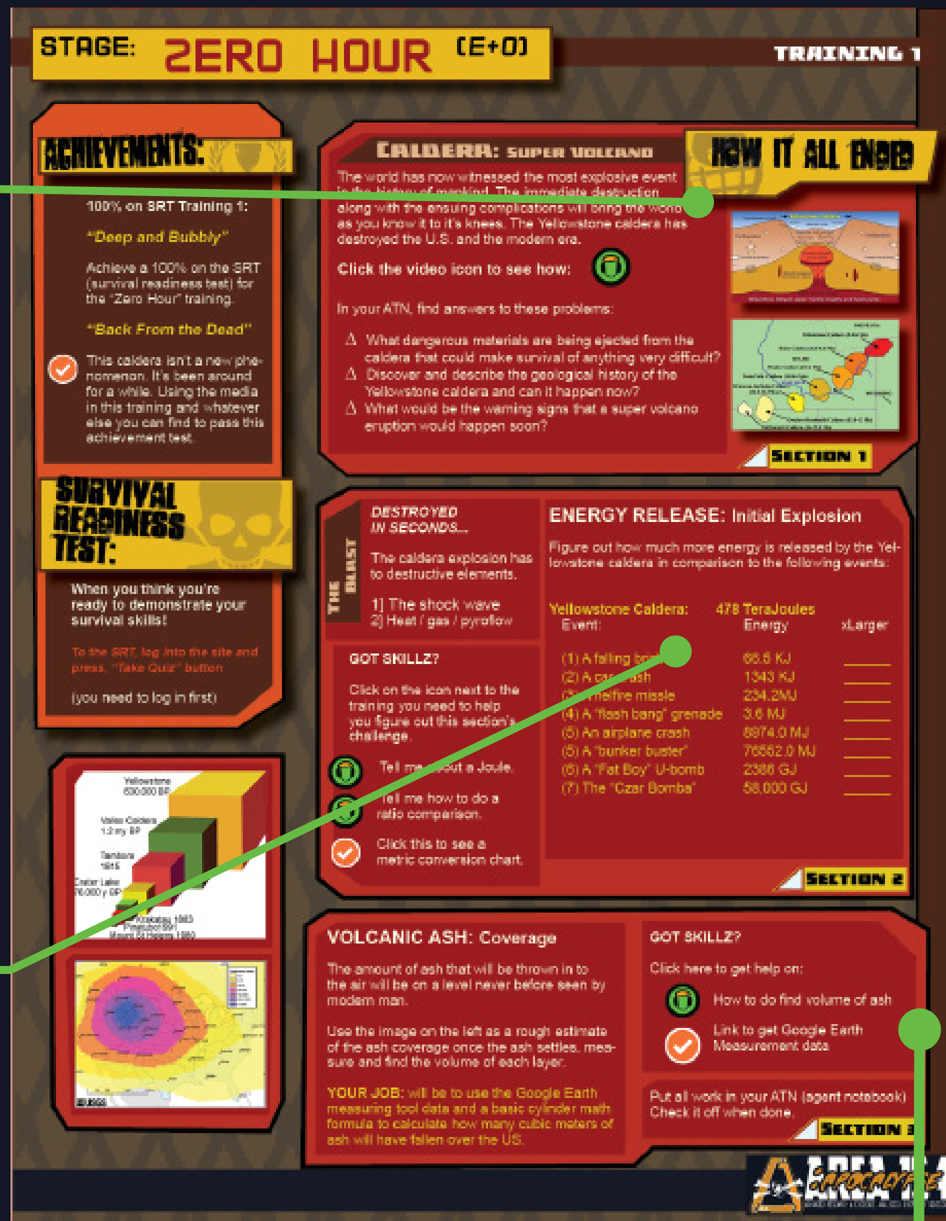
This area of the cover page is dedicated to show the chemistry and STEM content addressed in this scenario.

NOTES:

APOCALYPSE BY CALDERA : CASE FILE ORIENTATION

TRAINING ONE

THREE [3] SECTIONS



SECTION 1:

TIME LINE: 1 CLASS PERIOD

This section includes a 24 minute video on the technical aspects of the Yellowstone Caldera. In addition to completing the questions (∆) are next to questions most students will complete this area at or near the end of the period.

Suggestion: Finish watching the video if agents have not yet done so.

From the director...

Watch for connectivity issues with YouTube. For now it's linked there. If lots of agents have Chromebook issues, perhaps show the video as a class.

HOTSPOTS

SECTION 2:

TIME LINE: 1-2 CLASS PERIODS

Students will be comparing the energy output of events they might be familiar with to the energy released in a caldera eruption Agents will be doing a ratio comparison, but have to ensure all the units are the same first. Support videos are listed on the side.

Suggestion: Perhaps use the iPad and the AppleTV to do an example on the front screen. Go slow. Use small steps.

From the director...

The videos connection to YouTube for now. Consider class views for internet connection issues. Agents will struggle with the math and metric unit conversion.

HOTSPOTS

SECTION 3:

TIME LINE: 1-2 CLASS PERIODS

The calculations here request the agent to make a calculation that sums all of the layers of volcanic ash. The thickness of the area is given and the area data is provided by accessing the link provided. The goal is to continue to establish shock and awe of the super volcano. Ask agents what they think the volume of erupted ash might be. Perhaps write predictions on the front screen with the iPad.

From the director...

In the past students when allowed to tackle the math on their own... struuuuuglllled. I've noticed that any applied math that takes more than two steps loses most students. Working with the agents in stages might work better. Explain one step. Let them work. Check on them, then move to the next step.

HOTSPOTS

TRAINING TWO

THREE [3] SECTIONS

SECTION 1:

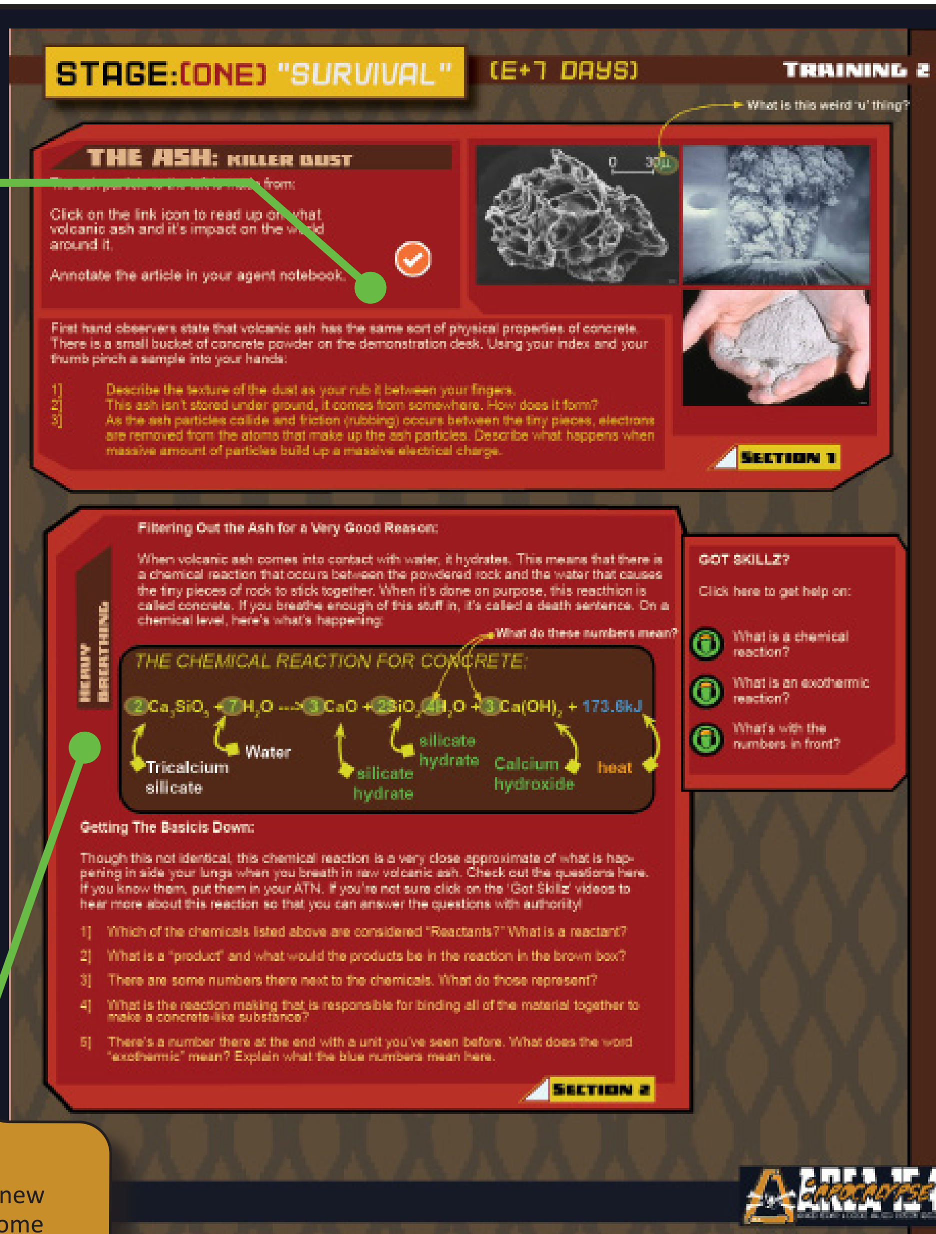
TIME LINE: 0.4 CLASS PERIODS
Volcanic ash is the focus here. The link here goes to an off-site page that presents the structure, features, and dangers of the volcanic ash. The directives are in the box below along with the focus areas agents should answer in their notebooks.

ESTABLISHING HABITS: Insist on full sentence answers!

MATERIALS: Dry concrete powder for agents to put hands in and feel.

From the director...
Agents will use "it" to describe key terms that they should be getting familiar with. NEVER USE 'IT'! Any agent with 'it'-syndrome should be sent back to their seat to fix it.

HOTSPOTS



SECTION 2:

TIME LINE: 0.5 - 0.75 CLASS PERIODS
The exposure to the reaction equation will be a new experience for most of the agents. As a result, some time is spent breaking down this reaction equation of concrete and water. This reaction is very similar to the reaction that volcanic ash has with the water in a person's lungs when ash is inhaled.

VIDEOS: The reaction equation is explained in sections using the videos. The area to the right has the links to those videos. While the videos are short and sweet and to the point, some direct instruction might be beneficial.

From the director...
This construct is not an each thing for students to immediately grasp. Perhaps an analogy of a chemical reaction equation is a lot like a sentence. The reactants side would be like the subject, the arrow the verb, the products would be the predicate. Coefficients act like modifiers or adjectives

HOTSPOTS

HEADS UP...

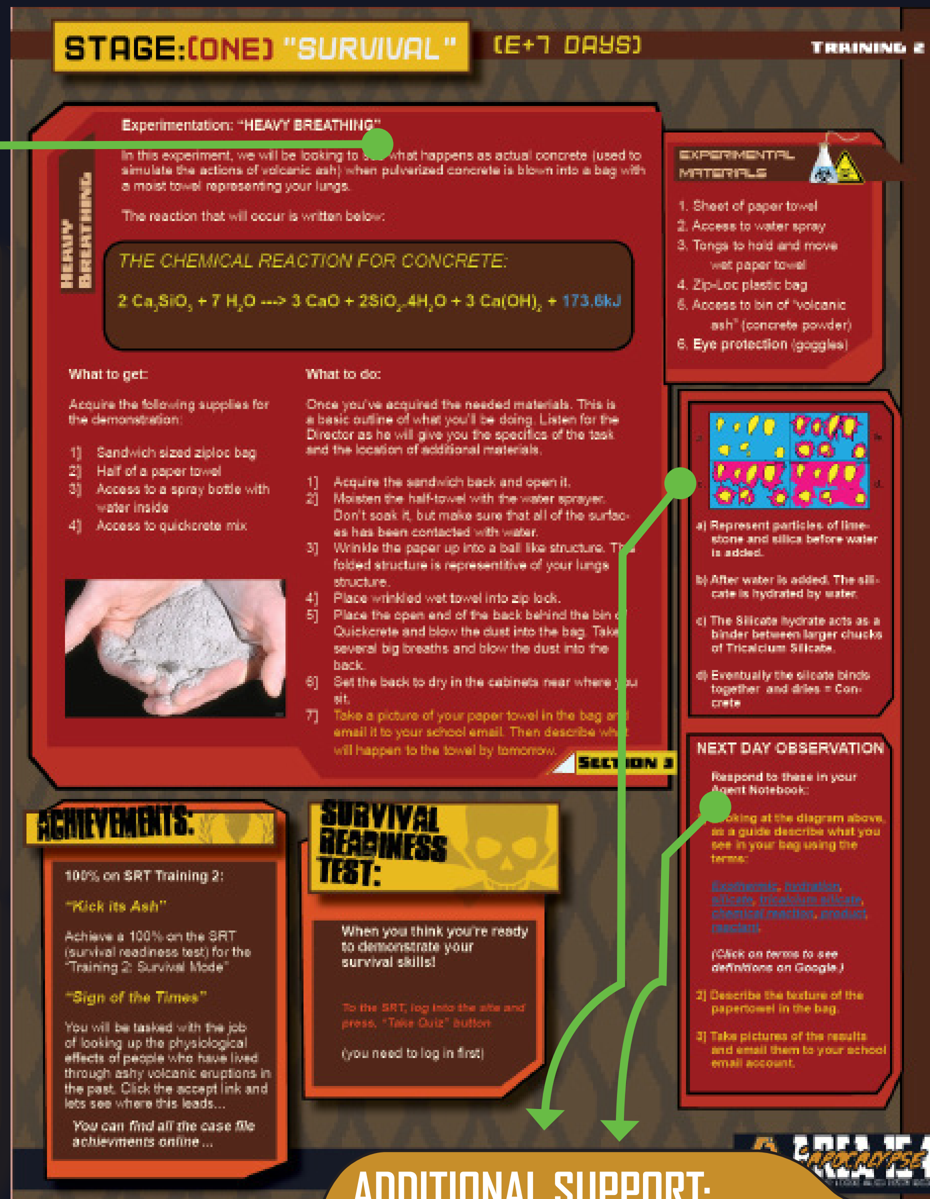
SIGNATURES / STAMPS
You might be signing Agent Training Notebooks. Either works, just be mindful that each agent should have FIVE (5) of these stamps or signatures.

If you, the director, have not stopped and offered time for students to get their books stamped or signed, this would be a great time to do it.

Encourage the students to not fall behind. Most agents are NOT used to being giving this type of freedom and pacing. They will slack.

TRAINING TWO

THREE [3] SECTIONS (CONT.)



SECTION 3:

TIME LINE: 2.0 CLASS PERIODS

HANDS-ON: Analysis and observation of the effects of volcanic ash on the lungs. Simulating the lungs would be wet paper towels or school toilet paper (because it's really strong).

MATERIALS:
concrete, paper towels, water sprayer (hand bottle), Ziploc sandwich bags.

BASIC INSTRUCTIONS:
Agents can access the instructional parts of the experience in the upper right hand corner of the training.

PHASE 1: In stages, groups take their towel, wet it, and expose it to the concrete.
PHASE 2: In an open Ziploc bag, set aside to dry for as long as it takes to dry. Students observe each day.

AGENT OUTPUT: Setup seven (7) asks the agent to take a picture of the final dried lung sample. The picture acts as the basis for their conclusions paragraph.

From the director...

The exposure phase (1), will take about 0.75 of a class period if the verbal explanations are included in the timing. If students finish early or are waiting for their turn, encourage agents to go ensure all previous sections are done.

Drying should take 2-3 days depending on classroom ventilation.

HOTSPOTS

ADDITIONAL SUPPORT:

CONCRETE FORMATION: This graphic can be used by students to answer questions from the hands-on experience. The availability of a video for this process might be a great media element to have, though locating one might prove to be problematic. Special prize for the Director that can find one!

TERMINOLOGY SUPPORT:
This content zone encourages the use of experience terminology in their answers. Definitions for these terms are linked here for students to have access to information defining the terms and providing additional sources to encode the meanings.

HEADS UP...

SRT TIME!

Getting agents to take the assessments on their own is an exercise in futility. In the past, the use of a 15 min challenge to get ALL of the agents to at least take the Training SRT once.

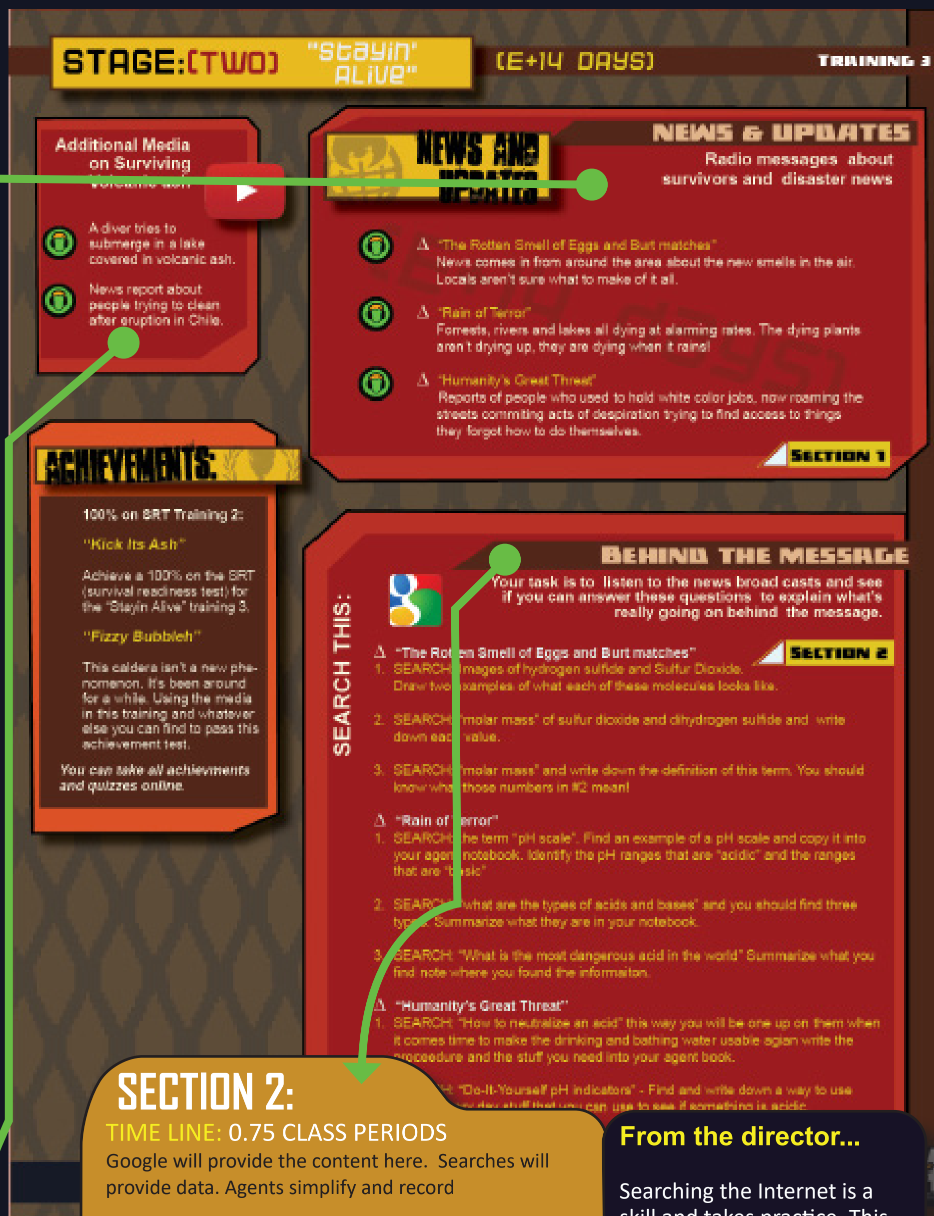
USING THE COMPUTER AS A TIMER:
Click on this link (http://www.online-stopwatch.com/countdown/)

USE THE IPAD:
Go to the "Clock" App and set the timer for 15 min and project the timer through the AppleTV for all students to see.

ENGAGEMENT TRICKS:
Use small prices (like a candy drawer) or perhaps a Google doc that keeps track of the number of 100% each period. Contest, baby!

TRAINING THREE

FOUR [4] SECTIONS



SECTION 1:

TIME LINE: 0.3 CLASS PERIODS

HUMAN EXPERIENCE: These three pieces of media are audio files taken from a radio show. The audio clips portray radio personalities reacting to the caldera eruption days weeks afterward.

AGENT RESPONSE:
Listen to the audio file then write a 2-3 sentence response elaborating on what the would feel if they were listing to the radio and heard these clips.

WHAT IS THE PURPOSE OF THIS METHOD?
The design methodology in AREA154 is founded on the use of psychological and emotional arousal. The content is buried into these pieces of audio. From time to time the curriculum or the Director should revisit the catastrophic circumstances under which the agents are being trained.

OPTIONS: Keep your eyes on sites that monitor the swelling activity of the Yellowstone Caldera. Any time the park goes through a swelling cycle. Post it. That will get agents' attention!

From the director...

In the past, agents have listened to the audio clips and then asked, "Now what do I do." In future versions of this section students will receive more specific directions on specifically what and how much to write.

Focusing on the emotional impact of the after effects of the eruption helps drive engagement.

HOTSPOTS

SECTION 2:

TIME LINE: 0.75 CLASS PERIODS

Google will provide the content here. Searches will provide data. Agents simplify and record

SCIENCE FOCUS: Discuss the content of the radio messages after a set time period (15 min or so) to flush out key details.

KEY SEARCH WORDS: Agents should use terms they heard and words in the questions to guide their search to find missing information.

Provide examples of how to translate content in the messages into scientific facts about the situation.

"Rotten egg smell"
Means SO_2 (g) being ejected into the air

Demonstrate how an agent can pose a question to Goolge to get this information.

From the director...

Searching the Internet is a skill and takes practice. This activity might go smoother if the Director places examples of search techniques on the AppleTV with the iPad or to place some instruction of this process on the front screen.

Or perhaps show this video on how to search stuff on Google to ensure you get the information agents need.

Click here for video:

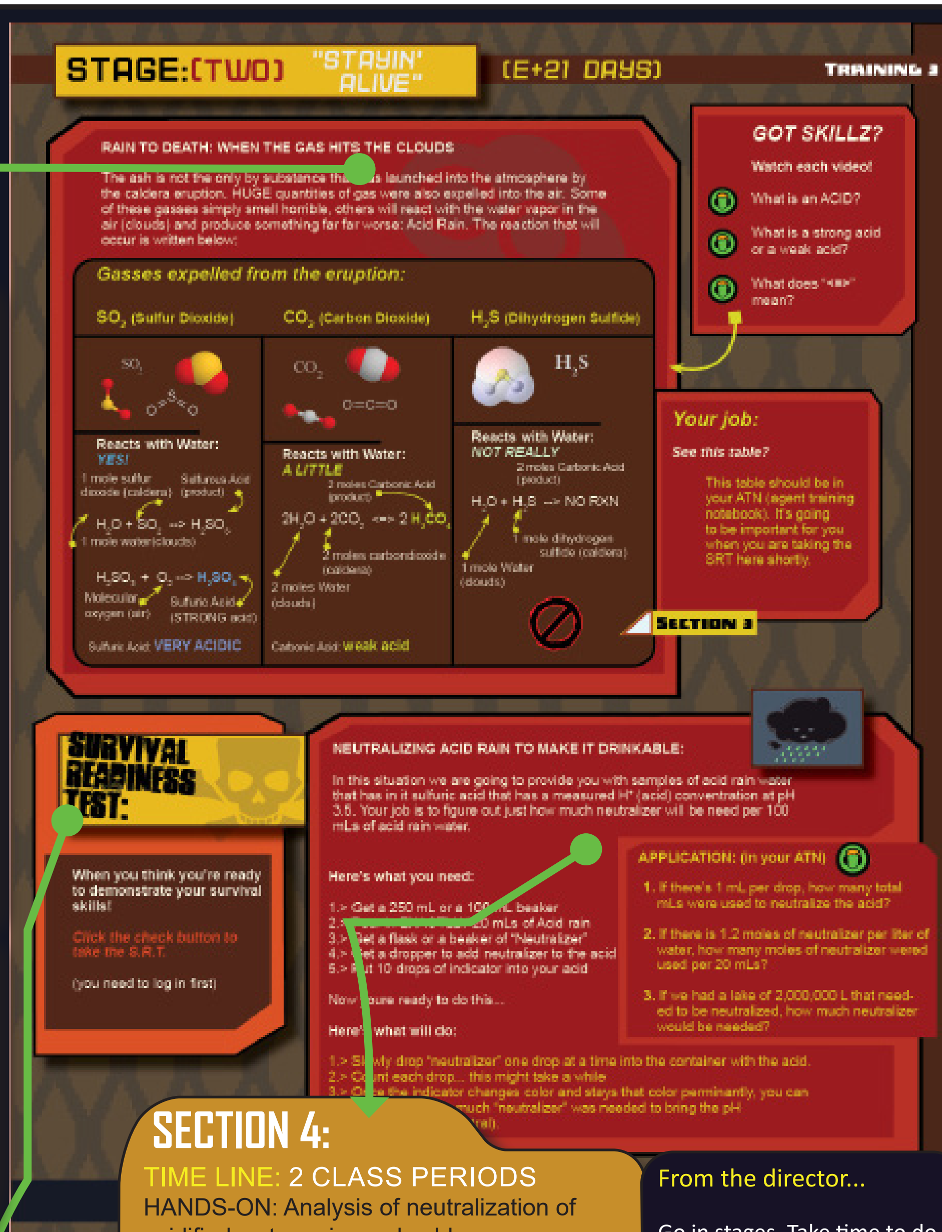
HOTSPOTS

ADDITIONAL SUPPORT:

CONCRETE FORMATION: These videos are additional to the curriculum and are provided for extension and class discussion. None of the material in these videos appear on any assessments. Agents curious about the caldera and its impact will access these videos.

TRAINING THREE

FOUR [4] SECTIONS (CONT.)



SECTION 3:

TIME LINE: 0.3 CLASS PERIODS

VISUALLY REPRESENT THE CHEMISTRY: The graphic in the brown region visually presents what happens to the gasses when exposed to water in the atmosphere.

AGENT RESPONSE:
It's suggested that the students take some time and record this chart into their ATN. The process is a little time laden, but gives each student the opportunity to slowly process a complex subject matter. This chart is what the Director will sign off or stamp.

WHAT IS THE PURPOSE OF THIS METHOD?
Chemistry is, arguably, the most difficult science to grasp for high school students. Traditionally students don't even see a reaction equation until well into the second semester. The reaction equation is a recurring focus across almost all of the apocalypse scenarios. Exposure and changes of context lowers the anxiety associated with the symbolism and formatting used in chemical communication of reaction systems.

From the director...
If rulers are not provided to use to make this chart, the results are very sloppy. Also, indicate that the chart should be about 1/3 to 1/2 of the page before they start drawing. Agents might also ask, "Can I just print this out?" No, and here's why. The process of using small motor muscle systems along with visual support, the research states, encodes information longer when written by hand.

HOTSPOTS

SECTION 4:

TIME LINE: 2 CLASS PERIODS

HANDS-ON: Analysis of neutralization of acidified water using red cabbage as an indicator.

MATERIALS:
Acid solutions (Carbonic acid, Sulfuric acid) sectioned out into small 150 ml beakers. One acid beaker per table is good.
Indicator solution: Use "Ninja" blender to chop up red cabbage with water. The purple solution extracted from the mix is the indicator.
Eye droppers: Used for standardization and then for the neutralization.

BASIC INSTRUCTIONS:
Standardize the volume delivery with a 0.25 M HCl Solution, then titrate unknown by counting drops.

From the director...

Go in stages. Take time to do just the standardization of the dropper volume. OR do it ahead of time and have it ready for the students.

Counting drops is pretty easy but doing the math to figure out how much acid was added. Perhaps use this as an advanced or achievement worthy topic.

The neutralization point sneaks up fast. If they pass it they MUST start over. The first few will be unthrilled!

HOTSPOTS

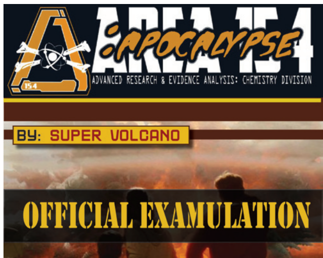
HEADS UP...

SRT TIME

Getting agents to take the assessments on their own is an exercise in futility. In the past, the use of a 15 min challenge to get ALL of the agents to at least take the Training SRT once.

USE COMPUTER OR IPAD AS A TIMER:
Click on this link (http://www.online-stopwatch.com/countdown/)

COMPETITION:
100% count! Candy and competitions are have been solid leverage for focusing wayward students.!



THERE'S NO TEST LIKE IT.

Part exam and part simulation, the summative assessment for each of the 5 apocalypse level challenges puts students into the exact event they have been training for. The assessment begins, like any story would, at the begining. The exam itself reads like a story. Videos support the simulation and add contect to the questions. The questions are then answered on the AREA154 website.

VARIOUS INPUT

VIDEO SUPPORT

Click the video icons to watch videos that support the simulation and assist in answering questions.

GRAPHS & CHARTS

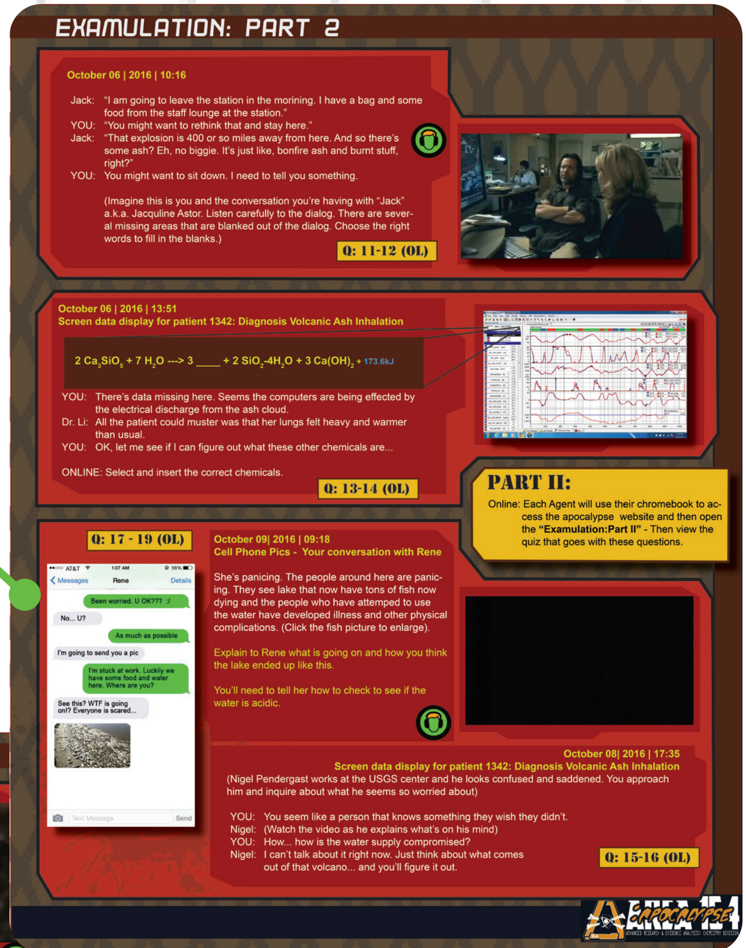
Students access charts and graphs that are directly connected to the storyline. Results actually help drive the story element of the simulation.

VARIOUS OUTPUT

NARRATIVE EXPLANATIONS

Questions addressing larger more important content standards require the ***student to write their answers out in full sentences on the website***. This provides the teacher a better understanding of the students thinking and preperation.

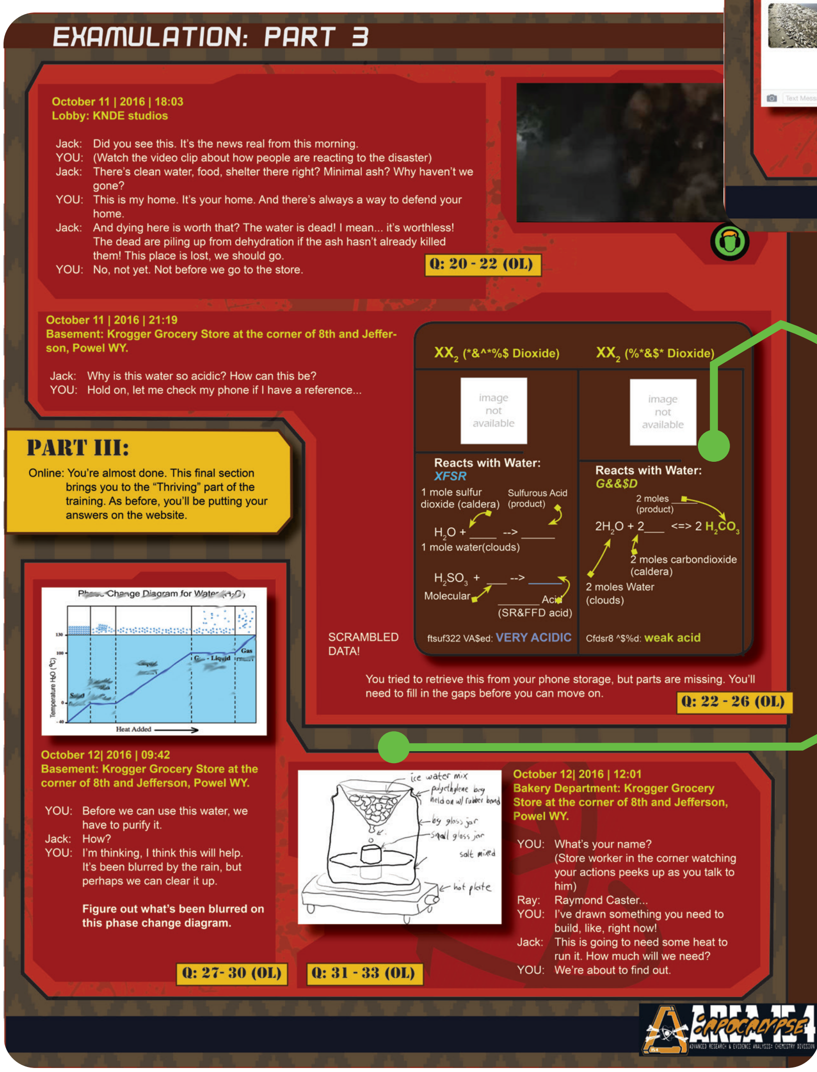
SUMMATIVE: THE "EXAMULATION"



RELATIONAL INPUT

QUESTIONS PLAY ON SOCIAL MEDIA

The examulation plays upon the rampancy of social media and includes it into the assessment process. In part 2 the ***students explain in narrative*** about the reason for the dead fish in the picture that was texted. All the questions within the examulation are contextualized and part of the simulation story line.



STEM ASSESSMENT

STEM REVSITED

The hands-on STEM activities also play a role in the simulation. Students are provided incomplete data that was presented to them during their trainings and applied in this simulated event.

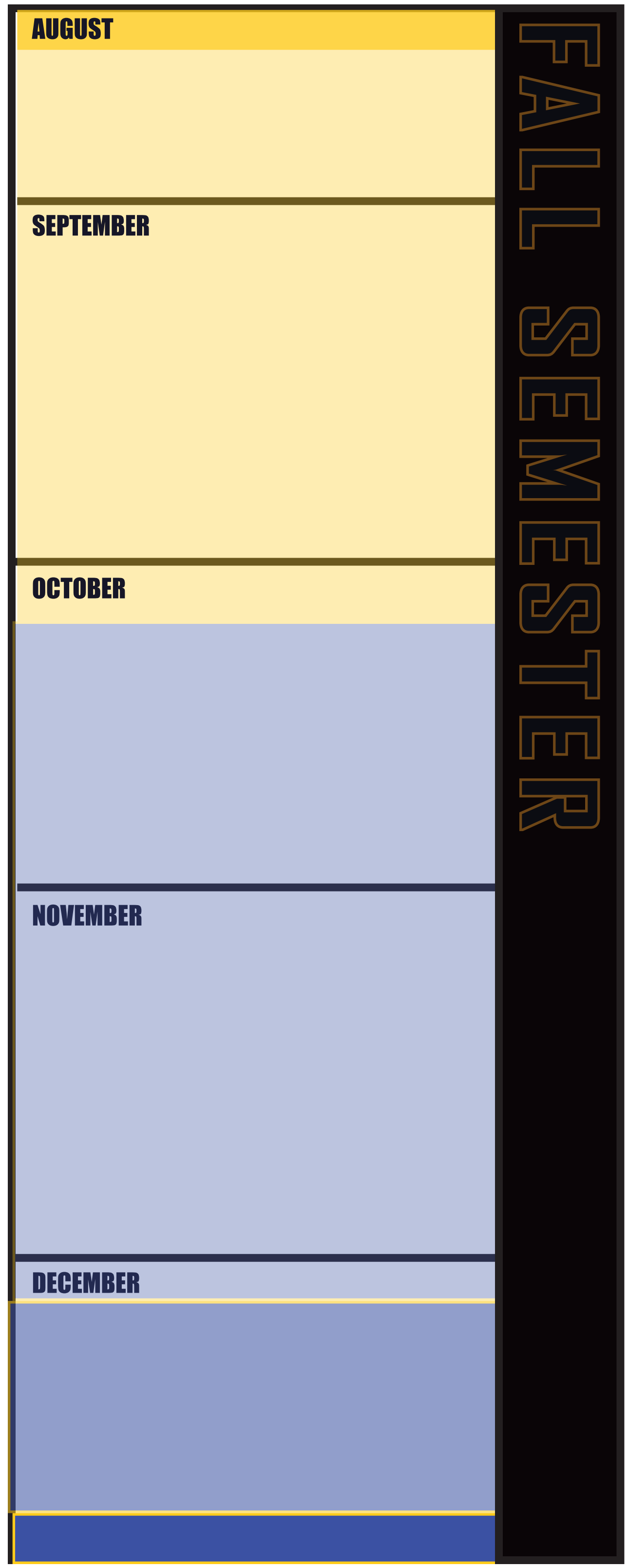
AREA154: APOCALYPSE DIVISION FALL TIMELINE

FALL SEMESTER

AT A CONSERVATIVE PACE:

The diagram to the right presents a general timeline for the first semester. The speed by which the students pass through the curriculum largely depends on at-home time alotted to finishing the training sections.

The pattern here represnts a timeline where little or no support was provided to the students and most of the trainings were completed during class.



- INTRODUCTION WEEK
- CALDERA
- ZOMBIE APOCALYPSE
- FINALS WEEK

From the director...

The AREA154: Apocalypse Division curriculum has been refined over the last three years in live classroom settings. The times suggested here will vary depending upon the pace the teacher feels is productive.

Please note thought... There's no real "correct" order for the casefiles.

Each one of the AREA154 apocalyptic scenarios are stand-alone NGSS STEM designed unites of learning. Everything needed to learn the material is contained within the unit. Some topics are revisited in several of the case files such as the use of reaction equations and density. Our research has demonstrated that these topics require several reinforcement opportunities.

That being said, it is suggested that the "Economic Collapse" unit be done at the end of the year. The last part of the case file involves building pressurized water rockets and would benefit student focus to be done near the endf of the academic year (May - June).

HOTSPOTS

Appendix C – IRB Subject Recruit Documentation

(Documents following this page)

BOISE STATE UNIVERSITY

INFORMED CONSENT

Study Title: Theories connecting ubiquitous learning technologies and Hispanic STEM students.

Principal Investigator: Torrence Temple **Co-Investigator:** Dr. Young Baek

Sponsor: Boise State University

Greetings once again. As you know, I was your chemistry teacher during the 2019-2020 school year and was responsible for the prototype learning tool called *AREA154: Apocalypse Division*. This unique design of this program has produced some interesting results that will be the focus on my doctoral research. My intention here is simple. I would like you to participate by being interviewed about your experiences as an student (or agent) within the program.

I encourage you to ask questions at any time and to talk to your parents about participating. If you decide to participate, you will be asked to sign this form and it will be a record of your agreement to participate. You will be given a copy of this form to keep.

➢ PURPOSE AND BACKGROUND

As a part of the dissertation process, extensive topical background research has to be done about the research focus. The background research revealed vast amounts of government data, and studies suggested that Hispanic students are falling behind academically. Additionally, they have the highest high school dropout rate of any significant minority group. Moreover, Hispanic students also demonstrated a surprising lack of confidence relating to their abilities to be successful in STEM-related subjects. I had witnessed this through decades of professional experience, but the research confirmed it. The question now was, "What can be done about it?" That is where the AREA154 project comes into play. The AREA154 program is centrally located and accessible from any device anywhere on Earth with an internet connection. Additionally, the learning content is available 24 hours a day. This combination of factors appears to be making an impact on that achievement gap. These observations concerning AREA154 were only that, general anecdotal data collection. However, it laid the groundwork for this study to identify the uLearning characteristics that were most responsible for the changes, and what did these changes ultimately mean for the students?

➢ PROCEDURES

The data collection procedures are straightforward and completed in just a couple of steps:

2. Watch a video prepared for them and intended to remind them of the environment, tools, events, curriculum, and other experiences related to their time within the uLearninig environment. Memory-refreshing material would include images of notebooks (names removed), screenshots of web-interfaces, class videos, and other instructional media. The goal would be to help them recall more of their experiences from a year or more ago. The video would likely not be longer than 10 minutes.

2. Participate in a recorded online interview/discussion where they discuss their experiences related to the uLearning system under investigation. The interview process would likely not last longer than 20 minutes. The interviewer may ask to follow up with additional questions that do not appear in the original question list. These questions would only act to clarify information provided by the participant during the initial interview. The participant has the right to choose not to answer if they wish. If a post-interview was needed, it would occur a week or two would likely occur after the initial interview and not last more than a few minutes over a zoom conversation.

- **RISKS/DISCOMFORTS**

There might have been a time where being on a Zoom conference call might have seemed awkward. Perhaps not so much anymore. There is no risk to your grade, as all of that is in the past. So speaking your mind about the *AREA154: Apocalypse Division program* will have ZERO impact on your grades. However, some discomfort might be experienced if you have to tell me critical things about a program I invested so heavily in the making. Rest assured, critical well-thought-out input is EXACTLY what I am looking for in this study. Critical feedback could mean specific elements played a mostly positive role for you – and that's good! Critical feedback can also mean identifying aspects of the program that, if addressed, could make the program even more useful. THAT is my goal. Research the impact the system had, see how your experiences affected you, and investigate possibilities for an even better experience.

- **EXTENT OF CONFIDENTIALITY**

The research procedure ensures reasonable efforts to keep the personal information in your research record private and confidential. Any identifiable information obtained in connection with this study will remain confidential and disclosed only with your permission, or as required by law, the members of the research team and the Boise State University Office of Research Compliance (ORC) may access the data. The ORC monitors research studies to protect the rights and welfare of research participants.

Your name will not be used in any written reports or publications which result from this research. Data will be kept for three years (per federal regulations) after the study is complete and destroyed.

BENEFITS / PAYMENT

As you know, there is a graduation requirement for Community Service Hours (CSH). As a perk for participating in the study, you will earn three (3) community service hours upon successfully completing the interview. Other than the allocation of CSH, there will be no official payment for your participation.

➢ QUESTIONS

If you have any questions or concerns about your participation in this study, you should first contact the principal investigator, Dr. Young Baek, at youngkyunbaek@boisestate.edu or the co-principal investigator, Tory Temple, at torytemple@u.boisestate.edu or (951) 973-4141.

If you have questions about your rights as a research participant, you may contact the Boise State University Institutional Review Board (IRB), which is concerned with the protection of volunteers in research projects. You may reach the board office between 8:00 AM and 5:00 PM, Monday through Friday, by calling (208) 426-5401 or by writing: Institutional Review Board, Office of Research Compliance, Boise State University, 1910 University Dr., Boise, ID 83725-1138.

DOCUMENTATION OF CONSENT

I have read this form and decided that I will participate in the project described above. Its general purposes, the particulars of involvement, and possible risks have been explained to my satisfaction. I understand I can withdraw at any time. I have received a copy of this form.

I understand that I can choose not to participate in this study or to withdraw from participating at any time with no adverse effect.

____________________________ ____________________________________

Printed Name of Study Participant **Signature** of Study Participant Date

____ ______________________

Signature of Person Obtaining Consent Date

BOISE STATE UNIVERSITY

INFORMED CONSENT

Study Title: Theories connecting Hispanic STEM students and perceived success through applied ubiquitous learning technologies.

Principal Investigator/Faculty Adviser:
Dr. Young Baek

Co-Principal Investigator:
Tory Temple, Doctoral Student

Sponsor: Boise State University, Department of Education

Dear Parent/Guardian:

My name is Tory Temple and I am a doctoral student in the educational technology program at Boise State University. I am asking for your permission to include your child in my research. This consent form will give you the information you will need to understand why this study is being done and why your child is being invited to participate. It will also describe what your child will need to do to participate as well as any known risks, inconveniences or discomforts that your child could encounter while participating. I encourage you to ask questions at any time. If you decide to allow your child to participate, you will be asked to sign this form and it will be a record of your agreement to participate. You will be given a copy of this form to keep.

- **PURPOSE AND BACKGROUND**

This research study attempts to learn more about how the use of an educational instruction paradigm referred to as "ubiquitous learning" effects how Hispanic students demonstrate engagement, perception of knowledge, and their perceptions of the quality of their learning experiences in a STEM oriented chemistry class at San Jacinto High School. Th project maintains the theory that uLearning provides unique access to learning that could benefit and promote successful STEM learning experiences. This study is designed to investigate how uLearning technologies might assist in building the sense of self-confidence in science, technology and math related subjects.

- **PROCEDURES: INTERVIEW**

If you agree to be in the study, you will be asked to participate in two brief interviews: one at the beginning and one at the end of the semester. Each interview will last approximately twenty to twenty-five minutes. During this time you will be asked to answer questions based on your experiences with the uLearning technology and design properties. The interview will take place a time that is convenient for you (participant) and will be conducted on Zoom (or similar platform). Please note that the sessions will be recorded. The audio and video will be recorded for data collection purposes. As some of the questions are complex, all modes of communication are encouraged, including facial expressions, hand movements, and other types of non-verbal communication. The questions will be delivered to you in a conversational format. Some questions may require some follow-up questions to help acquire a better understanding of the participants experiences with the AREA154: Apocalypse Division STEM curriculum (The uLearning technology under study).

- **RISKS/DISCOMFORTS**

It is possible, however unlikely, your child may be uncomfortable being recorded on video through the Zoom application. Each participant is being asked to conduct the interview with the camera on. The video of the interviewee (your child) provides non-verbal feedback in a manner that may be critical to understanding the students experiences while participating in the AREA154 Apocalypse Division program (the uLearning system under study). High school students are apt to use their hands and be visually very expressive and that data can help communicate where words cannot. You can ask for your child not to be taped at any time. Your child may also ask not to be taped at any time. We may continue with the interview if you and your child are willing. You are able to remove your child from the study at any time and for any reason.

- **EXTENT OF CONFIDENTIALITY**

Reasonable efforts will be made to keep the personal information in the research record private and confidential. Any identifiable information obtained in connection with this study will remain confidential and will be disclosed only with your permission or as required by law. The members of the research team and the Boise State University Office of Research Compliance (ORC) may access the data. The ORC monitors research studies to protect the rights and welfare of research participants.

Your child's name will not be used in any written reports or publications which result from this research, Data will be kept for three years (per federal regulations) after the study is complete and then destroyed.

- **EXTENT OF CONFIDENTIALITY**

Reasonable efforts will be made to keep the personal information in your research record private and confidential. Any identifiable information obtained in connection with this study will remain confidential and will be disclosed only with your permission or as required by law. The members of the research team and the Boise State University Office of Research Compliance (ORC) may access the data. The ORC monitors research studies to protect the rights and welfare of research participants.

- **PAYMENT**

There will be no payment to you or your child as a result of your child taking part in this study. They will however be offered some compensation for their time in the form of three (3) signed community service hours for their voluntary contributions to the study.

- **QUESTIONS CONCERNING THE RESEARCH PROCESS**

If you have any questions or concerns about your participation in this study, you should first contact the principal investigator, Dr. Young Baek, at youngkyunbaek@boisestate.edu or the co-principal investigator, Tory Temple, at torytemple@u.boisestate.edu or (951) 973-4141.

If you have questions about your rights as a research participant, you may contact the Boise State University Institutional Review Board (IRB), which is concerned with the protection of volunteers in research projects. You may reach the board office between 8:00 AM and 5:00 PM, Monday through Friday, by calling (208) 426-5401 or by writing: Institutional Review Board, Office of Research Compliance, Boise State University, 1910 University Dr., Boise, ID 83725-1138.

DOCUMENTATION OF CONSENT

I have read this form and decided that my child will participate in the project described above. Its general purposes, the particulars of involvement and possible risks have been explained to my satisfaction. I will discuss this research study with my child and explain the procedures that will take place. I understand I can withdraw my child at any time.

____

Printed Name of Child

____________________________ _____________________________________

Printed Name of Parent/Guardian **Signature** of Parent/Guardian Date

____ __________

Signature of Person Obtaining Consent Date

Sample recruitment email for potential participants

Greetings Agent, I could use your help.

As Agents of AREA154, you have experienced a unique opportunity to experience NGSS chemistry taught in a very different way. This makes your experience valuable and I'm here to ask if you would consider being a part of a study that wants to learn more about your experiences in the program.

As may recall, I am in the dissertation phase of my doctoral work at Boise State University. I am looking for about 15 – 20 students that might be willing to provide some of their time to be interviewed about their experiences with the *AREA154: Apocalypse Division* program. I have hand selected students to reach out to because they meet specific criteria that is important to the study, and YOU were selected.

Here are some basic details about the interview process:

- The **interview would be held on the SJUSD's Zoom platform** and would be held a time to be scheduled by you.
- **Two days prior to the interview you will be specifically briefed** on what the my research is about, your role in the interview process, and you will watch a 10 minute (approx.) video that will walk you through visual images that are designed to take you back to your AREA154 experiences. A long time has passed between then and now, the video will help you recall some those experiences.
- **The interview will be video screen-recorded** and, ideally, your camera would be on as well. People communicate physically with their hands and facial expressions, and all of that data is important for the research.
- **I (Mr. Temple) will be conducting the interview** via audio only and it will be very casual and conversational. I may ask some follow up questions to make sure I understand the true nature of your message.
- **Once your done, you will receive 3 hours of community service!** All you need to do form to me and I will sign it for you.

Permissions:

If you are interested, that would be great! I will also need your parents (or whoever is legal in charge of you) to also sign off to provide permission. As soon as you reply to this email that you would like to participate, I will send you the form that you and your legal guardians will need to sign. Once that's done, we will set up a time online to meet. Two days before the interview I'll send you a copy of the questions so you can think about your answers along with the preview "reminder" video.

If you have any questions, please email me at torytemple@u.boisestate.edu or text me at (951) 973-4141.

Thank you for your help!

Mr.Temple

Data Collection Acknowledgement

Courtney Hall (Principal, SJHS)
chall@sanjacinto.k12.ca.us

10/9/2020

Dear Torrence Temple,

Based on my review of your proposed research, I permit you to conduct the study entitled Theories pertaining to the application of uLearning technology and Hispanic STEM students' engagement behaviors within the San Jacinto High School. As part of this study, I authorize you to conduct recruitment through district allotted resources, contact parents, and conduct data collection procedures at this facility. Individuals' participation will be voluntary and at their discretion.

We understand that our organization's responsibilities include:
Use of district-provided communication tools to acquire participants and conduct data collection interviews with students provided parental consent was obtained prior to the data collection procedures. We reserve the right to withdraw from the study at any time if our circumstances change.

The research will include the use of San Jacinto's licensed Zoom communication tool and district email services procured through Google. We understand that the Interviews will take place online (not on campus), will be recorded, and stored for analysis at a later date on secured servers located at Boise State University. This authorization covers the span of the Fall 2020-2021 school year (August – mid-December 2020.) The possibility of a time extension can be if deemed necessary for the completion of the research.

I confirm that I am authorized to approve research in this setting.

I understand that the data collected will remain entirely confidential and may not be provided to anyone outside the research team without permission from the Boise State University IRB.

Sincerely,

Courtney Hall
Principal
San Jacinto High School

Briefing statement – appears before the reminder video explaining to the participant the protocol for the interview process.

Greetings Agent!

First, thank you for taking the time to do this. I know you have things to do, and working my project into your schedule is much appreciated. Before we start the video that is designed to walk you down memory lane of your AREA154 experiences, I wanted to brief you a little on the project and your role in it.

Step one: Please check the email that has the research questions in it. I want you to have some time to think about them before we talk online.

Step two: Watch the video here. Now that you've read the questions let's take that walk down memory lane.

Step three: The interview – I will be asking you questions that focus on your experiences with the AREA154 system, your interactions with it, and how those interactions affected you and your feelings of confidence in STEM-related subjects.

Step four: I might schedule a follow-up call or Zoom call to ask follow up questions.

That's it! Your responsibility as a participant is to provide honest, trustworthy, and well thought out responses. There are NO WRONG ANSWERS. If there is reason to be critical, be critical. Critical evaluation can have positive effects as well as effects that would be considered not so great. All data is valuable, and if there are problems with the system, your feedback will help make for a better, more robust experience in the future.

If you've read the interview questions, then you're ready to proceed.

[Review video begins]

Sample verbal consent – via Zoom if parent did not sign form for student permission

[Pre-screen-recording briefing]

My name is Tory Temple, Mr. Temple, and I was not only your student's chemistry teacher in the past, but I am also a doctoral student at Boise State University. I am conducting some research that would require your permission for your son (daughter) to participate. But first, let me tell you a little about the research.

They participated in a very unique, specifically designed curriculum when they were with me as my students. They have been chosen based on a selection criterion that best fits the type of students the curriculum was designed to reach. All your students need to do is to answer the interview questions about their experiences while in the program.

As your son (daughter) is under the age of 18, I would like to ask for your permission for them to participate in the study. They have already consented to participate, however, I would also like to attain yours as the legal guardian. If you would like to give that permission, that would be great. All I will need to do is begin a short screen recording with your face in the video. I will read a small script, and you will replay when asked to provide your information.

Do you have any questions for me? If at any time later you have questions or concerns about your participation in this study, you should first contact the principal investigator, Dr. Young Baek, at youngkyunbaek@boisestate.edu or the co-principal investigator, Tory Temple, at torytemple@u.boisestate.edu or (951) 973-4141.

[Start screen recording]

My name Mr. Temple and I am conducting qualitative research interviews that include (name of student). I am seeking your permission for them to participate in the project. Know that you or your child can quit the interview at any time or may opt to skip questions if any questions are ones that you would wish not to answer. Please state your name and your relationship to the participant. As legal guardian of ______ do you provide your consent for him (her) to participate in this research, to affirm this statement, simply say, "I give my permission."

Thank you, and let's schedule a time for the interview.

[end recording]

Appendix D – Research agenda page for online interviews

(Documents following this page)

My Trainings (Login) The Case Files AREA154 Backstory
Agent Ranking System Director's Lounge

Research

Briefing statement

First, thank you for taking the time to do this. I know you have things to do, and working my project into your schedule is much appreciated. Before we start the video that is designed to walk you down memory lane of your AREA154 experiences, I wanted to brief you a little on the project and your role in it.

- **Step one:** A little about what I'm going – briefing + That whole consent thing (The permission documents).
—
- **Step two:** A little question and answer session where we talk about some of your social behaviors
—
- **Step three:** Watch the video here. Now that you've read the questions let's take that walk down memory lane.
—
- **Step four:** The interview – I will be asking you questions that focus

Top A.R.K. Agents

	USER NAME	POINTS
1	3-christiana-tautolo	500
2	6-Emely-Viveros	484
3	6-Erick-Ramirez	469
4	4-Omar-hazeen	460
5	3-miriam-perez	455

on your experiences with the AREA154 system, your interactions with it, and how those interactions affected you and your feelings of confidence in STEM-related subjects.

—

- **Step five:** I might schedule a follow-up call or Zoom call to ask follow up questions.

That's it!

Your responsibility as a participant *is to provide honest, trustworthy, and well thought out responses. There are NO WRONG ANSWERS. If there is reason to be critical, be critical. Critical evaluation can have positive effects as well as effects that would be considered not so great. All data is valuable, and if there are problems with the system, your feedback will help make for a better, more robust experience in the future.*

If you've read the interview questions, then you're ready to proceed. [Review video begins]

PERMISSION

STEP 1

You've been CHOSEN to participate in a study that focuses on the technology design used for the AREA154: Apocalypse Div. Chemistry class. Here's how this works:

- If you are over 18: **Click here**
- If you are under 18: **Click here**

You might want to open and save a copy to your device.
Cultural information

STEP 2

The research is specifically geared to Hispanic psychosocial traits. In this next part, can you take a minute and answer the questions in this survey.

——

1. Can you describe a little bit about your priorities?
2. What would you say are the top five most important areas of your life?

6	6-Cynthia-Agosto	403
7	3-Keila Serrano	400
8	4-rodrigo-rodriguez	400
9	5-Jessie-JImenez	335
10	5-steven-bello	335
11	6-Isaiah-Garcia	314
12	6-Liliana-Ruiz	275
13	1-Amaya-Mcwilliams	260
14	1-Elyssa-Mancilla	205
15	4-Alexis-esqueda	195
16	1-Aysel-Franco	185
17	4-Branden-Herrera	165
18	6-Megan-Valdez	165
19	5-nadia-favela	155
20	6-Bryahjahne-Smith	150

3. What would you say are your responsibilities are each day when you get home from school?
4. If schoolwork is done at home, when does that time usually occur? How frequently did you do your homework at home?
5. Cultural influence survey: **Click here.**

A Time to Reflect

STEP 3

Watch this video. It was made so that you can recall some of the experiences and memories you had during your time in that classroom.

—

What I will ask you

STEP 4

The questions I will ask you in the video are below

You will be provided some time to look over them and think about them before the interview begins.

Perceptions of success:

1. Tell me about how you perceived your confidence level in STEM subjects (your freshman biology class for example), prior to the year in AREA154.
2. Talk about your level of confidence while enrolled in the AREA154 program.
3. Were there areas (case files or specific trainings) of the program that you felt more confident than others?
4. What sorts of behaviors are common for you when you feel confident in a subject *(levels of attention, actions engaged in during class, study habits, order in which work is completed – before other subjects or after)*?
5. Can you talk about occasions when you exhibited these behaviors in our program?
6. As I mention different aspects of our program can you talk about which elements would lead you towards behaviors demonstrating a sense of confidence in this STEM subject.

21	3-Leopoldo-Martinez	145
22	4-Kaydense-Matuu Malepeai	135
23	6-Lawrence-Henzon	133
24	1-Maria-Salgado	130
25	1-soowut-rodriguez	125
26	1-Beatrice-Corona	115
27	4-Miguel-Diaz	115
28	6-Zoe-Boatright	110
29	5-Damian-Lamadrid	105
30	3-Nancy-Pedraza	100
31	4-candice-sumaran	100
32	6-Gael-Manriquez	94
33	1-Alayjah-Collins	90
34	1-Nicholas-Litton	86

1. *The central location of all learning content*
2. *Daily posts of class activity*
3. *Content organized as case files*
4. *Downloadable interactive PDFs*
5. *PDF – The Briefing Icon (**Sample to view**)*
6. *PDF – Media Icons (**Sample to view**)*
7. *PDF – The comic book inspired panel design (**Sample to view**)*
8. *PDF – The use of full color*
9. *The SRTs – Instant feedback*
10. *The SRTs – Retakes*
11. *The ATN – Dedicated place for classwork*
12. *The ATN – signatures & feedback*
13. *The ATN – Flexible deadlines*
14. *The ATN – As a tool for learning*
15. *The Leaderboard – top agents*
16. *Achievement points – ranking*
17. *Achievement points – as a currency for extra credit (did you use?)*
18. *The Examulation – the experience as a tool for assessment.*
19. *The AREA154 theme – to foster engagement*
20. *The AREA154 theme – applicability to the world around you / changed perceptions*

35	6-henry-aguilera	80

Away from class

1. In general, what were your experiences like when trying to do school work at home?
2. Did you ever attempted to access the site on a device besides your school Chromebook? If so, what did you attempt to use?
   1. *Describe any times you may have tried to access the site when in the car or on the go.*
3. How did your level of confidence change with this STEM subject when you engaged with it at home?
4. If, you did attempt to do AREA154 work at home when, where would it take place?
5. Describe how the construction of the program played a role in your ability to get the information you needed to complete work at home?
6. Where there times where you couldn't get what you needed to complete the tasks? What did you usually do to adapt?
7. How frequently did you talk about AREA154 content or experiences at home with parents or other family?
   1. How did they react?
   2. *Would you say this level of conversation was normal for all your STEM classes?*

Thematic elements – A sense of purpose

1. The class was themed around some pretty extreme topics. How did you feel about the thematic approach to teaching STEM-related topics?
2. Did you feel that the "Apocalypse" was theme was interfering with your ability to understand the content?
3. Which case file to you recall having the biggest impact on you?
    1. *What did that impact spur you to do?*
4. Did you feel that the application of the survival theme of this STEM class empowered you in any way?
5. Did you feel that this class provided a way for you to take care of your friends and family?
6. Was that part of your motivation to learn?
7. In an actual event, do you think your parents or other family would have turned to you for input on what to do?
8. How would you describe any impact the AREA154 STEM experience had on your perceptions of the world around you?

Academic perspectives

1. Would you describe yourself as academically in comparison to the rest of your immediate family?
2. What is being in a traditional science environment like after having spent time in an ulearning (AREA154) climate?
3. How would you describe your grade in the AREA154 STEM experience as opposed to other science-related class you have had?
4. How would you describe how much you feel you learned in comparison to other STEM subjects?
5. Did your experience in AREA154 influence your confidence to take more STEM related courses?
    1. *If it did, what courses did you consider?*
6. Did your experiences in AREA154 influence you in your possible career choices? If it did, what careers did you consider?
7. How would you describe your level of confidence in STEM subjects now compared to where you started at the beginning of the year?
8. Did you experience any feelings of community while a part of the program? If you did, can you talk about how that affected your sense of success in the class?
9. Do you think that the AREA154 program design I could be successful if taught by a different teacher?
    1. What traits would an instructor need to have for this type of

curriculum to produce the same sorts of success-like behaviors as it did in you?

10. Give this some thought…. If you could change any part of the SRT that might supply you with more confidence in the subject area, what might that be?

My Achievements

You must be logged in to view earned achievements

Days in Training

Days in Training

Select Month

AREA154: A.D.

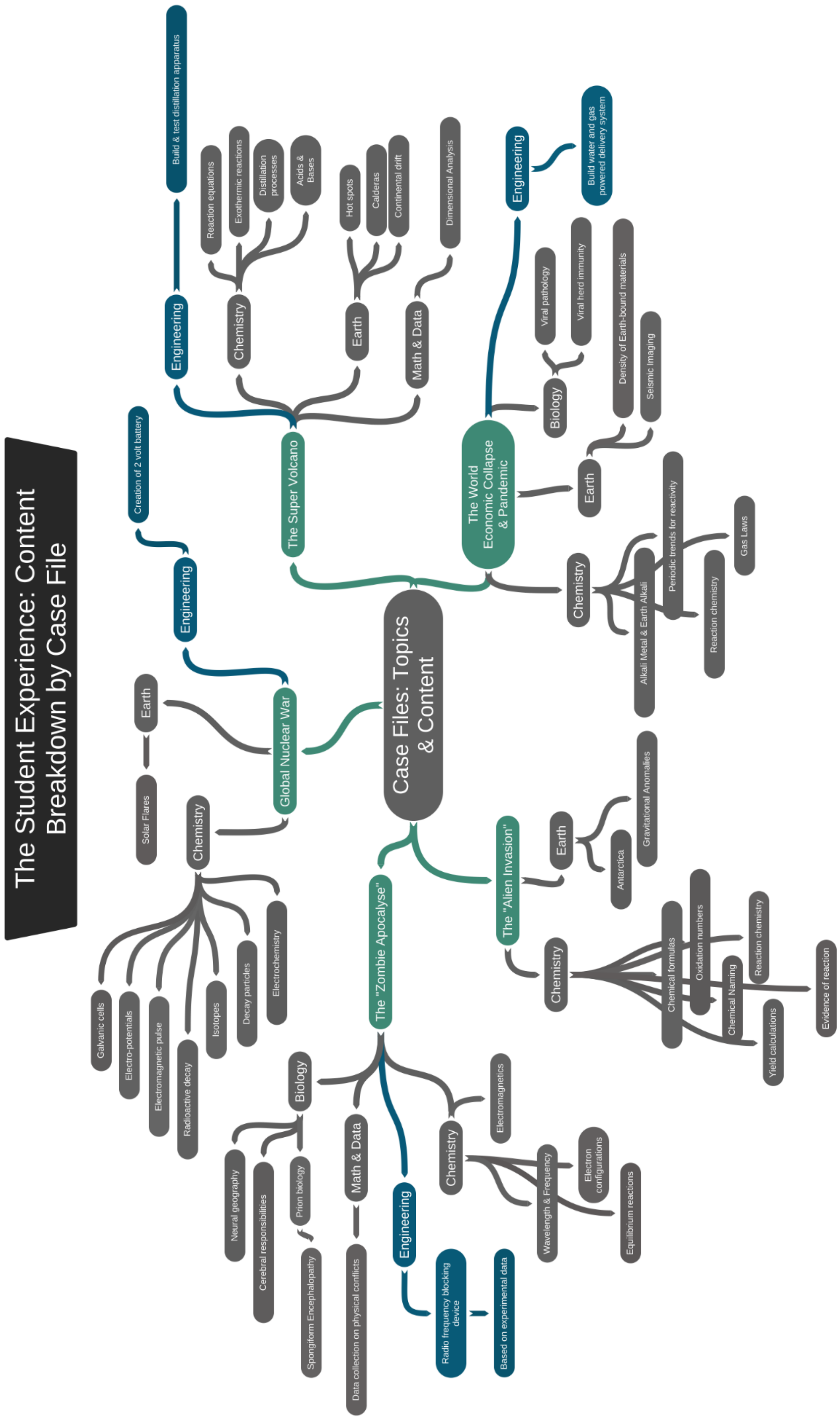
February 2021

M	T	W	T	F	S	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28

« Jan

Appendix E – AREA154 case file content flow chart

(Documents following this page)


The Student Experience: Content Breakdown by Case File
Case Files: Topics & Content
The Super Volcano
Engineering
Build & test distillation apparatus
Chemistry
Reaction equations
Exothermic reactions
Distillation processes
Acids & Bases
Earth
Hot spots
Calderas
Continental drift
Math & Data
Dimensional Analysis
The World Economic Collapse & Pandemic
Engineering
Build water and gas powered delivery system
Biology
Viral pathology
Viral herd immunity
Earth
Density of Earth-bound materials
Seismic Imaging
Chemistry
Alkali Metal & Earth Alkali
Periodic trends for reactivity
Reaction chemistry
Gas Laws
Global Nuclear War
Engineering
Creation of 2 volt battery
Earth
Solar Flares
Chemistry
Galvanic cells
Electro-potentials
Electromagnetic pulse
Radioactive decay
Isotopes
Decay particles
Electrochemistry
The "Alien Invasion"
Earth
Gravitational Anomalies
Antarctica
Chemistry
Chemical formulas
Oxidation numbers
Chemical Naming
Reaction chemistry
Yield calculations
Evidence of reaction
The "Zombie Apocalypse"
Biology
Neural geography
Cerebral responsibilities
Prion biology
Spongiform Encephalopathy
Math & Data
Data collection on physical conflicts
Engineering
Radio frequency blocking device
Based on experimental data
Chemistry
Electromagnetics
Wavelength & Frequency
Electron configurations
Equilibrium reactions