ABSTRACT

KLESATH, MARTA JEAN. Exploring the Viability and Perceived Pedagogical Value of the Virtual Interactive Biology Experience (VIBE) Assignment Format in Higher Education Life Science Courses. (Under the direction of Dr. Shawn Holmes and Dr. John Park).

The current *Net* generation has grown up surrounded by technology. Today's technological devices have become integrated in every aspect of our lives, including education. Utilizing design-based research methodology we have developed a unique technology-rich, multimedia embedded 3D virtual assignment format dubbed *Virtual Interactive Biology Experiences*, or *VIBE*. The focus of this sequential mixed methods study was to gather empirical data related to the viability and perceived pedagogical value of the VIBE assignment format. Quantitative data was collected on the student's current usage of, and attitudes towards, technology prior to their exposure to the VIBE format. Students' responses to an assignment questionnaire indicated their perceived value of the VIBE assignment format. Student responses were collected immediately following both the first and last (third) exposure to the VIBE format. A repeated *T*-test indicated that students' attitudes towards the pedagogical value of this format become more positive with increased familiarity. Additionally, specific covariates associated with the students responses on the technology survey were identified as predictive for the students reported values of the VIBE format to varying degrees. Multiple regression predictive models were developed which differed between the initial and repeated measures data. This variation supported the repeated measures finding emphasizing differences in responses associated with the first and subsequent uses of the VIBE format. Future studies are planned in which potential learning gains associated with the use of this format may be evaluated.

Exploring the Viability and Perceived Pedagogical Value of the Virtual Interactive Biology Experience (VIBE) Assignment Format in Higher Education Life Science Courses

by
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DEDICATION

I dedicate this work, as I do my entire life, to my family. Truly nothing else would matter if I didn't have you.

To my daughters:

There never has been, nor will there ever be, anything that is more important to me than you! You are my greatest gifts in life and I cherish and love you both more than I could ever express.

To my husband:

I love you, I need you, and I couldn't have done it without you.

To my parents:

You've always been there for me, not only throughout this degree, but throughout my life. You've always supported me. You've always believed in me. You've always given me all of your love. You will always have mine in return.

BIOGRAPHY

Marta was born and raised in Missouri where she received her B.S. in biology from Southwest Missouri State University. She moved to North Carolina in order to attend the University of North Carolina at Wilmington where she earned a M.S. in marine biology. Next, she continued her studies at the Veterinary College at North Carolina State University where she ultimately completed a Masters in Toxicology. Throughout her graduate career she gained significant teaching experience within both the North Carolina Community College and North Carolina University Systems. It was her love for teaching, and her interest in the continued development of new educational technologies, that brought her back to North Carolina State University to complete her PhD in Science Education.

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CHAPTER 1

Introduction

Purpose of the Study

The purpose of this exploratory study was to collect empirical data concerning students' satisfaction in, and perceived value of, uniquely formatted multimedia embedded 3D virtual assignments (dubbed *Virtual Interactive Biological Experiences* or VIBE) in a higher education entomology course. The VIBE format was developed to engage students with course content in an interactive way while utilizing both current and emerging technologies. The goals of this project included development of the VIBE format, the creation of three VIBE assignments, and the evaluation of the VIBE format from the students' perspective. Additional aspects of this study included the collection of data on students' self-reported technology usages to determine if these indicators are predictive of students' attitudes towards the VIBE format and the evaluation of possible changes in attitudes towards the VIBE format with increased usage.

This study seeks to summarize student opinions of the VIBE format by collecting both qualitative and quantitative data on the reported engagement/interaction level of the format, perceived learning value, and overall attitude and interest in the development of future VIBE assignments. Cumulatively, these results will illuminate the feasibility of this format while guiding its future implementation in higher education courses.

Significance to Current Literature

Through our research we hope to provide insight on the feasibility and usefulness of the technology-rich VIBE assignment format in higher education life science courses. Although specific in nature, our results will add to the current literature concerning student attitudes towards the continued incorporation of technology-rich assignments in academia. Conclusions regarding possible shifts in students' attitudes towards the assignment format with increased familiarity, as well as the possible predictive value of student's current attitudes towards technology, cumulatively have the potential to impact the overall evaluation processes for future technology-rich assignments.

The Role of Technology in Higher Education

Today's higher education students are immersed in technology, both in and out of the classroom. Students have more powerful technological devices at their fingertips than ever before, carrying iPads or compact laptops to class. Smart phones allow students to be continually connected to the world around them in a variety of ways. The extensive availability of wireless internet access allows students can get online almost anywhere. There is little doubt that today's higher education students are using a record number of different technologies, and that they are using them for record amounts of time ("Kaiser Family Foundation Study", 2010).

This surge in technology usage has made its way to the classroom as well. Today's higher education students may download lectures via podcast, collaborate on a project utilizing an online videochat system, or complete group work synchronously from a variety

of places utilizing online virtual environments (Allen, 2005; Annetta et al., 2008; Annetta, Folta, & Klesath, 2010).

This all-encompassing explosion of technological tools being utilized in higher education courses has blurred the lines between how students utilize technology in courses taught in what has been historically referred to as the "traditional or seated format" and those taught in the "distance education (DE) format" (Bray, Harris, & Major, 2007). Additionally, there has been an increase in offerings of blended or hybrid courses in higher education, a relatively new course format. Although variations of the hybrid format exist, typically it either allows or requires individuals to attend face-to-face sessions (which are usually on campus) while providing significant amounts of course content online. Since DE courses have existed, so has the ambiguity in the format and technologies used within these courses. Powar (2003) argues that DE is by nature "polycentric" and that the ambiguity in distance education formats complicates both its classification and data analysis. Bray, Harris, and Major (2007) emphasize the variation that exists in DE formats when they stated "Rarely is a distinction between these different offerings made in literature. This blurring affects our ability to learn from early adopters of distance education." (p. 891). To further complicate matters, DE formats evolve rapidly in response to changes in technology. Therefore, DE courses always appear to be somewhat in a state of flux.

Students currently taking seated courses are not exempt from using technology. Today's higher education students are expected to access and utilize online learning materials to much greater degree than ever before due to the increased availability and accessibility of technology. This is evident in the almost universal use of online learning management

systems for both seated and DE courses. Because of the high level of technology incorporated into higher education courses taught in all formats, it is somewhat difficult to distinctly separate the students' use of technology between formats.

Course format labels aside, in reality almost all higher education courses taught today incorporate varying levels of technology use, both in and out of class. Therefore accessing students current level of technology use, their attitudes toward technology, and innate interest in using different types of technology is important information in curriculum planning at the higher education level. Additionally, the thorough examination of emerging educational technologies within higher education is necessary in order to properly assess its viability as a learning tool. Since the underlying purpose of higher education is to prepare students with the skills they need to enter the work force (Cradler, McNabb, Freeman, & Burchett, 2002) it could be argued that the higher education institutes have a responsibility to expose their students to current technologies they are likely to encounter, and be required to use, throughout their career.

This design based research study not only furthers the use of technology within higher education courses through the development of the VIBE format, it evaluates possible pedagogical significances associated with the incorporation of this technology-rich assignment. The VIBE format packages a variety of educational technologies together; including 3D virtual environments, online interactive multimedia materials, and learning management systems. Information gathered from this research will provide important data concerning students' attitudes towards these types of technology-rich assignments while concurrently providing information that will be used to effect improvements of the format

itself. The focus of this study is to explore the efficacy of the VIBE format, with results guiding future development and utilization of this format within higher education life science courses. Once the viability and pedagogical significance of this technology-rich assignment format has been established, this research may be expanded to include data to determine if this format provides for potential learning gains by the student. Cumulatively, data collected from this and future VIBE studies will add to the growing literature concerning the viability and possible pedagogical significance concerning the use of various educational technologies in higher education.

Research Questions

This study was designed to address the following four research questions:

1. What are students' self-reported usages of technology?
2. What are students' self-reported satisfaction in, and perceived value of, the VIBE assignment format?
3. Do students' attitudes of the perceived pedagogical value of the VIBE assignment format increase with familiarity?
4. Are students' current usages of technology predictive of their overall satisfaction in, and/or perceived value of, the VIBE assignment format?

Hypotheses

1. Students will report that they use a variety of technical devices on a regular basis with large usages represented by both frequency and duration.
    a. *Null Hypothesis*: Students will not report using a variety of technological devices, nor high level of usages.
2. Students will report overall satisfaction in, and perceived value of, the VIBE format. Variations in responses, including both positive and negative comments, are expected amongst the individualized and specific components associated with the assignment format.
    a. *Null Hypothesis:* Students will report low levels of satisfaction in, and perceived value of, the VIBE format and its components.
3. A positive relationship will exist between the utilization of the format and students overall attitudes and reported value of the VIBE assignments (Category 1 and Category 3 responses).
    a. *Null Hypothesis:* The independent variables derived from the technology survey will have either no relationship, or a negative relationship, with familiarity to the format.

4. Predictive models derived from statistical analysis of potential covariates associated with the technology survey responses will account for at least some of the variability associated with the students' responses concerning the overall value of the VIBE format. Because we hypothesize that students will become attitudes will become more positive towards the format with increased exposure, we will run statistics on the initial and repeated measure values separately. We hypothesize that the predictive models for both the initial and repeated measures values will differ.
    a. *Null Hypothesis:* Statistical analysis of this data will not reveal predictive models associated with the technology survey responses for any of the categorical responses associated with the repeated measure data from the assignment survey.

Definitions

Virtual Interactive Biology Experiences or ***VIBE*** **-** refers to a unique multimedia embedded 3D virtual assignment format developed by Marta Klesath. VIBE assignments are defined by the presentation of instructional materials through a combination of the following three integrated VIBE components; a 3D virtual learning environment which allows the student to explore the assignment content in the form of an avatar, a multimedia video presentation which provides instructional information utilizing the case based learning format, and an interactive content file which must be activated in some way in order to receive instructional materials. In the VIBE assignment format these three components compliment each other, building a single *virtual vignette*. Individual VIBE assignments may include one or more virtual vignette depending upon the complexity of the content.

Virtual Learning Environments or VLE – are defined within this study as dynamic 3D online environments designed for instructional purposes. These environments allow for individuals to navigate throughout the environment as avatars, providing information about the world from the viewpoint of the avatar. Individuals may interact with materials contained within the environment alone, or they may collaborate with other individuals within the virtual space. VLE's allow for real time communication.

CHAPTER 2

Literature Review

The Integration of Technology in the Lives of Today's Students

The lives of today's students are more immersed in technological tools than ever before. This generation, often referred to as the *Z* or *Net Generation*, does not remember a time before the internet. These "digital natives" (Prensky, 2001) take advantage of wireless internet service that is practically ubiquitous. They own and use a plethora of technical devices on a daily basis. For this generation technology has become personal. More choices exist in the types of tools used than ever before. Their choices are not limited to either a desktop or a laptop, but they also may use touchscreen tablets such as an iPad. Cell phones have ascended in priority, considered by most to be an essential item. To complicate matters, cell phones are not just phones anymore. They are often used for a variety of things other than "talking", including texting, surfing the net, taking pictures or videos, and playing music.

Over the past five years there has been a huge increase in media use among young people from 8 to 18 years old which has been contributed to the increased accessibility of mobile and online media ("A Kaiser Family Foundation Study", 2010). It's not unusual for today's students to watch TV on their computer, TiVo whole seasons of shows with one click, load and view videos instantaneously from You Tube (through a myriad of devices), and check out videos their friends posted on Facebook. In fact it is not that unusual for them to be doing several of these things at once, earning them the title of the M^2 generation based on their extensive multitasking skills ("Kaiser Family Foundation Study", 2010).

Clearly, the role of technology in the lives of this generation has expanded to an extent never before seen. Technological tools are no longer used specifically for work. This generation also uses technology for entertainment. They play digital games on a variety of mobile devices, engage in multiplayer online games synchronously with players in different locations, they even use their body as the game controller, and when they tire of that they can enter a virtual world and explore the digital space as an avatar.

Based on the overall trends and key findings from each of three Kaiser Reports containing data from 1999, 2004, and 2009 ("A Kaiser Family Foundation Study", 2000, 2005, 2010) technology use among 8 to 18 year olds does not appear to be waning anytime soon. Some of the statistics from this study are shocking such as; the 1 hour and 35 minutes per day average that 7th through12th graders spend sending/receiving texts, the combined average of 10 hours and 45 minutes of media exposure per day for 8 to 18 year olds, and the 74% of 7th through 12th graders that have created a profile on a social networking site.

This comprehensive study paints a clear picture of this generation's dependence upon technology in most aspects of their lives including communication, entertainment, and task completion. Not only have these students increased their dependency on digital media, but this study also reports a decline in the time 15 to 18 year olds spent reading printed materials, averaging a mere 21 minutes a day. In fact, the only decrease in media use reported between the 2004 to 2009 studies was related to time spent reading print with increases noted in the use of media; music/audio, TV, computers, and video games. Clearly this generation is accessing more information through digital media while reading less. Considering this generation's complete and total immersion in technology, it is not surprising that research has

demonstrated that today's students not only want to use these technologies in higher education, but that they expect to (Hagner, 2001).

Technology as Mediating Tools

Vygotsky's sociocultural theory (Vygotsky, 1978) focused on the integration of an individual's learning within the context of their sociocultural surroundings. It is clear through Vygotsky's work that he identifies both the intermental and intramental as being inseparable entities, one impacting the other. Vygotsky defined mediating tools, such as language and other sign systems (diagrams, arithmetic), as the way in which information is exchanged within this sociocultural structure. Vygotsky's research focused largely on the use of verbal language as the primary mediating tool used, which was a reflection of his own sociocultural environment and personal experiences within the context of a 1930's Marxist Russia. In contrast to his experiences, today's Western culture is dominated by various forms of electronic sharing of information. This communication stretches from a variety of discrete forms of written language (including e-mail, texting, and electronic sharing of information) to advanced multimedia presentations which may incorporate both visual and/or audio components as well as interactive features.

Carmona (2008) argued that Vygotsky's ideas of mediating tools, and their role in sociocultural development and learning, apply to today's students who are deeply immersed in technology. This sentiment is evident in the following excerpt.

> Although Vygotsky's theory was not developed with current technological environment in mind, it can be argued that in a technology-mediated learning environment, language can take the form of email, forums, discussion boards, chat room, collaborative document exchanges and cooperative experimentation. (p. 14)

Integration of Technology-Rich Assignments in Higher Education

Educational researchers have historically shown a positive relationship between the use of computer mediated environments and learning gains (Fletcher, Hawley, & Piele, 1990; Kulik, Kulik, & Bangert-Drowns, 1990; Coley, Cradler, & Engel, 1997). Other benefits, such as increased student satisfaction, have also been shown to be positively correlated with increased use of technological tools within the classroom (Robyler & Wiencke, 2003).

Songer (2007) emphasizes that it is not just the technological tool itself that may contribute to learning, but rather how that tool is used may be a more relevant factor. For example, a student could look up a data set online or they could use a program to simulate a process and collect their own data. Songer (2007) would refer to the former as a *digital tool* and the later as a *cognitive tool*. Other researchers have argued the same point using the term "learning technologies" synonymously with cognitive tool (Kyza, Erduran, & Tiberghien, 2009).

Certainly the utilization of learning technologies has been playing an increasingly important role in higher education. Based on the technologies available today, it is not surprising that the sole use of a textbook to support higher education learning is considered as an ancient idea by some. The utilization of technology for both the presentation and expansion of course content in today's higher education classes has become a reality (Annetta et al., 2010). However, variation exists in both the specific types of technology used and the degree to which technology is integration within courses. These differences not only occur between institutions, but also among professors within the same institution.

At the lower end of the technological spectrum instructors store course materials in a learning management system such as Blackboard™ or Moodle™. The increased use of interactive features available within these systems, such as discussion forums and wikis, also occurs. Additionally instructors often utilize digital media and animations developed by textbook companies as instructional supplements and may require students to purchase and/or use specific digital instructional products such as WebAssign™. Instructors at the higher end of the technological spectrum actually create digital materials for their courses such as web pages, videos, and even interactive materials such as Flash™ files.

The sheer prevalence of technology within today's academia may be opportunistic for potential learning gains, but it can also provide unique challenges. Just keeping up with the fast pace of emerging technologies can be difficult and becoming adept at using these ever changing technologies can be overwhelming for both instructors and students. Even under ideal circumstances, where faculty development and instructional technology support is readily available, instructors may struggle just to stay up to date with the technology their

students are currently using. Additionally, identifying specific pedagogical benefits associated with the use of such technologies not only requires familiarity with the technological tools available but also requires significant limited resources such as time, money, and either intrinsic or extrinsic motivation for instructors to learn additional technological skills outside their field (such as a biologist learning to program Flash™ files or to build a virtual environment). Given these considerations it is critical that the integration of technology in higher education courses is done knowledgably, logically, and is constantly being evaluated.

Design Based Research

Ann Brown (1992) and Alan Collins (1992) were some of the first educational researchers to publish design based research, or DBR, methodology under the coined term of "design experiments". This unique research paradigm which included the concurrent testing of both the design of an interactive and the value of the interactive also went by a variety of other terms in and around this era including *formative research* (Walker, 1992; Reigeluth & Frick, 1999), *design research* (Cobb, 200; Collins, Joseph, & Bielaczyc, 2004), and *development research* (Richey, Klein, & Nelson, 2004). Cobb, diSessa, Lehrer, and Schauble (2003) identified the two main tenets of DBR as being interventionist (creating a design) and as taking place in the naturalistic context.

In 2001 a group of researchers supported by the Spencer Foundation founded the design based research collective with a goal "…to refine a definition of design experimentation that is broad enough to encompass a diversity of research perspectives, yet rigorous enough to sustain theoretical and methodological attacks on its robustness and

cumulativity" (http://www.designbasedresearch.org/index.html, 10.13.11). These researchers went on to publish a seminal article which described, evaluated, and advocated for the use of design based research in education while highlighting four specific areas where DBR could greatly enhance educational research (Design-Based Research Collective, 2003). These included; exploring possibilities for creating novel learning and teaching environments, developing theories of learning and instruction that are contextually based, advancing and consolidating design knowledge, and increasing our capacity for education innovation.

The collective argued the potential value of this methodology by stating "Design-based research, by grounding itself in the needs, constraints, and interactions of local practice, can provide a lens for understanding how theoretical claims about teaching and learning can be transformed into effective learning in educational settings." (pg. 8).

Although this unique methodology is arguably critical to the integration of technology-rich assignments in higher education, it is messy since the focus is on creating a design that works in the natural setting. The complexity of this research methodology is evident in Wang and Hannafin's (2005) description of this research paradigm as one that "…advances design, research, and practice concurrently…." (pg. 5). To compound these issues, educational researchers in DBR do not just "observe" interactions, rather they develop the interaction. Wang and Hannafin (2005) describe this duality by stating "Researchers assume the functions of both designers and researchers, drawing on procedures and methods from both fields, in the form of a hybrid methodology." (p. 6).

Mediating tools are ways in which students establish their sense of social presence within the learning community. Garrison and Anderson (2003) identified social presence as

"the ability of participants in a community of inquiry to project themselves socially and emotionally, as real people through the medium of communication being used" (pg. 29). Based on this definition, variation exists in the mediating tools used to create social presence.

As technological tools become more embedded within the higher education classroom, instructors are utilizing these tools in a variety of ways to engage the students in content. Although the extent to which this occurs varies greatly, the instructor is arguably taking on the role of the developer to a greater degree. This phenomena, which is described by Barab and Squire (2004) in the following passage, has driven the growing field of design based research.

> Increasingly, learning scientists are finding themselves developing contexts, frameworks, tools and pedagogical models consistent with and to better understand pedagogical theories….the research moves beyond simply observing and actually involves systematically engineering these contexts (pg. 2).

Today's economical constraints highlight not only the pedagogical value of these designs but also the efficacy of such designs. Reality is that how well something works is not the only concern, the realistic adoption of such designs depends upon the usability, scalability, and sustainability of the design (Wang & Hannafin, 2005). Barab, Hay, Barnett, and Keating (2000) demonstrated strong learning gains through their DBR but the model they developed was not viable for larger institutions since it limited classroom size from 100-150 to just 20. This example highlights the importance of foresight in the design process. In order for an educational technology to be accepted and implemented, it has to be designed so that it can be affordably integrated within current classroom structures. Wang and Hannafin

(2005) emphasize these ideas by arguing that for DBR methodology to be of value it must be "…an alternative approach that emphasizes direct, scalable, and concurrent improvements in research, theory, and practice" (p. 6).

Case Based Learning and Virtual Learning Environments

Various definitions of problem-based learning (PBL) exist, however scholars agree that PBL engages the student, assisting in their development of independent thinking. Scientific literacy depends upon the ability of students to not only collect data, but also to use this information to develop and manipulate experiments and analyze and apply results. These criteria align with both problem based learning and critical thinking skills. Critical thinking requires assumptions, knowledge, and competence from the student in order to identify and challenge ideas as they explore and create alternatives (Brookfield, 1987; Paul, 1993). Richardson (2003) argues that critical thinking not only encompasses the possession of information, but is inclusive of the ability to understand and use this information. Meta-analysis studies conducted by both Albanese and Mitchell (1993) and Vernon and Blake (1993) determined a correlation between the use of PBL and increased critical thinking skills. Sendag and Odabas (2009) found that online learning utilizing PBL methodology resulted in increased critical thinking skills although no content knowledge difference was noted.

Case-Based Learning (CBL), or Case-Based Reasoning (CBR), is founded in the same principles of problem based learning (PBL). Shulman (1992) defines a case as "…. a narrative, a story, a set of events that unfolds over time in a particular place" (p. 21). Cases often tell a story, one that hopefully captures the student's attention. Case Based Learning often utilizes authentic problems and tasks using one or more characters as the scaffolding

for learning. Annetta, Folta, and Klesath (2010) emphasize this argument by stating "The more realistic and relevant a case is, the more engaging it is likely to be to the student. Therefore, whenever possible, cases should reflect authentic problems and tasks modeling the real world" (p. 63).

Roger Schank was at the forefront of this research in the 1980's and 1990's with his extensive publications on case-based learning and multimedia (Schank & Leake, 1989; Schank, Fano, Bell, & Jona, 1993-1994; Schank, 1994). Bolt (1998) and Stoiber (1991) demonstrated that CBL could be used to enhance traditional teaching and learning experiences. Lombardi (2007) argues that CBL used to provide students with authentic situations can strengthen the transfer of learning. Since the underlying goal of case base learning is to have the student collect information in a variety of forms and build upon these experiences, this type of instruction allows the novice student to move towards an expert as they continue to progress through a case.

Case based learning is often the theoretical frame utilized in the development of virtual interactions including virtual learning environments, serious educational games, and simulations (Annetta, Folta, & Klesath, 2010). Data collected on the direct relationship between increased content knowledge and the use of these case based virtual formats has been mixed and somewhat inconsistent which may be related to variation in research designs. However, there are some encouraging results. Belanich, Sibley, and Orvis (2004) demonstrated that student recall was better for spoken text in the virtual game environment than when presented in printed text. Yaman, Nerdel, and Bayrhuber (2008) showed increased learning gains specifically for students with low subject-interest through the use of

computer simulations. Belanich (2004) found that individuals utilizing computer simulations recalled information embedded within games more accurately than when the same information was provided as printed text. Valke and Dewever (2006) noted that students participating in a virtual simulation retained knowledge longer than students exposed to the same information via text.

Some education studies have demonstrated and/or argued potential gains for these case based virtual formats that are not directly related to content knowledge but that may affect the overall learning process. Taradi, Taradi, Radic, and Pokrajac (2005) demonstrate that video game play can contribute to self-reliance through independent learning. Annetta, Minogue, Holmes, and Cheng (2009) found an increase in student engagement for students interfaced with the video game format. Belanich (2004) found that individuals utilizing computer simulations demonstrated overall procedural knowledge gains. Green (2003) argued that the learning occurring through game play may actually transfer to real world situations better than learning occurring via traditional methods. Steinkuehler (2004) highlights the value of virtual interactions in developing situational understanding. Cumulatively, these studies indicate that we should consider a multifaceted approach when determining the efficacy of these case based virtual formats.

This research focuses specifically on the utilization of case based learning embedded within a Virtual Learning Environment, or *VLE*. VLE's are dynamic 3D online environments designed for instructional purposes. These environments allow individuals to navigate throughout the virtual landscape, providing them information from the viewpoint of an avatar. Individuals may interact with materials contained within the environment alone or

they may collaborate with other individuals within the virtual space. VLE's allow for real time communication. Students are immersed visually within their virtual surroundings and are capable of maneuvering the environment therefore controlling their own learning experience. Examples of software formats that support the development include: Second Life™, ActiveWorlds™, There™.

The ability of the student to engage in content as an avatar allows them a sense of identify within the virtual learning environment content. Rovai (2002) demonstrated that students self-identify within online courses correlated with a students' sense of social presence or belonging. Annetta and Holmes (2006) identified student personalization in the form of avatar selection as an important component of student self-identity and presence, both of which are strongly correlated with student satisfaction and enhanced student engagement and performance within virtual learning environments (Tu & McIsaac, 2002; Richardson & Swan, 2003). Annetta, Klesath, and Holmes (2007) suggested that the customization of characters, through increased physical feature options for avatars, may be a way of further increasing self-identity and student immersion within VLEs. The expected result of such a response would be overall gains in student satisfaction of the VLE.

CHAPTER 3

Methods

Study Overview

This design based study utilized a pre-experimental, mixed methods, within-group research design to investigate the following four research questions:

1. What are students' self-reported usages of technology?
2. What are students' self-reported satisfaction in, and perceived value of, the VIBE assignment format?
3. In what ways do students' attitudes of the perceived pedagogical value of the VIBE assignment format increase with familiarity of the technology used for this format?
4. Are students' current attitudes towards, and usages of, technology predictive of their overall satisfaction in, and/or perceived value of, the VIBE assignment format?

Included within this methodology is an in depth description of the research design and study participants followed by a discussion of the development and utilization of the VIBE assignments used within the study. Additionally, both quantitative and qualitative instrumentation and data collection methods will be described followed by a summary table which aligns each research question with the coordinating hypothesis, relevant data, and data analysis information.

Research Design

There is a growing body of information on pedagogical affordances, or lack thereof, of emerging technologies in higher education. However, inconsistency both in the research methodologies utilized and the relevance of data reported, for many of these studies has led to unclear and/or conflicting results. The relative newness of the technologies being evaluated presents potential difficulties in the use, data collection, and appropriate analysis of data. These technology associated pedagogical issues may contribute to the overall blurriness of information collected on learning outcomes, one of the most common variables evaluated. This study was designed to evaluate what factors, other than learning outcomes, contribute to the pedagogical significance of the technology rich VIBE format. Additionally this study sought to illuminate if and how these factors continue to impact pedagogy after increased exposure to the VIBE format. Collectively, the information collected through this study is expected to direct the potential future development and utilization not only of the newly developed VIBE format and add to the growing body of information on pedagogical significance of the use of emerging technologies in higher education.

The focus of this design based research study was not to assess the potential learning gains of this format, rather to explore the efficacy of this tool and assess students' attitudes towards the VIBE format. Data was collected utilizing pre experimental, sequential mixed methods within group research methodology as defined by Creswell (2009).

Quantitative data collected included student responses from separate Technology and Assignment Surveys. The Assignment Survey instrument contained 5-point Likert scale question items pertaining to one of three categories. This instrument was a repeated measure,

used to evaluate if students attitudes towards, and perceptions of, the unique VIBE format changed with increased exposure. Students completed the Assignment Survey in association with their first (AS) and last (AF) exposure to the VIBE assignment format. The Technology Survey (TS) data was collected prior to the students' first exposure to the VIBE format. This survey contained both binomial and categorical questions related to students' self-reported attitudes towards, and use of, a variety of technologies. Data from this instrument was used to provide descriptive summary statistics on the study participants. Additionally, data gathered from this instrument was used to identify independent variables evaluated for possible relationships between students' attitudes and usages of technology and their perceived pedagogical value of the VIBE format. Since a repeated measure design was employed, two analyses were completed; one using the AS data and one using the AF data.

Qualitative data was collected in the form of semi-structured in depth student interviews. A self-selected subset of students ($N = 6$) participated in the one-on-one 30-45 minute interviews. These interviews occurred after all VIBE assignment had been completed which allowed us to probe students after maximum exposure to the VIBE format.

Study Site and Participants

The participants of this study included students (N = 64) enrolled in a 400 level entomology course North Carolina State University (NCSU), a research intensive Land Grant University. Students were able to register for this class as either a distance education (N = 20) or traditional student (N = 44). Regardless of registration status all students had access to the same online content and were given the same assignments and assessments throughout the semester. All students were given the same opportunity to attend optional live lecture sections which supported the online content, however no attendance records exist for which students attended these sessions. Because there were no clear differences between these groups in how they accessed the course information, or the opportunities they were afforded, no distinctions were made between the students with different registration statuses.

The three VIBE assignments were available to all students as a "for credit" assignment. However, the course was set up to allow students to selectively determine which assignments they completed throughout the semester in order to earn their cumulative assignment points. This meant that although students were awarded points for completing these assignments, they would not loose points by not completing a particular VIBE assignment given that they earned their assignments points through alternate methods. Therefore, not all students completed all of the VIBE assignments. However, this was not necessarily a selective choice either since other factors such as limited assignment options throughout the semester and previously missed assignments may have influenced different students to different degrees to complete the VIBE assignments.

The VIBE Assignment

Overview. All VIBE assignments utilize the principles of case based learning, allowing the student to explore a series of topic related virtual vignettes that built a unified story pertaining to the ecological and economic importance of a single insect species throughout each assignment. Each vignette consisted of a unique exploratory virtual scene representing the setting of the story, a short documentary style video which acted as the "voice" of the story, and an interactive informational screen which engaged the student with content related to the story. Each VIBE assignment consisted of 2-6 virtual vignettes which provided various educational aspects related to the same topic.

The format of each of the three VIBE assignments created for this study were identical in that it immersed the student in a 3D virtual environment represented as a mobile avatar and directed them to engage a series of virtual vignettes which cumulatively told a story emphasizing the ecological and/or economical importance of a particular insect species.

Development of the Virtual Environment. An empty virtual space was purchased through Active Worlds Educational Universe. This space was originally populated with copyright free 3D images (largely gathered through the MegaPath World available in ActiveWorlds EDU™) to create a virtual farm which was used for a virtual insect collection field trip for an undergraduate entomology taught at NCSU. The development and use of this environment acted as a precursor for this research in three ways; it enabled the investigator to develop and demonstrate the skills necessary to build a virtual environment, it provided an opportunity to test the clarity and effectiveness of the multimedia web-based instructional materials provided to the students, and it allowed for the collection of data on user presence

and immersion within the environment utilizing the *Presence and Immersive Tendency Questionnaire* [PITQ] created by Whitmer and Singer (1998). Development of this virtual environment using case based learning is described in Annetta et al. (2008). Results from this initial study indicated that the students felt both a sense of presence and a high level of immersion in the 3D virtual environment (Annetta, Klesath, & Meyer, 2009).

This virtual environment acted as the backdrop for the current study. However, large portions of the virtual farm had to be removed in order to create unique virtual environments which supported the learning objectives identified for each VIBE assignment. This involved not only removing and rebuilding scenes within the virtual environment but also providing built-in guidance within the virtual environment on how the students should proceed through the content. The currently existing roads within the virtual landscape were used to guide the students through the world. Additionally, signs were added both at the entrance point to the world and at each virtual scene indicating the relative placement of that scene within each assignment. These assignments were made available sequentially throughout the semester (roughly towards the beginning, middle, and end of the semester) which allowed us to provide additional guidance to the student through the activation of flashing arrows which directed the student through only the active assignment.

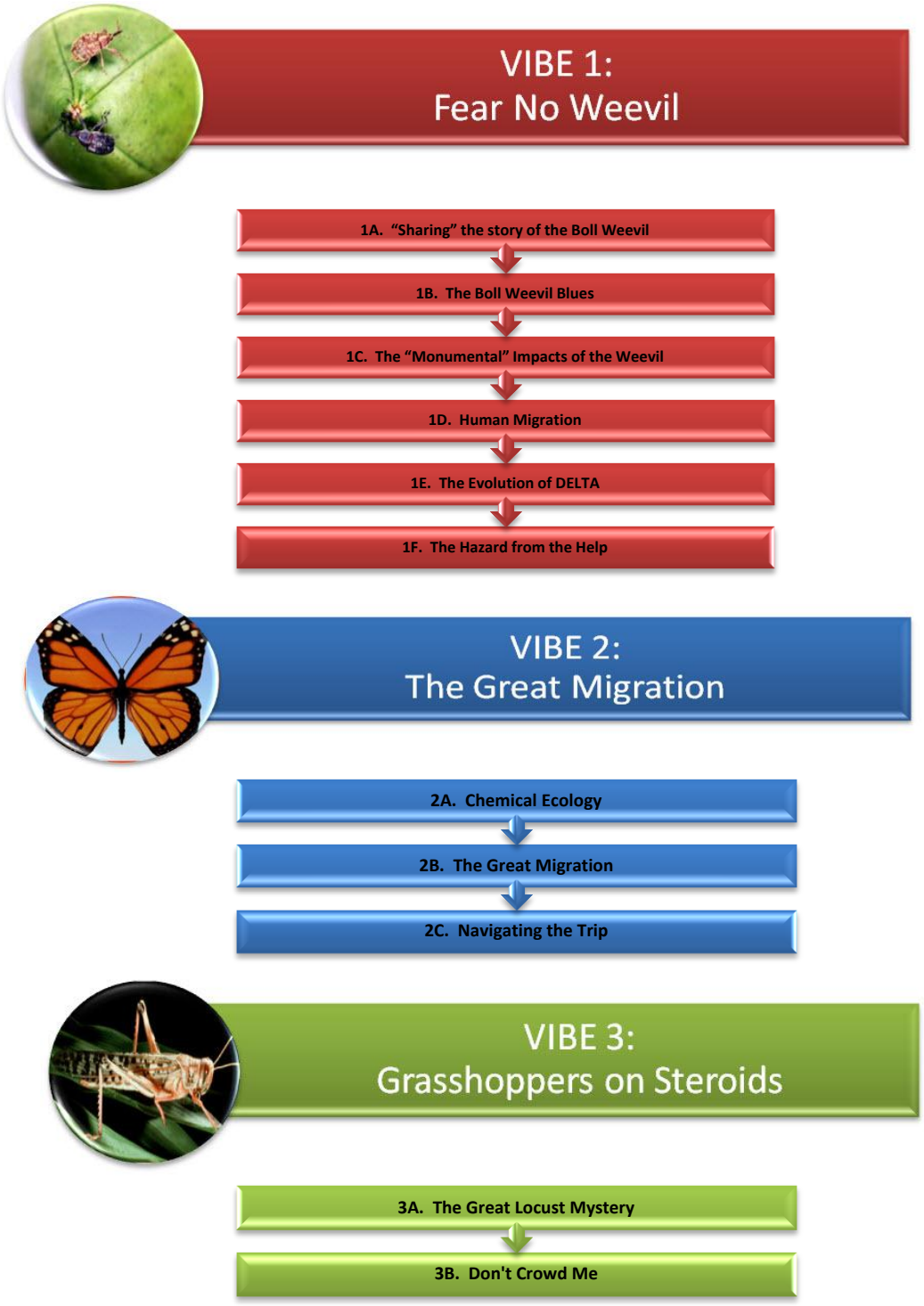

Figure 3.1. Visual outline of VIBE assignment content

Students all enter the virtual world, identified as BugWorld, at a specified entrance point. Here students are directed to the VIBE assignment content by blinking red arrows and signs.

Figure 3.2. BugWorld entrance. This image demonstrates the students view when entering BugWorld.

Within BugWorld students are able to self-select their avatar from the available options. They are also able to control their view by selecting from the first person, third person, chase camera, or front camera view. Although students are provided directional instructions at this point, they are free to explore the environment.

First Person View

Front Camera View

Chase Camera View

Third Person View

Figure 3.3. Optional views within ActiveWorlds™. Images showing each of the four views offered to the students. All images were taken from the same location in BugWorld.

The VIBE Assignment Format. Each assignment consisted of a series of virtual vignettes. Each virtual vignette had three components; an immersive virtual scene which depicted the setting of the related case, a short documentary style video which provided the case narrative, and an interactive Flash™ file which contained supplemental content related to the video which reinforced and emphasized major ideas associated with the case.

Figure 3.4. Diagram of the virtual vignette components. This figure identifies the three unique components that collectively form a single virtual vignette; the 3D virtual environment, an embedded video, and an embedded interactive file.

Both the video and flash files were embedded in the scene in a way in which exploration of the virtual scene was required. Color coded flashing icons were consistently used to indicate these resources. Once found, students activated these icons by clicking on them which activated a pop-up window containing the appropriate information. Students were instructed to locate and interact with both the video and flash files embedded within each virtual scene before moving to the next virtual vignette.

Figure 3.5. Virtual vignette scene. This image shows the students view within the virtual environment of *VIBE 1 Virtual Vignette B: The Boll Weevil Blues*. Students accessed videos and interactive files by clicking on the flashing blue and red icons within each scene.

Directional cues guided the students from one virtual vignette to the next within each assignment. The end of each assignment was marked by a sign located at the last virtual vignette. In VIBE assignments 1 and 3 an additional sign acted as a hyperlink, opening the Assignment Survey in a separate window with ActiveWorlds EDU™.

Students were also able to access 5 multiple choice questions located within the course Moodle site through a direct hyperlink provided within the virtual environment. Since this study did not seek to evaluate learning gains, no data was collected on the student responses to these low-level Bloom's Taxonomy questions. However, the presence of these questions provided incentive for the students to review all of the content provided within each assignment.

VIBE Content

The Department of Biology together with the Department of Entomology at North Carolina State University jointly funded the development of all three VIBE assignments. Through consultation with NCSU's teaching faculty within these departments, it was determined that each VIBE assignment would be developed as a modified case utilizing course content related to the ecological and/or economical impact of a particular insect species. Specific content for each VIBE assignment is addressed in more detail below. The video scripts created for each vignette can be found in Appendix A.

VIBE 1: Fear No Weevil. The first VIBE assignment was developed using a series of articles that discussed several aspects relating to the ecological and economic impacts of the boll weevil.

Virtual Vignette 1A: "sharing" the story of the boll weevil. The video describes the impacts the boll weevil had on the southern cotton crops from the perspective of a tenant farmer. The virtual scene consists of a cotton farm featuring the tenant's home. The interactive file contains a map which animates the progressive range of the boll weevil from 1892 to 1922. Students activate the information by rolling over the dates in the time scale on the image.

Figure 3.6. Image of the virtual scene associated with *VIBE 1 Virtual Vignette A: "Sharing" the story of the boll weevil.*

Virtual Vignette 1B: The boll weevil blues. The video describes the migration of farmers to the DELTA region due to the unique conditionals that allowed this area to survive the boll weevil better than the neighboring regions. The resulting birth of the blues was described with the audio of the boll weevil blues. The virtual setting for this scene is a rainy Blue's Nightclub. The interactive file contains a map indicating the associated regions of the different types of blues. Students activate sound-bytes highlighting the different blues styles by rolling over the associated regions on the map.

Figure 3.7. Image of the virtual scene associated with *VIBE 1 Virtual Vignette B: The boll weevil blues.*

Virtual Vignette 1C: The "monumental" impacts of the weevil. The video starts with an image of the Boll Weevil Monument from Enterprise, Alabama and describes the how the boll weevil devastated the regional cotton crops causing a major shift in the agriculture of the region ultimately leading to increased peanut crop production. George Washington Carver's role in the success of the peanut crops is also discussed. The interactive file contains a map of the US in which the major and minor peanut producing states are highlighted accordingly when triggered by the student rolling over the appropriate headings.

Figure 3.8. Image of the virtual scene associated with *VIBE 1 Virtual Vignette 1C: The "Monumental" impacts of the weevil.*

Virtual Vignette D: The human migration. The video is told from the perspective of a black, Jewish woman and takes place within the virtual setting representing the *Temple B'nai Isreal*, home of Mississippi's oldest Jewish congregation. As the story of how this once thriving cotton crop based economy became desolate because of the boll weevil unfolds, the subsequent mass migration of people from the rural town to the cities is described. The interactive file contains a map of the US in which hotspot icons are located across the southern region. Once activated by rolling over the icon, major Northern migratory corridors appear indicating the increase in population of the relocation cities.

Figure 3.9. Image of the virtual scene associated with *VIBE 1 Virtual Vignette 1D: The human migration.*

Virtual Vignette E: The evolution of DELTA. The video is told from the perspective of a white male crop duster. He describes how DELTA airlines grew out of a Southern Crop Dusting company. The application of pesticides is discussed as well as the economical impact of DELTA's growth within the region. The virtual setting consists of a small, empty airplane hanger and small dirt airstrip. The interactive file contains a map indicating the location of Monroe, Louisiana (the first home of DELTA) with a time line at the bottom. As you roll across the time line sequential slides appear describing the evolution of DELTA airlines including information on the meaning of its changing logos.

Figure 3.10. Image of the virtual scene associated with *VIBE 1 Virtual Vignette 1E: The evolution of DELTA.*

Virtual Vignette F: The hazard from the help. The video is told from the perspective of a female scientist. The virtual setting is an unnamed science laboratory. This narrative describes the discovery and acceptance of the ecological and human health hazards associated with the large scale use of the pesticides being used to attempt to eradicate the pest. Research associated with finding biologically safer ways to control the pests is discussed such as the discovery of pheromones used to create traps. Government involvement through the Boll Weevil Eradication Program is described. The interactive file contains a map of the US in which the student can view the changing regions related to success of the eradication program.

Figure 3.11. Image of the virtual scene associated with *VIBE 1 Virtual Vignette 1F: The hazard from the help.*

VIBE 2: The Great Monarch Migration. The second VIBE assignment focused on the science behind the migration of Monarch butterflies while emphasizing the ecological and economical considerations related to this migration.

Virtual Vignette 2A: Chemical ecology. The video describes the life cycle of the Monarch butterfly focusing on the dependence on the caterpillars on the milkweed plant. Information on predation and mimic coloration is discussed as well as biological information such as how to determine the sex of the butterflies. The virtual setting is an unnamed park with an abundance of flowering bushes and suitable butterfly habitat. Animated butterflies can be found throughout the virtual scene. The interactive file contains images related to identification of the different sexes in the Monarch butterfly. Students activate the male and female images separately and are provided with the appropriate written and visual information for comparative purposes.

Figure 3.12. Image of the virtual scene associated with *VIBE 2 Virtual Vignette 2A: Chemical ecology.*

Virtual Vignette 2B: The great migration. The video describes the amazing migrations associated with the Monarch butterflies. The virtual scene represents the Sierra Madre Mountains of Mexico, an important overwintering site for the Monarchs. Animated Monarchs cover the bare trees found in this region as they would in real life. The ecological importance of these important overwintering sites is discussed as well as the economic challenges associated with their preservation. The complex migratory pattern is described in which one generation travels to the southern overwintering site and subsequent generations continue the northern migration back. The interactive file shows a map of both the US and Mexico. Students roll over the fall migration hotspot found on the image and receive visual cues indicating the southerly migration of the single generation. A corresponding hotspot is present which shows the multi-generational northerly migration that occurs in the spring.

Figure 3.13. Image of the virtual scene associated with *VIBE 2 Virtual Vignette 2B: The great migration.*

Virtual Vignette 2C: Navigating the trip. This video relays the story of how the biological cues associated with the Monarchs migration were discovered. The virtual setting is an unnamed research lab. The successive discoveries of both the clock and compass functions are described through explanations of the experiments conducted. Students "paint" the butterflies antennae in this interactive file and receive information on how this impacted the butterflies migration. This interaction models one of the research studies described in the video.

Figure 3.14. Image of the virtual scene associated with *VIBE 2 Virtual Vignette 2C: Navigating the trip.*

VIBE 3: Grasshoppers on Steroids. The third and last VIBE assignment provided information on the science behind the transition of migratory locusts from their solitary to their gregarious form and the resulting ecological and economical impacts of these swarms.

Virtual Vignette 3A: The great locust mystery. The video tells the story of how the Rocky Mountain locust, *Melanoplus spretus*, became extinct from the US. The peak and fall of this population is described as well as the ecological impact the extinction of this species had on the Eskimo Curlew bird population. The virtual setting for this story is a general Midwestern farm, reminiscent of the farms in Nebraska and Kansas which were plagued by these locusts in the late 1800s. The interactive file shows the previous range of these locusts. When students roll over the adjacent image of the Eskimo Curlew an overlay of this species migratory corridor appears showing the overlapping areas.

Figure 3.15. Image of the virtual scene associated with *VIBE 3 Virtual Vignette 3A: The great locust mystery.*

Virtual Vignette 3B: Don't crowd me. The video describes the biological changes that trigger the Dessert Locust transformation from its solitary to its gregarious phase. The virtual setting is Egypt, a region famous for locust plagues. The ecological devastation caused by these swarming locusts is described as well as their global range. This is the only video that contains any material provided from another source. This is a video from National Geographic. This video describes how overcrowding of the locusts stimulates the change into the gregarious phase. The biological cues of the "hairs" of the legs being stimulated is discussed as well as the resulting surge in serotonin levels that is responsible for this species' physical transformation. Students "brush" the legs of a solitary locust in this interactive file. This action results in the release of high levels of serotonin and images of the newly transformed swarming "monster".

Figure 3.16. Image of the virtual scene associated with *VIBE 3 Virtual Vignette 3B: Don't crowd me.*

Utilization of the VIBE Assignments. Each of the three VIBE assignments were made available sequentially throughout the semester, roughly correlating to one at the beginning of the semester, one at the middle of the semester, and one at the end of the semester. Prior to the student's completion of any VIBE assignment, students completed the Technology Survey. This survey was used to collect data on the students' use of technology, utilization of technology, and attitudes towards technology.

After the students completed the Technology Survey, but prior to their completion of the first VIBE assignments, students were provided with links to a website (URL: http://www4.ncsu.edu/~mjklesat/index.html) which provided introductory information pertaining to the VIBE assignments. Specifically present on the website was a description of the VIBE format, summary information related to each of the VIBE assignments, and information and hyperlinks describing how to download and navigate ActiveWorlds EDU™. In order to log into BugWorld, the universe in ActiveWorlds EDU™ which housed the VIBE assignments, students needed to log into ActiveWorlds EDU™ using the "citizenship" information provided to them by e-mail.

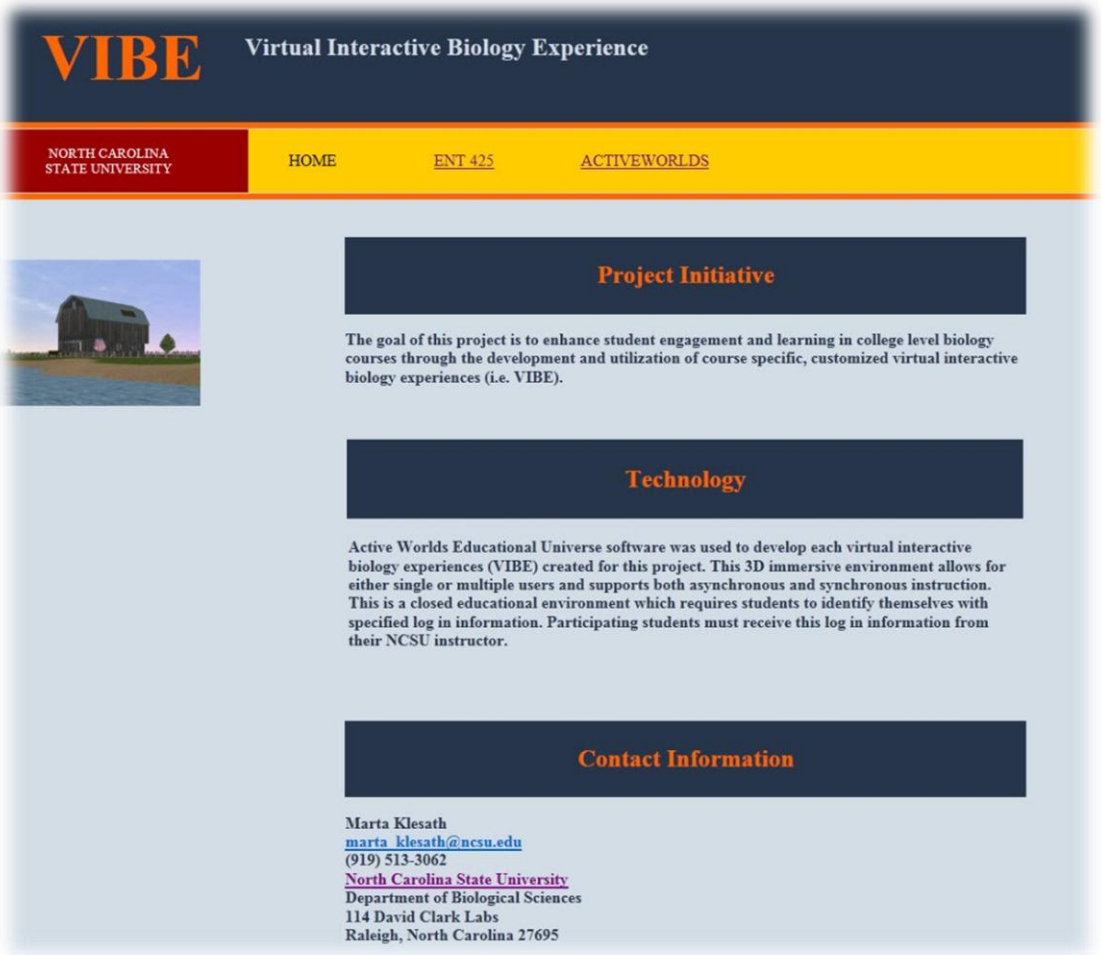

Figure 3.17. VIBE index webpage. This image shows the index page for the VIBE assignments. Hyperlinks found at the top of the webpage direct students to information on specific VIBE assignments as well as guidance on the following; how to download and use ActiveWorlds™, how to log into and access their assignments, and contact information for assistance with technical issues.

The ActiveWorlds EDU™ software used to develop the VIBE assignments could only be run using computers with Microsoft™ operating system. Therefore, students who used Macs to access the assignment had to run their Macs in a "virtual PC" mode. This was potentially problematic for some students. Therefore, students were provided opportunities to complete the assignments on a provided computer that was already loaded with the appropriate software.

Empirical data concerning students' usage, satisfaction in, and perceived value of the VIBE assignments was collected through the Assignment Survey instrument at two different times throughout the semester, after the first and third VIBE assignments. Students accessed this survey through direct links within found within the virtual environment. This allowed the students to seamlessly submit all responses directly from the virtual environment even though the survey was located in Moodle™.

Instrumentation and Data Collection

Both quantitative and qualitative data were collected. Quantitative data included self-reported responses from two different instruments; a Technology Survey (Appendix B) and an Assignment Survey (Appendix C). The Assignment Survey was a repeated measure, therefore two data sets were collected from this instrument, one after the first VIBE experience (AS) and one after the third and last VIBE experience (AF). The Technology Survey (TS) contained 32 items consisting of both binomial (yes/no) and categorical questions. The TS questions each aligned with one of four specific themes; 1) computer usage 2) cell phone usage 3) digital gaming experience and 4) attitudes towards technology.

The assignment survey was composed of 15 five-point Likert scale categorical questions. Each question item aligned with one of the following three major themes; 1) specific attitudes and reported value of the VIBE assignment format 2) degree to which this format supported specific types of learning and 3) overall attitudes and reported value of the VIBE assignments. Since the Assignment Survey was a repeated measure there were two sets of data, one pertaining the initial exposure (AS), and one pertaining to the third and final exposure (AF). An additional group of five questions were added to the final assignment survey which provided verification data on students' participation such as "Were you able to complete all three VIBE assignments". This information was used to determine if variation between these groups existed.

The qualitative data collected included responses from semi-structured interviews performed on a subset of self-selected students ($N = 6$). Retrospective probing was used to further characterize the students experience while exploring if other factors not evaluated in this study may be relevant to future work.

Quantitative Data

Technology survey (TS). The technology survey contained both binomial and categorical questions pertaining to the student technology usage. Students took this survey prior to completing any VIBE assignments. Summary statistics were used to provide descriptive characteristics of the population. Additionally, this information was used to establish descriptive categories in which students were grouped for comparative purposes. Both the independent and combined/deconstructed data from this survey was used to determine appropriate categorical data to be used as independent variables. These independent variables were evaluated to determine if the students' responses on the technology survey were related/and or predictive of their responses on the assignment survey.

Assignment survey (AS). The Assignment survey contained categorical questions pertaining to the perceived immersion/engagement and learning value of the VIBE assignment format. All questions on this survey were based on a 5-point Likert scale. Students took this survey after completing the first VIBE assignment which was made available towards the beginning of the semester. This data was used to characterize the overall students' attitudes towards the value of the VIBE assignment format. This data was also the initial data set in a repeated measure test designed to evaluate if students' attitudes towards the VIBE format changed with increased exposure. Additionally, the responses for each of these questions were used as dependent variables to determine which, if any, independent variables (identified through the technology survey) were predictive of student's responses on this assignment survey.

Assignment survey-repeated measure (AF). This was a repeated measure. Students took this survey after completing the third and last VIBE assignment. This instrument contained all of the same questions as the AS in addition to five additional questions used to validate student responses. Only the questions found on both the AS and AF were used as a repeated measure. The additional validation questions from the AF were evaluated to determine if differences existed between these populations. This repeated measure data was used to evaluate if students attitudes towards the VIBE format changed with increased exposure. Additionally, the response from each question was used as a separate dependent variable for the AF models. These dependent variables were evaluated to determine if the students' responses on the technology survey (grouped and identified as independent variables) were related/and or predictive of their responses on the assignment survey.

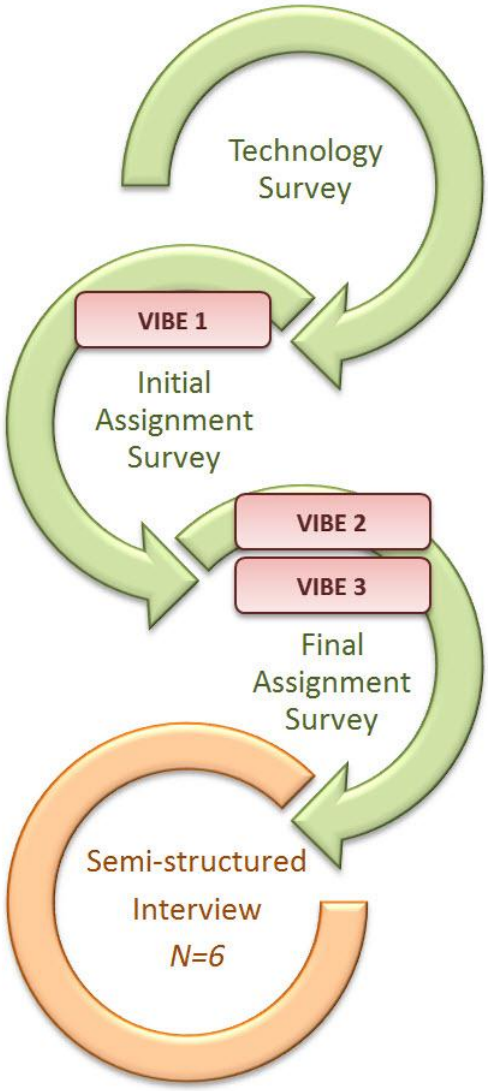

Figure 3.18. Research design figure. This figure indicates the timing of the data collection for each instrument within the overall research design.

Statistical Analysis of Quantitative Data

RQ1: What are students' self-reported usages of technology? Summary statistics were calculated using the Technology Survey responses to identify specific types of technology used and how students were using each type of technology.

RQ2: What are students' self-reported satisfaction in, and perceived value of the VIBE assignment format? Summary statistics were calculated using the AS responses to determine students' attitudes towards the VIBE assignment format.

RQ3: In what ways do students' attitudes of the perceived pedagogical value of the VIBE assignment format increase with familiarity of the technology used for this format? A repeated measures one sided *T* test was performed between the identical questions found on both the AS and AF to test the hypothesis that students' attitudes of the perceived pedagogical value of the VIBE assignment would increase with familiarity of the VIBE format.

RQ4: Are students' current usages of technology predictive of their overall satisfaction in, and/or perceived value of, the VIBE assignment format? Summary statistics were calculated on the reported measures from the Technology Survey. Students were categorized based on their collective responses to these questions. Categories were created through the analysis of summary statistics, the review of simple linear regression models for each survey response/dependent variable, and groupings that allowed for variability to be studied. Each unique categorical group identified as potentially relevant became a unique independent variable. A *Q-Q* plot was performed on each dependent variable to determine the normality of the data (Appendix G). Due to the large number of

dependent variables available, a simple linear regression was completed for each independent/dependent variable combination. A list of possible covariates ($p \leq 0.15$) was identified for each dependent variable. A step wise multiple regression was performed ($p \leq 0.10$) to determine which of the potential covariates should be included in the resulting predictive model. An Akaikes' Information Criteria (*AIC*) test was applied to each model in order to correct for the variation in the number of independent variables present in each model. The application of AIC provided an adjusted R^2 (ΔR^2) value which is more appropriate for the model, minimizing the mean squared error of the model.

Table 3.1.

Research Design Matrix for Quantitative Data

Research Questions	**Quantitative Data Sources**	**Data Analysis**
1. What are students' self-reported usages of technology?	Technology Survey	Summary Statistics
2. What are students' self-reported satisfaction in, and perceived value of, the VIBE assignment format?	Assignment Survey	Summary Statistics
3. Do students' attitudes of the perceived pedagogical value of the VIBE assignment format increase with familiarity?	Assignment Survey (AS & AF)	Repeated Measure T-test
4. Are students' current usages of technology predictive of their overall satisfaction in, and/or perceived value of, the VIBE assignment format?	Technology Survey Assignment Survey	Summary Statistics (*Identification of categorical independent variables*) Simple Linear Regression (*Identification of possible covariates*) Stepwise Multiple Regression *(Development of Predictive Model)*

Qualitative Data

All students were invited to participate in an approximately 30 minute interview in which they would receive a $10 gift card from a local business for their time. All six students that responded to the invitation were interviewed. Participating students were provided with IRB information concerning the study and were asked to sign consent forms prior to the interviews (Appendix D). The interviews were completed in an open office at the NCSU campus at the end of the semester, after all course work was complete but final grades had not yet been assigned. Retrospective probing followed a preapproved IRB interview protocol (Appendix E) throughout these approximately 30-45 minute, one on one, video recorded interviews. These in depth semi-structured interviews contained questions pertaining to four categories of information seeking as outlined below.

First tier questions. First tier questions provided background information on the students' previous exposure to, and use of, technology in both recreational and academic settings.

Second tier questions. Second tier questions focused on students' overall attitudes towards the VIBE format and provided for probing on the individualized components of the assignment.

Third tier questions. Third tier questions focused on the perceived educational value of the VIBE format.

Fourth tier questions. Fourth tier questions related to the students' comprehensive impression of the overall usability of the VIBE format.

Analysis of Qualitative Data

All interviews were video recorded and transcribed in full. A coding rubric (Appendix F) was established and used to code each of the six interviews. Each interview was coded independently by two individuals and statistics on the inter-rater reliability was performed. Responses from these interviews were used to expand upon the students' experience and allowed for the validation of survey responses. Additionally, the extended probing that occurred during these interviews allowed us to gain a more thorough picture of how students interpreted the VIBE format and better define their perspectives.

CHAPTER 4

Results

Quantitative Data Results

Students' self-reported usages of technology. Student responses from the Technology Survey were used to characterize students' usages of technology. The information collected on this instrument focused on four major categories; computer usage, cell phone usage, gaming usage, and self-reported attitudes towards technology. Summary statistics on this information is listed below.

Computer usage. A vast majority (96%, *N* = 53) of students owned a computer. Of these (*N* = 51) approximately 80% of the students had a laptop PC, approximately 12% had a laptop Mac, approximately 6% used desktop PC, and approximately 2% used a desktop Mac. All students who had a computer (*N* = 51) selected the highest frequency of computer usage category available, *using a computer at least once a day*, and indicated that they used a computer to complete course work (*N* = 51), send/receive e-mail (*N* = 44), and search the internet (*N* = 51). Other types of reported computer usages included; using a social network site (96%, *N* = 51), viewing videos (94%, *N* = 51), download/play music (92%, *N* = 50), playing single user games (27%, *N* = 49), participating in virtual worlds (20%, *N* = 50), and playing multi-user games (2%, *N* = 50). The lowest reported category pertaining to the duration of computer use was 1-20 hours per week (46%, *N* = 50) also had the highest frequency. Additional statistics for this category include the following 20-30 hours per week (30%, *N* = 30), 30-40 hours per week (12%, *N* = 50), and greater than 40 hours (12%, *N* = 50).

Cell phone usage. All students (N = 50) indicated that they owned a cell phone and that they used it to both talk and send/receive text messages. Variation existed on what type of phone the students used with 48% of the students indicating that they owned an internet enabled smart phone. The types of smart phone the students used was widely distributed with approximately 29% reporting they had a blackberry, approximately 25% indicating they had an iPhone, approximately 21% indicating they had a droid based phone, and approximately 25% indicating that they used "another" type of internet enabled phone not listed on the survey. All of the students with smart phones indicated that they used their phone to send/receive e-mail (100.0%, N = 24) while 83% (N = 24) of the students indicated that they used their smart phone to access the internet. Other phone usages not necessarily directly related to owning an internet enabled phone included the downloading/playing music (36%, N = 50) and playing games (28%, N = 50). The vast majority of students indicated that they used their phone at least once a day (98%, N = 50) while the least frequent category of use, at least once a week but less than once a day, accounted for only 2% (N = 50) of the responses. More variation appeared on the reported duration of use. The lowest category selected was 10-20 hours per week (30%, N = 50). The most frequent reported usage was 20-30 hours per week (40%, N = 50). Other categories included 30-40 hours per week (20%, N = 50) and greater than 40 hours per week (10%, N = 50).

Gaming device usage. Over half (62%, N = 51) of the students indicated that they used some sort of device to play digital games with 61% (n = 31) of these users indicating that they used more than one type of gaming device. Specific types of gaming systems indicated on the survey in order of frequency were X box™ (58%), Playstation™ (51%),

Wii™ (26%), and DS™ (13%). The frequency which students participated in gaming (*n* = 31) was reported as; Very limited use – a few times a year but less than once a month (39%), At least once a month but less than once a week (19%), At least once a week but less than once a day (26%), At least once a day (16%). High durational gaming, as defined by 20 or more hours per week spent gaming, was indicated by 16% of the total gaming population.

Attitudes towards technology. Students were asked two questions on the Tech survey related to their self-reported interest and attitudes towards technology. Frequencies for students' categorical responses toward the question "Indicate your self-perceived INTEREST in using technology" were (*N* = 51); Very High level of interest (12%), High level of interest (29%), Moderate level of interest (43%), Low level of interest (12%), No interest (4%).

Cumulatively 82% (*N* = 51) of the students indicated either strong or very strong agreement towards the use of technology in higher education. Frequencies for students' categorical responses were; I strongly agree in the incorporation of technology in higher education courses (26%), I agree in the incorporation of technology in higher education courses (57%), I am ambivalent on the use of technology in higher education courses (18%). No students indicated that they disagreed in the incorporation of technology use in higher education courses.

When asked reflective questions concerning their current use of technology at the University 90% (*N* = 51) of the students indicated that the use of technology played either a moderate or integral part of their courses while only 10% indicated that the use of technology had played only a minimal role in their courses. No students indicated that the use of technology had been essentially nonexistent throughout their courses. When asked about

technical support received at the University 81% (N = 51) of the students indicated that they received OK, good, or extremely good technical support compared to 6% of the students that indicated that poor technical support was received or the 13% of students that indicated that no technical support was provided.

Students' self-reported satisfaction in, and perceived value of, the VIBE assignment format. Students completed the Assignment Survey immediately after finishing the first VIBE assignment. Students responses from the Assignment survey provided information related to three specific pedagogical areas including; students' specific attitudes and reported value of the VIBE assignments, degree to which this format supported specific types of learning, and students overall attitudes and reported value of the VIBE assignments. These areas are referred to as category 1, 2, and 3 items respectively.

Category 1 question items. Category 1 question items addressed specific attitudes and reported values associate with the VIBE assignment format by identifying to what extent the VIBE assignment format interested, engaged, and/or immersed the student. Additionally, students' perceptions related to what degree the VIBE assignments supported their learning, extended their knowledge, and changed the way they viewed the topic was addressed. The range of means for all six of these question items was relatively small (2.76 to 2.94) indicating that students ranked the VIBE format as achieving similar pedagogical value for each of characteristics identified. The mean for each of these question items was most closely aligned with an "average" or "moderate" student response which had a value of 3 on the 5 point Likert scale.

Table 4.1.

Summary Statistics for Category 1 Question Items

Dependent Variable	Category 1 Question Items *Please indicate the level to which this assignment…*	*M (SD)*	*Kurtosis (ΔSD)*
V1	*Interested you*	2.76 (1.06)	-.43 (1.05)
V3	*Engaged you*	2.86 (1.08)	-.58 (1.07)
V5	*Immersed you in the activity*	2.79 (0.94)	-.71 (0.93)
V7	*Supported your learning*	2.90 (0.95)	-.22 (0.94)
V9	*Extended your knowledge*	2.94 (1.13)	-.62 (1.12)
V11	*Changed the way you originally viewed the topic covered*	2.85 (1.09)	-.78 (1.08)

Category 2 question items. Category 2 questions were used to indicate to what extent specific types of learning were emphasized through this format. Additionally, this allowed us to determine if this format appeared to be particularly well suited or ill-suited for a specific type of learning. Students were asked to identify the extent each of the following mental activities were emphasized throughout the VIBE assignment; memorizing, analyzing, synthesizing and organizing ideas, evaluating, and applying. Students were provided with specific definitions of the terms used for each item for purposes of clarification. A narrow range of means (2.79-2.98) for these question items indicated that this format supported each type of learning to a similar level. The mean for each of these question items was most closely aligned with an "average" or "moderate" student response which had a value of 3 on the 5-point Likert scale.

The highest mean for a category 1 question item was 2.98 which was reported for "***Evaluating*** *the value of information, arguments, or methods such as examining how others gathered and interpreted data and assessing the accuracy of their conclusions."* This category is the highest level of learning reported by Bloom (1956). It should be noted however that no question item existed referring to "creating", the highest level of learning identified on the revised version of Bloom's taxonomy (Krathwohl, 2002). The lowest mean, $M = 2.79$, was reported for "***Memorizing*** *facts, ideas or methods from your course and readings so you can repeat them in almost the same form"*. This question item would align with the lowest level of learning for both Bloom's and the revised Bloom's taxonomy.

Table 4.2.

Summary Statistics for Category 2 Question Items

Dependent Variable	Category 2 Question Items	*M (SD)*	*Kurtosis (ΔSD)*
V13	***Memorizing*** *facts, ideas or methods from your course and readings so you can repeat them in almost the same form*	2.79 (.93)	-.04 (.92)
V15	***Analyzing*** *the basic elements of an idea, experience or theory such as examining a specific case or situation in depth and considering its components*	2.91 (.87)	+.51 (.87)
V17	***Synthesizing and Organizing*** *ideas, information, or experiences into new, more complicated interpretations and relationships*	2.96 (.86)	-.06 (.85)
V19	***Evaluating*** *the value of information, arguments, or methods such as examining how others gathered and interpreted data and assessing the accuracy of their conclusions*	2.98 (.90)	+.01 (.89)
V21	***Applying*** *theories and/or concepts to practical problems or in new situations.*	2.81 (.92)	-.18 (.91)

Category 3 question items. All category 3 questions related to the students' attitudes towards the overall VIBE experience. The first two question items were specifically related to *satisfaction* and *learning value* of the VIBE assignments while the last two question items related to the students' opinions towards the increased use of this format. The question items within this category also had a relatively small range (2.85-3.17). However, the cumulative means for this category were the higher with the means for each of the following questions; "How would you rank your overall satisfaction with this assignment?", "How would you rank the overall learning value of this assignment?", and "To what extent do you agree with the statement I believe it is worthwhile to continue to develop these types of assignments" all receiving average response rankings above 3 (3.02, 3.17, and 3.06 reflectively) which roughly relates to an "average" or "moderate" student response which had a value of 3 on the 5-point Likert scale. The lowest reported mean for this group (2.85) related to the question item of "*I would like to see more of these types of assignments integrated into my courses at NCSU"*.

Table 4.3.

Summary Statistics for Category 3 Question Items

Dependent Variable	Category 3 Question Items	*M (SD)*	*Kurtosis (ΔSD)*
V23	How would you rank your overall *satisfaction* with this assignment?	3.02 (0.94)	-.01 (0.93)
V25	How would you rank the overall *learning value* of this assignment?	3.17 (1.00)	-.24 (1.00)
V27	*I believe it is worthwhile to continue to develop these types of assignments.*	3.06 (1.00)	+.05 (1.00)
V29	*I would like to see more of these types of assignments integrated into my courses.*	2.85 (1.03)	-.46 (1.02)

Students' attitudes of the perceived pedagogical value of the VIBE assignment format after increased familiarity with the technology. Students' responses on the Assignment Survey were a repeated measure. Students completed the initial data, referred to hereafter as Assignment Survey (AS) data, immediately after finishing the first VIBE assignment. Students completed the repeated measure, hereafter referred to as Assignment Survey Final (AF) data, after the third and last VIBE assignment. Not all students completed both the AS and AF surveys. Non-adjusted summary data from both groups of data (AS & AF) was calculated as a comparison, but was not used in the analysis of repeated measure. Adjusted summary data which only included paired data (student data existed for both AS and AF) was used to perform a paired *T*-test to determine if the student responses changed significantly after the increased exposure to the VIBE assignment format. Responses collected for the repeated measure were divided into the same 3 categorical groups previously used to evaluate the assignment summary data. These included; 1) students' specific attitudes and reported value of the VIBE format 2) degree to which this format supported specific types of learning 3) students' overall attitudes and reported value of the VIBE format.

***Category 1 repeated measure question items*.** Significant differences ($p < 0.1$) in responses were found for four of the six category 1 question items. These included; reported interest ($p = .058$), immersion of activity ($p = .074$), supportive of learning ($p = .033$), and extension of knowledge ($p = .052$). The only item response that was significant at the .05 level was the level to which the assignment supported your learning ($p = .033$). In all cases students reported more positive responses to the same items with increases use of the format.

Table 4.4.

Repeated Measures T test for Category 1 Question Items

Category 1 Question Items		Non-Adjusted	Non-Adjusted	Adjusted	*T* stat	*p* Value
The level to which this assignment…		*M*	(AF-AS)	Δ(AF-AS)		$\mathbf{H_A: \mu_1 - \mu_2 > 0}$
V1	*Interested you*	2.76	+0.56	+0.34	*t(34)* = 1.61	.058*
V2		3.36				
V3	*Engaged you*	2.86	+0.34	+0.19	*t(35)* = 1.19	.121
V4		3.20				
V5	*Immersed you in the activity*	2.79	+0.57	+0.31	*t(34)* = 1.48	.074*
V6		3.37				
V7	*Supported your learning*	2.90	+0.62	+0.40	*t(34)* = 1.91	.033**
V8		3.51				
V9	*Extended your knowledge*	2.94	+0.64	+0.35	*t(33)* = 1.68	.052*
V10		3.58				
V11	*Changed the way you viewed*	2.86	+0.47	+0.24	*t(33)* = 1.00	.162
V12	*the topic*	3.33				

Category 2 repeated measure question items. No significant differences ($p < 0.1$) in responses were found for the five category 2 question items. Both positive and negative differences were found amongst the items within this group including both non-adjusted data (AS and AF separate groups) and repeated measure data (paired AS and AF data). A positive difference (AF-AS) was reflective of perceived increased value relative to increased exposure while a negative difference indicated a perceived decrease in value. Additionally, the directional relationship (positive or negative) for the non-adjusted group data was not always representative of the directional relationship found in the repeated measure data.

Positive differences were found for the following non-adjusted group items; *memorizing* (+0.16, non-adjusted); *analyzing* (+0.39, non-adjusted); and *evaluating* (+0.05, non-adjusted). The repeated sample differences for each of these items varied from the non-

adjusted mean. No change (0.0) was found for *memorizing* while a lesser positive (+0.18) was reported for *analyzing.* The *evaluating* category, which was a positive value in the non-adjusted data, was negative for the repeated data. The two category 2 items that had a negative non-adjusted group difference were *synthesizing/organizing* and *applying*. Both of these items continued to have a negative difference in the repeated measure data, although the repeated measure data was more negative compared to the non-adjusted group data.

Table 4.5.

Repeated Measures T test for Category 2 Question Items

Category 2 Question Items		Non-Adjusted *M*	Non-Adjusted (AF-AS)	Adjusted Δ(AF-AS)	*T* Stat	*p* Value $\mathbf{H_A: \mu_1 - \mu_2 \neq 0}$
V13	*Memorizing*	2.79	+0.16	0.00	*t(33)* = 0	1.00
V14		2.95				
V15	*Analyzing*	2.91	+0.39	+0.18	*t(32)* = 1.23	.226
V16		3.30				
V17	*Synthesizing and*	2.96	-0.03	-0.15	*t(32)* = -0.87	.392
V18	*Organizing*	2.93				
V19	*Evaluating*	2.98	+0.05	-0.09	*t(32)* = -0.57	.572
V20		3.03				
V21	*Applying*	2.81	-0.01	-0.18	*t(32)* = -1.23	.226
V22		2.80				

Category 3 Repeated Measure Question Items. No significant differences ($p < 0.1$) in responses were found for the four category 3 question items. The group (non-adjusted) mean for all items were positive. However, this positive difference was not reflected in all of the item repeated measure means. Both non-adjusted and repeated measure means, although to a lesser degree, were positive for the reported *learning value* (+0.06) and responses to "*I believe it is worthwhile to continue to develop these types of assignments"* (+0.09). In contrast the repeated measures for both *satisfaction* (-0.06) and responses to "*I would like to see more of these types of assignments integrated into my courses at NCSU" (*-0.15) were negative in opposition to the positive group (non-adjusted) differences (+0.22 and +0.22 respectively). Both group summary statistics (non-adjusted data) and repeated measures analysis data for category 2 items can be found in the table below.

Table 4.6.

Repeated Measures T test for Category 3 Question Items

	Category 3 Question Item	Non-Adjusted M	Non-Adjusted (AF-AS)	Adjusted Δ(AF-AS)	*T Stat*	*p* Value $\mathbf{H_A: \mu_1 - \mu_2 \neq 0}$
V23	How would you rank your overall	3.02	+0.22	-0.06	*t(32)* = -0.35	.730
V24	*satisfaction* with this assignment?	3.28				
V25	How would you rank the overall *learning*	3.17	+0.33	+0.06	*t(32)* = 0.32	.751
V26	*value* of this assignment?	3.50				
V27	*I believe it is worthwhile to continue to*	3.06	+0.38	+0.09	*t(33)* = 0.44	.662
V28	*develop these types of assignments.*	3.44				
V29	*I would like to see more of these types of*	2.85	+0.22	-0.15	*t(33)* = -0.78	.443
V30	*assignments integrated into my courses.*	3.08				

Evaluating for a predictive relationship between students' current attitudes towards, and usages of, technology and their overall satisfaction in, and/or perceived value of, the VIBE assignment format. In order to determine if the students responses on the technology survey were predictive of their responses on the assignment survey several analytical steps had to be completed including defining both the dependent and independent variables, identifying possible covariates to evaluate for the model, determining if a predictive model exists and the identification of the most appropriate predictive model. Because the repeated measures analysis of assignment survey responses showed significant differences between the students' initial and final survey response, both initial and final assignment survey responses were used as separate variables in analysis. This allowed for the development of two predictive models for each dependent variable; one related to the students' initial responses and one related to their final responses. This also allowed for direct comparisons to be made between these models providing additional information on changes related to increased familiarity with the VIBE format.

Defining dependent variables. Each question item from the Assignment Survey was considered a unique dependent variable. Because of the variation demonstrated between the AS and AF data set, the repeated measure for each question item was also considered a unique dependent variable. A Q-Q normal plot analysis was performed on each independent variable (see Appendix G for images of all Q-Q norm plots) in order to visualize the normality of the data based on the graphing of residuals. The table below identifies each of the dependent variables used for this study.

Table 4.7.

Dependent Variables

Variables Reference AS	AF	Dependent Variable Question Items
V1	V2	*Interested you*
V3	V4	*Engaged you*
V5	V6	*Immersed you in the activity*
V7	V8	*Supported your learning*
V9	V10	*Extended your knowledge*
V11	V12	*Changed the way you originally viewed the topic*
V13	V14	*Memorizing*
V15	V16	*Analyzing*
V17	V18	*Synthesizing and Organizing*
V19	V20	*Evaluating*
V21	V22	*Applying*
V23	V24	How would you rank your overall *satisfaction* with this assignment?
V25	V26	How would you rank the overall *learning value* of this assignment?
V27	V28	I believe it is worthwhile to continue to develop these types of assignments.
V29	V30	I would like to see more of these types of assignments integrated into my courses.

Defining independent variables. Both the independent and combined/deconstructed data from the technology survey (denoted as TS) was used to determine appropriate categorical data to be used as independent variables. Additionally, the verification questions given with the AF (denoted as VQ), such as "Were you able to complete all three VIBE assignments", were also evaluated individually. All potential categories were created through the analysis of summary statistics, the review of simple linear regression models for each survey response/dependent variable, and groupings that allowed for variability to be studied. The number categories that met these analytical criteria were further reviewed for the logical groupings of data points and then accepted as unique independent variables. The table below indicates the independent variables that were selected through this process.

Table 4.8.

Independent Variables

	Item Source	Data Reference		
		Independent Variables-Binomial Data	**Success**	**Failure**
V31	VQ (3)	Did you complete one or more of these assignments on an instructors Computer?	1=yes	0=no
V32	TS (1A)	Did you complete one or more of these assignments on a PC?	1=yes	0=no
V33	TS (1C6-1C7)	Do you play either single or multiplayer games on the computer?	1=yes	0=no
V34	TS (1C8)	Do you utilize virtual environments?	1=yes	0=no
V35	TS (2A)	Do you have a smart phone?	1=yes	0=no
V36	VQ (1)	Did you complete all three assignments?	1=yes	0=no
		Independent Variables-Categorical Data	**Low**	**High**
V37	TS (1D)	Computer Usage-duration	0	3
V38	TS (1C4, 5, 9)	Computer for Entertainment - Types of usages OTHER than games	0	3
V39	TS (2D)	Phone Usage-duration	0	3
V40	TS (3A1-3A7)	Number of game devices	0	3
V41	TS (3B)	Game Usage-frequency	0	3
V42	TS (3C)	Game Usage-duration	0	2
V43	TS (4A)	Indicate your self-perceived interest in using technology.	0	4
V44	TS (4B)	Indicate your attitude towards the use of technology in higher education courses.	0	5

Selecting potential covariates. A single multiple regression was performed for all potential dependent/independent matches in order to determine potential covariates for each dependent variable. The independent variables for all regression combinations with a $p < 0.15$, indicating a significant regression coefficient, were considered as possible covariate candidates for the associated dependent variable tested. The frequency at which each independent variable appeared as a possible covariate greatly varied with the greatest frequency belonging to independent variable 43 which was selected as a possible covariate for 14 out of the 15 possible dependent variable groups. Independent variables 40 and 41 were the only variables that were not selected as possible covariates for any of the 15 dependent variable groups. The table below identifies which independent variables were selected as possible covariates for each dependent variable based on linear regression model results ($p \leq .15$).

Table 4.9.

List of Possible Covariates for the Predictive Model Associated with Each Dependent Variable

	Dependent Variable	**Possible Covariates** $p \leq 0.15$
V1 V2	*Interested you*	33, 34, 35, 36, 37, 38, 42, 43, 44
V3 V4	*Engaged you*	34, 35, 37, 39, 43, 44
V5 V6	*Immersed you in the activity*	31, 33, 35, 36, 43, 44
V7 V8	*Supported your learning*	35, 36, 37, 42, 43
V9 V10	*Extended your knowledge*	34, 35, 38, 39, 42, 43
V11 V12	*Changed the way you viewed the topic*	31, 34, 35, 36, 43, 44
V13 V14	*Memorizing*	31, 34, 36, 38, 42, 43
V15 V16	*Analyzing*	32, 34, 37, 43, 44
V17 V18	*Synthesizing and Organizing*	32, 33, 34, 37, 39, 43, 44
V19 V20	*Evaluating*	32, 33, 34, 37, 39,43, 44
V21 V22	*Applying*	33, 34, 37, 39, 43
V23 V24	*Overall satisfaction*	35, 36, 37, 39, 43, 44
V25 V26	*Learning value*	37, 43
V27 V28	*Worthwhile to continue to develop*	31, 36, 37
V29 V30	*Integrate more VIBE in courses*	31, 36, 37, 42, 43

Determining a predictive model for dependent variables. A stepwise multiple regression was performed using a value of $p < 0.15$ for each dependent variable using all possible covariates as previously identified. An Akaikes' Information Criteria (AIC) test was performed to evaluate the goodness of fit for each possible model. This allowed for a more relevant comparison between models through the production and evaluation of ΔR^2 values. This provided a correction for the variation in the number of independent variables used within each model. This analysis procedure allowed for selection of the most parsimonious model while minimizing potential errors.

Category 1 predictive models. A statistically significant ($p < 0.10$) multiple regression predictive model for both the AS and AF category 1 dependent variables (AS and AF) was established with the exception of V7, *supported your learning*, in which no model was determined. Even though the same possible covariates were used for each paired dependent variables, none of the resulting AS/AF paired dependent variables resulted in the same selected independent variables within the model. For example, the V9 dependent variable (from the AS data) model contained four covariates; V34, V35, and V39. However, the V10 paired dependent variable (from the AF data) model contained only one covariate; V34. Although all category 1 models were significant to the $p < 0.1$ level, variation in the significance levels existed amongst the models.

Table 4.10.

Predictive Models for Category 1 Question Items

Category 1 Question Items	Covariate Predictors	*β*	ΔR^2, *F*	*p* Value
V1. Interested you	V33 (β = .66, *p* = .172) V35 (β = -.57, *p* = .078) V36 (β =.87, *p* = .089) V42 (β =1.0, *p* = .011)	2.16	ΔR^2 = .47, *F*(2, 22) = 6.85	.001***
V2. Interested you	V33 (β = -.97, *p* = .061) V34 (β = 1.46, *p* = .003) V35 (β = -.49, *p* = .215) V36 (β = -1.61, *p* = .014) V37 (β = .51, *p* = .041)	3.97	ΔR^2 = .36, *F*(5, 21) = 3.98	.011**
V3. Engaged you	V35 (β = -1.02, *p* = .007) V43 (β = .61, *p* = .024)	1.96	ΔR^2 = .25, *F*(3, 28) = 6.00	.007***
V4. Engaged you	V34 (β =.87, *p* = .078) V35 (β = -.86, *p* = .047) V43 (β = .54, *p* = .091)	2.09	ΔR^2 = .20, *F*(3, 27) = 3.53	.028**
V5. Immersed you	V31 (β = -1.0, *p* = .002) V33 (β = 1.45, *p* < .001) V35 (β = -.90, *p* < .001)	3.16	ΔR^2 = .57, *F*(3, 26) = 14.04	<.001***
V6. Immersed you	V35 (β = -.60, *p* = .13) V43 (β = .73, *p* = .016)	1.91	ΔR^2 = .17, *F*(2, 27) = 3.96	.031**
V7. Supported your learning	*N/A*	*N/A*	*N/A*	*N/A*
V8. Supported your learning	V35 (β = -.93, *p* = .041) V36 (β = -1.10, *p* = .118) V42 (β = .64, *p* = .093) V43 (β = .60, *p* = .058)	3.33	ΔR^2 = .25, *F*(4, 22) = 3.12	.035**
V9. Extended your knowledge	V34 (β = .70, *p* = .087) V35 (β = -.81, *p* = .027) V39 (β = .38, *p* = .106)	2.75	ΔR^2 = .25, *F*(4, 22) = 3.12	.016**
V10. Extended your knowledge	V34 (β = .97, *p* = .060)	3.32	ΔR^2 = .25, *F*(1, 24) = 3.91	.060*
V11. Changed the way you viewed the topic	V31 (β = -.71, *p* = .112) V34 (β = .78, *p* = .049) V35 (β = -.77, *p* = .037) V43 (β = .61, *p* = .019)	1.75	ΔR^2 = .31, *F*(4, 25) = 4.25	.009***
V12. Changed the way you viewed the topic	V35 (β = -1.11, *p* = .003) V36 (β = -1.38, *p* = .019) V43 (β = .61, *p* = .018)	3.52	ΔR^2 = .34, *F*(3, 26) = 5.87	.003***

Category 2 predictive models. A statistically significant ($p < 0.1$) multiple regression predictive model for both the AS and AF category 2 dependent variables (AS and AF) was established for each dependent variable with the exception of V16, *analyzing* ($p = .134$). Like category 1 dependent variables, the category 2 variable models differed between the AS and AF data. Additionally, different predictive models were found between paired AS and AF data.

Table 4.11.

Predictive Models for Category 2 Question Items

Category 2 Question Items	Covariate Predictors	*β*	ΔR^2, *F*	*p* Value
V13. Memorizing	V34 (β = .66, *p* = .079) V36 (β = -1.31, *p* = .014) V43 (β =.72, *p* = .003)	2.23	ΔR^2 = .41, *F*(3, 23) = 6.90	.002***
V14. Memorizing	V31 (β = 1.52, *p* = .004) V34 (β = .84, *p* = .042) V36 (β = -1.69, *p* = .004) V43 (β = .78, *p* = .002)	2.26	ΔR^2 = .61, *F*(4, 22) = 10.96	<.001***
V15. Analyzing	V32 (β = -1.25, *p* = .128) V34 (β = .63, *p* = .065)	4.00	ΔR^2 = .11, *F*(2, 26) = 2.78	.080*
V16. Analyzing	V37 (β = .40, *p* = .134)	2.47	ΔR^2 = .05, *F*(1, 27) = 2.388	.134
V17. Synthesizing and Organizing	V32 (β = -1.89, *p* = .002) V34 (β = .36, *p* < .107) V43 (β = .45, *p* < .003)	3.64	ΔR^2 = .51, *F*(3, 25) = 10.79	<.001***
V18. Synthesizing and Organizing	V39 (β = .57, *p* = .009)	1.87	ΔR^2 = .20, *F*(1, 27) = 7.99	.009***
V19. Evaluating	V38 (β = .34, *p* = .002) V43 (β = .51, *p* = .013)	1.50	ΔR^2 = .26, *F*(2, 26) = 5.99	.007***
V20. Evaluating	V39 (β = .40, *p* = .157) V43 (β = .44, *p* = .176)	1.27	ΔR^2 = .19, *F*(2, 26) = 4.19	.027**
V21. Applying	V33 (β = .58, *p* = .118) V34 (β = .46, *p* = .167) V43 (β = .44, *p* = .046)	1.67	ΔR^2 = .24, *F*(3, 25) = 3.91	.020**
V22. Applying	V33 (β = .70, *p* = .158) V34 (β = .66, *p* = .142) V43 (β = .44, *p* = .128)	1.30	ΔR^2 = .17, *F*(3, 25) = 2.97	.051*

Category 3 predictive models. No model was developed for two category 3 dependent variables; V25 (*overall learning value*) and V29 (*would like more of these types of assignments*), both of which are AF variables. Unlike the other paired AS/AF models which shared at least some covariates, no paired AS/AF category 3 models contain any like covariates. Variation existed in the significance levels of the models as indicated in the provided table.

Table 4.12.

Predictive Models for Category 3 Question Items

Category 3 Question Items	Covariate Predictors	*B*	ΔR^2, *F*	*p* Value
V23. Overall satisfaction	V35 (β = -.83, *p* = .013) V36 (β = 1.09, *p* = .037) V39 (β =.44, *p* = .027)	1.82	ΔR^2 = .34, *F*(3, 25) = 5.89	.003***
V24. Overall satisfaction	V37 (β = .51, *p* = .035)	2.17	ΔR^2 = .12, *F*(1, 27) = 4.91	.035**
V25. Overall learning Value	*N/A*	*N/A*	*N/A*	*N/A*
V26. Overall learning Value	V43 (β = .67, *p* = .031)	1.73	ΔR^2 = .13, *F*(1, 27) = 5.15	.031**
V27. Worthwhile to develop	V36 (β = 1.01, *p* = .093)	2.33	ΔR^2 = .07, *F*(1, 27) = 10.79	.093*
V28. Worthwhile to develop	V31 (β = .82, *p* = .093) V37 (β = .45, *p* = .058)	2.48	ΔR^2 = .19, *F*(2, 26) = 4.25	.025**
V29. More of these types of assignments	*N/A*	*N/A*	*N/A*	*N/A*
V30. More of these types of assignments	V31 (β = .91, *p* = .071) V42 (β = .60, *p* = .053) V43 (β = .46, *p* = .071)	1.62	ΔR^2 = .29, *F*(3, 23) = 4.59	.012**

Table 4.13.

Visual Summary of Accepted Covariates β Values for Each Dependent Variable

	V31	V32	V33	V34	V35	V36	V37	V38	V39	V40	V41	V42	V43	V44
V1			.66		-.57	.87						1.00		
V2			-.97	1.46	-.49	-1.61	.51							
V3					-1.02								.61	
V4				.87	-.86								.54	
V5	-1.00		1.45		-.90									
V6					-.60								.73	
V7														
V8					-.93	-1.10						.64	.60	
V9				.70	-.81				.38					
V10				.97										
V11	-.71			.78	-.77								.61	
V12					-1.11	-1.38							.61	
V13				.66		-1.31							.72	
V14	1.52			.84		-1.69							.78	
V15		-1.25		.63										
V16							.40							
V17		-1.89		.36									.45	
V18									.57					
V19								.34					.51	
V20									.40				.44	
V21			.58	.46									.44	
V22			.70	.66									.44	
V23					-.83	1.09			.44					
V24							.51							
V25														
V26													.67	
V27						1.01								
V28	.82						.45							
V29														
V30	.91											.60	.46	

Qualitative Data Results

Overview of interview responses. A sub-sample of six self-selected students participated in the in depth, one-on-one interviews. All interviews were video recorded, transcribed, and coded independently by two researchers using the coding rubric provided (Appendix D). Inter-rater reliability on this coding structure was 98%.

During these semi-structured interviews retrospective probing was used to better define the students perceptions and attitudes towards the VIBE format. These inquiries were related to one of the following four categories; first tier questions which provide background information on the students use of technology, second tier questions which focused on questions related to defining students impressions and attitudes towards the combined and individualized VIBE format components, third tier questions related to the perceived learning value of the assignments, and fourth tier inquiries which seek to describe the students impressions on the overall value and usability of this format in higher education.

Sub-sample population characteristics. The overall characteristics of this population as identified through their responses to the categorical 1 interview questions were diverse considering the small sample size.

Table 4.14.

Summary of Responses for Tier 1 Interview Probes

Tier 1: Population Characteristics	**Frequency of Responses (*N* = 6)**
Gender	4 females
	2 males
Computer Used to Complete Assignments	4 used their own computer
	2 used a computer provided for them on campus or in class
Type of Computer Owned	4 Personal Computer (PC)
	2 Macintosh or Apple (Mac)
Previous Experience with Online Instruction	1 no experience
	1 limited experience; had never taken online courses
	2 some experience; taken 1-2 online courses
	1 experienced; taken more than 2 online courses
	1 other; some experience but from other institutions
Self-Identified Technical Skills	3 average
	3 high
Digital Game Experience	2 experienced use
	3 limited use
	1 changes in patterns

Students' attitudes towards the VIBE format and its individualized components.

The focus of the tier two interview questions was to gain a comprehensive picture of the students' experiences while using the VIBE format and to seek to explain how these experiences impacted students' attitudes and perceived value of the VIBE format.

Table 4.15.

Summary of Responses for Tier 2 Interview Probes

Tier 2: VIBE Format	**Frequency of Responses (*N* = 6)**
Completion of all 3 VIBE Assignments	3 completed all three VIBE assignments 2 completed two of the three VIBE assignments 1 fully completed two, and partially completed one assignment
Technical Issues Encountered	1 User Error Starting; forgot password 3 User Error During Assignment; couldn't find BugWorld, couldn't figure out where or how to maneuver in BugWorld 1 Other; slow loading time
Overall Combined VIBE Format Inclusively	6 somewhat positive responses
Virtual Environment Component Individually	3 somewhat positive responses 2 somewhat negative responses 1 indifferent response
Embedded Video Component Individually	6 somewhat positive
Interactive Flash Component Individually	2 somewhat positive 4 no clear response; ambiguous, indifferent, unclear, or lacking
VIBE format versus Print Format	4 indicated preference for the VIBE format 1 indicated preference for the print format 1 unsure

Completion of the VIBE assignments. Not all students completed each of the three VIBE assignments. Two of the students interviewed missed one of the three assignments. One of these students had difficulty in maneuvering the technical requirements of the assignment. Not surprisingly, this student was the most negative overall concerning this format and at times was somewhat hostile towards the assignment format. As probing occurred during the interview the student was asked if they had made any attempt to contact the instructor to seek help in utilizing these assignments and/or if they made any attempt to take advantage of the computers and technical assistance provided to the students. Admittedly she had made no attempt to contact anyone by either phone or e-mail to seek help. It was not clear why she did not utilize these avenues but factors that may have contributed include embarrassment in admitting the student's perceived lack of technical skills, waiting until it was too late to receive help before attempting to complete the assignment, or just being too overwhelmed with the format to even care to ask for help. Although we do not know if any these factors were directly related to this situation, the student was able to resolve her issues without help and completed the last two VIBE assignments.

A major limitation to this format is that these assignments were developed using ActiveWorlds EDU, a software that does not run on Macintosh operating systems. This was by far the biggest technological barrier for the project. We overcame this issue by offering all students the ability to complete the assignments either on campus during scheduled times or during specific on campus scheduled lab dates. The only other student interviewed that completed only two of the VIBE assignments owned a Mac and was unable to complete the

assignment on her computer. This student clearly stated that she knew this was an issue and she just did not get around to arranging for a different computer prior to the due date. Somewhat surprisingly this student did not appear too distressed about this issue. In fact, overall this student provided very positive comments about her overall experience with the VIBE assignments. One student indicated that she had only partially completed one of the assignments after getting lost in the virtual environment. Although no other students interviewed indicated this as a reason for not completing part or all of any VIBE assignment, several students indicated that they had some level of navigation confusion in the world which is reflected in the summary of comments related to the overall format.

The VIBE format. During the interviews students were asked questions pertaining to the cumulative VIBE format as well as questions concerning each of the three individualized components; the 3D virtual environment, the embedded videos, and the interactive content files. All students indicated somewhat positive comments towards the embedded instructional videos. There appeared to be some confusion by the students in differentiating the interactive content file as a separate component. These files were embedded within the 3D environment and were activated, or opened, when clicked upon in the same way the video opened. However, the interactive file required the student to engage with the provided content in some way, such as rolling over a hotspot to see additional information appear and/or click on a hotspot or hyperlink to activate some change in the content. These files were all created using Flash software and were often referred to as "Flash files" in the interviews which appeared to add to both the student's and the coder's confusion related to this category. Therefore, it is not surprising that the majority of the students (n = 4)

responses were coded as ambiguous, indifferent, unclear, or information lacking in the coding rubric for this question. However, two of the six students did indicate a somewhat positive response to this question with responses towards this component such as "It was helpful, yeah. I liked it being able to show you exactly what it's talking about, like lighting up this part and lighting up that part". The 3D virtual environment received the most conflicting responses, some very positive and some negative. Most of the negative comments were related to the navigation in the world, rather than the environment itself. The majority of these comments pertained to difficulty in finding the BugWorld Universe within ActiveWords EDU where the assignment was located or difficulties maneuvering from one virtual vignette to the other within each VIBE assignment. A few students mentioned that they would like to see more self-exploration available within the virtual environment. Once of these students described walking around the surrounding areas but being disappointed that they did not find any "hidden" or "surprise" materials. Another student indicated that they would like to see some of the more traditional abilities in SIMS worlds included as part of the assignment format. The tables below provide a summary of both the positive and negative comments related specifically to the virtual environment component of the VIBE assignment.

Table 4.16.

Summary of Positive Comments for the Virtual Environment VIBE Component

Positive Comments Related Specifically to the Virtual Environment Component of VIBE
It's definitely easier like just like remember like when you walk through here and you see the butterflies in the trees and then you go and you watch the video about like the butterflies and trees like I feel like I feel like you do remember it better. It sticks in your brain better than just like watching it, you know. Something different it makes it stand out in your mind more
Because I'm a visual learner to that….you know like I make that connection when I see it
I just remember that being like "Oh this is helping me stay focused."… seeing things is always better
Well, I know for myself personally being a distant ed student it was nice having the interaction that I don't normally get because I'm not in the classroom
It showed what he was talking about

Table 4.17.

Summary of Negative Comments for the Virtual Environment VIBE Component

Negative Comments Related Specifically to the Virtual Environment Component of VIBE
It was hard finding the assignments. I know that they were red arrows the whole time but sometimes I didn't know which stops were part of this assignment and which ones were maybe a part of a different assignment
I really like the assignments, and I was engaged in those, but I lost interest when I started getting lost…I like when we got to these places I like the red and the blue dots…I like those
You need to walk faster...that would be good if it teleported you to the outside so you could at least do a little bit of walking. It isn't a bad thing that you walk…maybe if they happen to be in there more communication within the environment
Yeah. Sometimes…this is just me though….I was wishing that it would be more like a SIMS world where you could go in and play around with things and do stuff

VIBE format versus the traditional print format. During the interviews students were informed that these assignments were developed from a series of printed articles. Students were then asked that assuming equal content and time spent completing the activity would they prefer completing the assignment in the VIBE format or reading the printed materials. The majority of the students agreed (*n*= 5) that they preferred the VIBE format to the printed version. However, one student indicated a somewhat strong preference for the printed format as indicated in their following response.

> I'd probably much rather read or even access these some a different way. Just because I feel like even non-traditional students would have kind of a disadvantage if they're not from a generation that is the gaming generation. Because I know I had problems with it and I know there are a lot of students who are not traditional and they're out of my age bracket. I think they would find this very difficult to do and it's kind of frustrating when your assignment is put in this way.

Consequently, this was the same student that had missed one of the assignments due to perceived technical issues. However, these student's comments should be considered closely as they do include valid concerns over a perceived dependency of the student to have a specific set of technical skills in order to complete the VIBE format. A summary of the responses related to a preference for the VIBE format over the print format is provided in the table below.

Table 4.18.

Summary of Responses Indicating Preferences for the VIBE Assignment Format

Students Responses Related to Preferences for the Virtual Format Over a Print Format
Just more of a modern format than just sitting in class or reading a book in class
it was a little more interesting than reading a piece of paper…It's just a little bit more interesting and something different…I was definitely more engaged and immersed than I would have been than just doing a worksheet.
It's more interesting…than just staring at a paper…you can watch a video
I would much rather do the virtual assignment… Well, I am one of the distant ed students, so all of our learning material, beside short ten minute videos at the beginning of each lecture, was all reading, so this was a really nice change. Plus, you know, like the locust you can just being able to like see them all swarming in the actual, you know it was just a lot more interesting than just reading about it
Yeah…Definitely over a written. I have a hard time reading things otherwise I probably would have seen the first e-mail and put that two and two together so hearing something and even having the video…Yeah…I mean it definitely taught me some things I didn't know about. And the guy you know, he had an interesting voice, so you know so you kind of wanted to listen kind of like a story book…when you get a book on tape kind of thing….. I can watch a video and remember way more than I can if I'm having to read something

Educational value of VIBE assignments. Although the students unanimously indicated that they learned a lot from these assignments, 4 out of the 6 students were unable to specifically identify the purpose of the assignments as related to the ecological or economic importance of the species. However, several of the students related the purpose in some way to the history of the insect which may be indirectly related to the specific purpose. Regardless of whether or not the student properly identified the assignment purpose, they stated that the assignment fulfilled the identified purpose "well" (n = 4) or "very well" (n = 2). The majority of the students (n = 4) indicated that they found the VIBE assignment format more engaging than the other online assignments offered for the course with one student each indicating that the VIBE format was either just as engaging or not as engaging. When probed on the specific levels of learning emphasized by this environment the students unanimously identified *Synthesizing and Organizing* as being supported. The other levels of learning indicated were *Evaluating* (n = 5), *Applying* (n = 4), *Analyzing (*n = 4), and *Memorizing* (n = 4).

Table 4.19.

Summary of Responses for Tier 3 Interview Probes

Tier 3: Educational Value of VIBE	**Frequency of Responses (*N* = 6)**
Clear identification of Assignment Purpose (Ecological or Economical Importance of Species)	2 identified specific ecological or economic purpose 4 did not identify specific ecological or economical purpose
VIBE effectiveness Fulfilling Identified Purpose	2 indicated fulfilled purpose "very well" 4 indicated fulfilled purpose "well"
Do you think you learned a lot from this assignment?	6 responded as "yes"
Perceived Engagement/Immersion of VIBE format versus other online assignments offered	4 reported VIBE format as "more engaging" 1 reported VIBE format as "just as engaging" 1 reported VIBE format as "not as engaging"
Specific Type of Learning Supported by the VIBE Format: *Memorizing*	3 indicated "yes" 1 indicated "maybe" 2 indicated "no"
Specific Type of Learning Supported by the VIBE Format: *Analyzing*	3 indicated "yes" 3 indicated "maybe"
Specific Type of Learning Supported by the VIBE Format: *Synthesizing and Organizing*	6 indicated "yes"
Specific Type of Learning Supported by the VIBE Format: *Evaluating*	5 indicated "yes" 1 indicated "maybe"
Specific Type of Learning Supported by the VIBE Format: *Applying*	4 indicated "yes" 1 indicated "maybe" 1 indicated "no"

Some of the most intriguing student responses to learning occurred through retrospective probing. Student alluded to ideas of increased retention of content and increased interconnectivity of ideas. Since specific learning gains were not evaluated in this study, no data was collected which may bolster these student claims. However, the fact that these educational goals were even mentioned to a lesser degree by the students is encouraging as it applies to future research designs. A summary of these comments is listed within the table below.

Table 4.20.

Summary of Comments Related to the Perceived Learning Value of VIBE

Student Comments Related to the Learning Value of the VIBE Assignments
I remember what was talked about in each specific (assignment), each one of (the) three about how the little grasshopper turned into locust by being rubbed on so many times with a certain amount of time and it becomes a plague of the in the middle East and areas like that. I just remember the stuff. I don't remember a lot if I read through a book as I did as watching a video
Well, I did notice that on the exams, they're open book, and when it came to anything that needed that as an example, like migration or you know the locust swarming, like I didn't even have to look at my notes or anything like, like I already knew everything if that makes sense. So when I was taking the quizzes at the end I didn't, I thought I was going to have to go back notes but I was, oh yeah, yeah, I know this
It was supplemental in our class and I feel like I learned a better background for this field
It definitely helped with the memorizing. I definitely remember more from that than I do the assignments
Dr. Meyer always likes to talk about certain examples of things, so you know if you talk about environmental factors and he'll like bring up examples or talk about, you know, social insects he talks about examples, so this is a way to show the examples and to reiterate what was taught in class in a much more interesting way
Being able to correlate the theories that we learned and the real life examples, it helped a lot with my understanding

Overall impressions and usability of VIBE assignments. In order to gain an overall impression of the student's perceived value of the VIBE Assignments the students were asked, *"If another student asked you what you thought about these virtual assignments what would you tell them?"* The overall responses were mixed with two being coded as very positive, two being coded as somewhat positive, one coded as ambiguous, and one coded as somewhat negative. A summary of both the positive and negative responses is provided within the following tables.

Table 4.21.

Summary of Positive Comments Related to Students' Overall Impression of the VIBE Assignments

Overall Positive Comments Related to the Perceived Value of the VIBE Assignments
It just gives you more of an interaction with your class, you get to, you know, you walk around the world, you find what you're looking for to click on or scroll over to tell you what you need to figure out. It's kind of like a video game in a way and I like video games, so, just more fun than being in a class reading a book or doing a worksheet or something
It was kind of cool… it's pretty interesting… It's something unusual that I haven't done before
The, um, virtual worlds was a lot more engagement. I, um, I did a lot of the other assignments on moodle like just watching TV, like not using half my brain to do it just, you know, searching for the answer, writing down and going to submit it but this was, you know, I was completely, in virtual worlds I was completely focused on it. That was, it had all my full attention. I was just a lot more interested in it. I was very, very focused on it. In fact my boyfriend kept interrupting me and I was like, had to pause it, you have to stop talking to me…he actually came over and watched the videos with me….and he loved it…we sat there and watched them together….I really enjoyed them. This is very cliché, but it makes learning fun…because I originally didn't want to do them. When I, you know, spend all this time doing this, but it was fun, you know, I really, really enjoyed it
Just playing an active role in it like, it's almost like you're running the show. You're in charge of everything. You can take it at your own pace, you can go back to things that, you know, you had trouble learning

Table 4.22.

Summary of Negative Comments Related to Students' Overall Impression of the VIBE Assignments

Overall Ambiguous or Negative Comments Related to the Perceived Value of the VIBE Assignments
They weren't bad but they weren't anything like crazy exciting……I felt like it was on its way…I felt like it had potential
I would tell them they're annoying some but really, again, it was just because I wanted to find the assignment, that's what I would tell them, that I had trouble find the assignment, but other than that it was fine…. I thought it was a cool concept. I mean I knew it was a first go round so it's not perfect the first time
I didn't do one of the assignments…..I never found it so I did the next one I did find…I bet a lot of my fellow classmates are probably more tech savvy than me. My friend in the class had a little bit of trouble but she completed all of her assignments. But I'm just thinking because I'm friends with a lot of non-traditional students that they would probably be like, what is the point, and I don't think they've ever played video games. I would feel terrible if this was integrated into all of our classes because I think they would have a really hard time. I remember trying to control things and thinking…I'm stuck on a wall and I forgot you can do the control something. And I was like I can't do my assignment because I'm stuck on a wall. And I was like….uhhh. I just feel like NC State has already put a lot of new technology that isn't completely all quirked out and I think it, I think it is good to allow [for] the students who aren't tech savvy [who are] a little bit wary of [technology based] classwork

A range of student responses were reported as to whether the technology helped or hindered their learning of the target content. Two students indicated that the technology helped a lot, two indicated it helped some, one responded indifferently, and one indicated that the technology somewhat hinder their learning.

Students were somewhat more positive to the prompt, "*Would you like to see more of these types of assignments integrated into your courses at NCSU?"* Two of the students indicated that yes, they would like to utilize more of these assignments without any change in the format. Half of the students (n = 3) indicated that they would like to see more of these types of assignments integrated if some of their requested changes/suggestions were addressed. As previously discussed most of these suggestions were specific to the maneuverability within the virtual environment. One student indicated indifference by stating "*I don't know. If they are, that's fine….I found it interesting, but I don't really care*". The table below summarizes the overall responses for all tier four questions.

Table 4.23.

Summary of Responses for Tier 4 Interview Probes

Tier 4: Overall Impression and Usability	**Frequency of Responses (*N* = 6)**
Comments to other students about VIBE	2 very positive 2 somewhat positive 1 ambiguous 1 somewhat negative
Effectiveness of Technology Utilized in Supporting Assignment	2 helped a lot 2 helped some 1 indifferent 1 somewhat hindered
Preference for more VIBE assignments	2 yes; add more without changes 3 yes; add more if requested changes included in design 1 indifferent to the adding more assignments

CHAPTER 5

Discussion

Overview

This chapter further describes and explains our results while focusing on how they cumulatively represent the perceived pedagogical value of the VIBE format. Additionally, we discuss the viability of this format and highlight the potential implications of our research on science teaching and learning.

Perceived Pedagogical Value of the VIBE Format

Cumulatively, our results indicate that the student's believe the VIBE assignment format has pedagogical value which is both directly and indirectly related to perceived student learning. These results correlate strongly with the 71% of the students that agreed to the statement that they would like to see more of these types of assignments integrated into their courses at NCSU, This sentiment was supported by the following student interview response "I'm glad you all are doing stuff like this [creating the VIBE assignments]."

Specific suggestions for improvement were identified through the interview responses. These included suggestions of greater interactivity within the virtual environment component of VIBE as demonstrated by the following comments; "I was wishing that it would be more like a SIMS world where you could go in and play around with things and do stuff." and "I think it would have been cool if you could incorporate that [additional interactions] into the regular assignment. Like maybe just walking along and you see like a little bug over here and click on it….Because it was kind of cool to explore and stuff and just walk around but it could have been a lot cooler if there was stuff [to find]."

One of the most intriguing findings of this study was that students' attitudes towards the format became more positive with increased exposure. These results were specifically associated with following Category 1 question items; the level to which this assignment interested you ($t(34) = 1.61$, $p = .058$), immersed you in the activity ($t(34) = 1.48$, $p = .074$), supported your learning ($t(34) = 1.91$, $p = .033$), and extended your knowledge ($t(33) = 1.68$, $p = .052$). This data demonstrates that a student's initial experience with a technology varies from later experiences. Specifically, our data indicates that students respond more positively with increased exposure. Our findings suggest that the newness of a technology may mask its full educational potential, at least until students become acclimated to using the new technology. We are referring to this phenomenon as the "digital veil". This finding is especially relevant to the overall tenets behind design based research methodology which was utilized in this study.

Predictive Indicators of Perceived Pedagogical Value

Through our data we were able to identify predictive models for 27 out of the 30 dependent variables while no predictive models were identified (N/A) for three of the independent variables. Out of the 27 predictive models identified, two were deemed not significant (N/S) based on having either a $\Delta R^2 \leq .10$ or a $p \geq .1$.

Table 5.1.

Summary of Relevant Predictive Models for Each Category of Dependent Variables

Category 1 Dependent Variables	**ΔR^2, F**	***p* Value**
V1. Interested you	ΔR^2 = .47, $F(2, 22) = 6.85$	.001***
V2. Interested you	ΔR^2 = .36, $F(5, 21) = 3.98$	.011**
V3. Engaged you	ΔR^2 = .25, $F(3, 28) = 6.00$	.007***
V4. Engaged you	ΔR^2 = .20, $F(3, 27) = 3.53$	.028**
V5. Immersed you	ΔR^2 = .57, $F(3, 26) = 14.04$	<.001***
V6. Immersed you	ΔR^2 = .17, $F(2, 27) = 3.96$	.031**
V7. Supported your learning	N/A	N/A
V8. Supported your learning	ΔR^2 = .25, $F(4, 22) = 3.12$	.035**
V9. Extended your knowledge	ΔR^2 = .25, $F(4, 22) = 3.12$	.016**
V10. Extended your knowledge	ΔR^2 = .25, $F(1, 24) = 3.91$	.060*
V11. Changed the way you viewed the topic	ΔR^2 = .31, $F(4, 25) = 4.25$	.009***
V12. Changed the way you viewed the topic	ΔR^2 = .34, $F(3, 26) = 5.87$	.003***

Category 2 Dependent Variables	**ΔR^2, F**	***p* Value**
V13. Memorizing	ΔR^2 = .41, $F(3, 23) = 6.90$	0.002***
V14. Memorizing	ΔR^2 = .61, $F(4, 22) = 10.96$	<.001***
V15. Analyzing	ΔR^2 = .11, $F(2, 26) = 2.78$	.080*
V16. Analyzing	N/S	N/S
V17. Synthesizing and Organizing	ΔR^2 = .51, $F(3, 25) = 10.79$	<.001***
V18. Synthesizing and Organizing	ΔR^2 = .20, $F(1, 27) = 7.99$	.009***
V19. Evaluating	ΔR^2 = .26, $F(2, 26) = 5.99$	.007***
V20. Evaluating	ΔR^2 = .19, $F(2, 26) = 4.19$	.027**
V21. Applying	ΔR^2 = .24, $F(3, 25) = 3.91$	.020**
V22. Applying	ΔR^2 = .17, $F(3, 25) = 2.97$	.051*

Category 3 Dependent Variables	**ΔR^2, F**	***p* Value**
V23. Overall satisfaction	ΔR^2 = .34, $F(3, 25) = 5.89$	.003***
V24. Overall satisfaction	ΔR^2 = .12, $F(1, 27) = 4.91$	.035**
V25. Overall learning value	N/A	N/A
V26. Overall learning value	ΔR^2 = .13, $F(1, 27) = 5.15$	.031**
V27. Worthwhile to develop	N/S	N/S
V28. Worthwhile to develop	ΔR^2 = .19, $F(2, 26) = 4.25$	.025**
V29. More of these types of assignments	N/A	N/A
V30. More of these types of assignments	ΔR^2 = .29, $F(3, 23) = 4.59$	.012**

Most frequently identified covariates in predictive models. Due to the exploratory nature of this study we evaluated a variety of independent variables to determine their overall predictive value. Six independent variables emerged as a covariate in five or more predictive models. In each case, these covariates were found in both AS and AF predictive models. The AS predictive models are specific to the students initial assignment survey responses while the AF predictive models are specific to the students reported final assignment survey responses. We have focused our discussion to these most frequently identified covariates. Table 5.2.

Most Frequently Identified Covariates in Predictive Models

	Covariate Identification	Frequency in Predictive Model	Frequency in AS Model (+β , - β)	Frequency in AF Model (+β , - β)
V31	Did you complete one or more of these assignments on the provided computer?	5*	2 (0 , 2)	3 (3 , 0)
V33	Do you play either single or multiplayer games on the computer?	5*	3 (3 , 0)	2 (1 , 1)
V34	Do you utilize virtual environments?	11**	6 (6 , 0)	5 (5 , 0)
V35	Do you have a smart phone?	10***	5 (0 , 5)	5 (0 , 5)
V36	Did you complete all three assignments?	6*	2 (1 , 1)	4 (0 , 4)
V43	Indicate your self-perceived interest in using technology.	15**	6 (6 , 0)	9 (9 , 0)

*indicates covariate had a positive β value in some models and a negative β in others
**indicates covariate had a positive β value in all models
***indicates covariate had a negative β value in all models

Two of the six most frequently occurring covariates were related to the students' utilization of the assignments. These were "V36. Did you complete all three assignments?" and "V31. Did you complete one or more of these assignments on the provided computer?"

V36. Did you complete all three assignments? Although most students completed all three VIBE assignments, some students completed only two out of the three and therefore had less overall exposure to the format. The number of exposures to the format was identified as covariate in eight predictive models, four AS models and four AF models. It was positively correlated with the following AS dependent variables; level of interest, overall satisfaction, and belief that it is worthwhile to develop these VIBE assignments. However, it was negatively associated with level of interest within the AF model. This indicates that the students that completed all three assignments reported a lower level of interest in the format. Other negative relationships identified in AF models included responses related to both how this format supported your learning and how this assignment changed the way you originally viewed the topic. Additionally, students that completed all three assignments reported lower values associated with memorization in both the AS and AF models. The prevalence of this covariate in both AS and AF predictive models indicates that the number of exposures to a novel technology is a valuable covariate to consider for future studies. The mixed positive and negative correlation results associated with this covariate within the models suggest that further clarification is needed to determine precisely how students' attitudes change with each exposure and why these differences exist.

Table 5.3.

Summary of Predictive Models in which V36 was Identified as a Covariate

V36. Did you complete all three assignments?			**Predictive Model Statistics**
V1	(β =.87, *p* = .089)	Interested you	ΔR^2 = .47, *F*(2, 22) = 6.85, *p* = .001***
V2	(β = -1.61, *p* = .014)	Interested you	ΔR^2 = .36, *F*(5, 21) = 3.98, *p* = .011**
V7	N/A	Supported your learning	
V8	(β = -1.10, *p* = .118)	Supported your learning	ΔR^2 = .25, *F*(4, 22) = 3.12, *p* = .035**
V11	N/A	Changed view of topic	
V12	(β = -1.38, *p* = .118)	Changed view of topic	ΔR^2 = .34, *F*(3, 26) = 5.87, *p* = .003***
V13	(β = -1.31, *p* = .014)	Memorizing	ΔR^2 = .41, *F*(3, 23) = 6.90, *p* = .002***
V14	(β = -1.69, *p* = .004)	Memorizing	ΔR^2 = .61, *F*(4, 22) = 10.96, *p* < .001***
V23	(β = 1.09, *p* = .037)	Overall satisfaction	ΔR^2 = .34, *F*(3, 25) = 5.89, *p* = .003***
V24	N/A	Overall satisfaction	
V27	(β = 1.01, *p* = .093)	Worthwhile to develop	ΔR^2 = .07, *F*(1, 27) = 10.79, *p* = .093*
V28	N/A	Worthwhile to develop	

V31. Did you complete one or more of these assignments on the provided computer?

The student's use of the provided computer to complete the assignment, rather than their own computer, was considered an independent variable since both of these groups of students had a potentially different experience. For example, the students that used the provided computer did not have to download the ActiveWorlds EDU™ software or locate BugWorld, the virtual universe that housed the VIBE assignments. However, in order to utilize the provided computer students had to plan ahead, committing to complete the assignment at a designated time and place. The students that used their own computers had more flexibility in when and where they completed the assignment, but they had to download the appropriate software and maneuver their way to the BugWorld universe in order to access the assignment. Depending upon the individual student's perspective, these differences may be considered as either a convenience or as an inconvenience.

This covariate appeared in 5 out of the 25 relevant predictive models, two AS models and three AF models. When present in an AS model this covariate always had a negative β. In comparison, this covariate always had a positive β when included in an AF model. For example, students that used the provided computer reported a lower level of immersion on the AS survey ($\beta = -1.0$, $p = .002$) than the students that completed the assignment on their own computer. Although no specific data was collected to identify why this difference occurred, it may be a reflection of the different settings in which each group completed the assignment. It is important to note that this difference did not persist after repeated exposure.

In contrast, the group that utilized the provided computers responded more positively to the statement "I would like to see more of these types of assignments integrated into my courses" ($\beta = .91$, $p = .071$) and indicated to a greater extent that these assignments were worthwhile and that they would like to see more VIBE assignments developed. These results may indicate that what at first may have appeared to be a negative to the students (i.e. having to schedule a time to complete the assignment, having to come on campus, etc.) was eventually perceived as a positive (i.e. the assignments took less time to complete when they used the preloaded computers). These results suggest that providing these preloaded computers may enhance the students experience with long term use. This was supported by some student interview comments such as "Sometimes I like to finish lab earlier and your [computer] was there. It was pretty convenient". In light of these findings, making assignment ready computers available to students should be considered when planning any future implementation of the VIBE format. Furthermore, utilization of these computers should be tracked for future comparisons.

Table 5.4.

Summary of Predictive Models in which Computer Utilization was Identified as a Covariate

V31. Did you complete one or more of these assignments on an instructor's computer?			**Predictive Model Statistics**
V5	(β = -1.0, *p* = .002)	Immersed you in the activity	ΔR^2 = .57, $F(3, 26) = 14.04$, $p < .001$***
V6	N/A	Immersed you in the activity	
V11	(β = -.71, *p* = .112)	Changed view of topic	ΔR^2 = .31, $F(4, 25) = 4.25$, $p = .009$***
V12	N/A	Changed view of topic	
V13	N/A	Memorizing	
V14	(β = 1.52, *p* = .004)	Memorizing	ΔR^2 = .61, $F(4, 22) = 10.96$, $p < .001$***
V27	N/A	Worthwhile to develop	
V28	(β = .82, *p* = .093)	Worthwhile to develop	ΔR^2 = .19, $F(2, 26) = 4.25$, $p = .035$**
V29	N/A	more VIBE assignments	
V30	(β = .91, *p* = .071)	more VIBE assignments	ΔR^2 = .29, $F(3, 23) = 4.59$, $p = .012$**

Digital gaming and previous exposure to virtual environments. We included questions on the Technology Survey that would indicate the students' participation in both digital games and virtual worlds. We were particularly interested in evaluating the role of these variables in our predictive models. Since the VIBE format included a virtual world component we were interested to see if students that currently utilized virtual environments were generally more positive, or more negative, towards the VIBE format. We felt as though students that were already using virtual environments may be more intrinsically motivated towards the VIBE format. However we also believed that these students may be more negative towards this format due to the lower quality graphics that our educational world provided compared to many commercial products. In other words, we were not sure if they would be disappointed that our VIBE assignment was not as realistic as what they were already using.

Virtual Environment. Our results indicated that a student's current participation in virtual environment was an important covariate, appearing in 10 out of the 25 relevant predictive models. Furthermore, whenever previous experience with virtual worlds appeared as a covariate within a model it was always a positive predictor. This group indicated on the AS that the VIBE format contributed to learning in the following ways; extended your knowledge, changed the way you viewed the topic, and emphasized specific learning including memorization, analysis, synthesis and application of material. After repeated exposure to the VIBE format, these students indicated that this format extended their knowledge, and emphasized both memorization and application of content to a greater degree than students that did not participate in virtual worlds prior to using the VIBE format.

Surprisingly, the experienced group did not initially report any greater interest or engagement in the assignment but did so after repeated exposure. Although we do not have any specific data that can conclusively explain why this occurs, we hypothesize these results are directly related to both the student's intrinsic motivation towards, and familiarity with, this format.

Table 5.5.

Summary of Predictive Models in which Virtual Environment Experience was a Covariate

V34. Do you utilize virtual environments?			**Predictive Model Statistics**
V1	N/A	Interested you	
V2	($\beta = 1.46$, $p = .003$)	Interested you	$\Delta R^2 = .36$, $F(5, 21) = 3.98$, $p = .011$**
V3	N/A	Engaged you	
V4	($\beta = .87$, $p = .078$)	Engaged you	$\Delta R^2 = .20$, $F(3, 27) = 3.53$, $p = .028$**
V9	($\beta = .70$, $p = .087$)	Extended your knowledge	$\Delta R^2 = .25$, $F(4, 22) = 3.12$, $p = .016$**
V10	($\beta = .97$, $p = .060$)	Extended your knowledge	$\Delta R^2 = .25$, $F(1, 24) = 3.91$, $p = .060$*
V11	($\beta = .78$, $p = .049$)	Changed view of topic	$\Delta R^2 = .31$, $F(4, 25) = 4.25$, $p = .009$***
V12	N/A	Changed view of topic	
V13	($\beta = .66$, $p = .079$)	Memorizing	$\Delta R^2 = .41$, $F(3, 23) = 6.90$, $p = .002$***
V14	($\beta = .84$, $p = .042$)	Memorizing	
V15	($\beta = .63$, $p = .065$)	Analyzing	$\Delta R^2 = .11$, $F(2, 26) = 2.78$, $p = .080$*
V16	N/A	Analyzing	
V17	($\beta = .36$, $p < .107$)	Synthesizing and Organizing	$\Delta R^2 = .51$, $F(3, 25) = 10.79$, $p < .001$***
V18	N/A	Synthesizing and Organizing	
V21	($\beta = .46$, $p = .167$)	Applying	$\Delta R^2 = .24$, $F(3, 25) = 3.91$, $p = 0.20$**
V22	($\beta = .66$, $p = .142$)	Applying	$\Delta R^2 = .17$, $F(3, 25) = 2.97$, $p = .051$*

Digital Gaming. The virtual environment format of the VIBE format is similar to a digital gaming in that the student controls their interactions within the environment and interfaces with computer mediated materials throughout their experience. Because of these similarities we hypothesized that students that enjoyed digital gaming may also be more motivated to utilize the VIBE format. This relationship is supported by the following student's interview comment,

> It just gives you more of an interaction with your class, you get to, you know, you walk around the world you find what, you find what you're looking for to click on or scroll over to tell you what you need to figure out. It's kind of like a video game in a way and I like video games.

Our results indicate that the gaming population did initially report a higher interest in this assignment format then reversed their decision by subsequently reporting lower interest levels than non-players. The game playing students also reported higher levels of immersion in this activity after the initial experience but not after repeated exposures. If intrinsic motivation is responsible for the increased interest and immersion, our data indicates that this positive indicator is only applicable to the initial use of the technology. Therefore, it appears that the initial excitement by this group of students in the game-like format of this assignment quickly wanes after repeated exposures. This decrease in enthusiasm may be related to gamers potentially higher expectations of the computer interactions and graphics offered in the VIBE format compared to the commercially available digital games.

The duration of game play was an independent variable that did not often appear as a covariate in the predictive models (n=3). However, when duration of play was identified as

a covariate it was always a positive predictor. The high duration gamers initially indicated an increased interest in the VIBE format, but this difference did not persist after repeated exposures. Our data revealed that after repeated exposure high duration gamers felt as though this format supported their learning to a greater extent than lower duration gamers and non-gamers. Not surprisingly, after repeated exposure this group also reported a higher interest in the creation of more VIBE assignments.

These somewhat conflicting results between the overall gaming population and the high duration gamers may indicate that merely identifying a student as a "gamer" may not provide us with adequate information. It appears from our data that the average time spent playing games per week may potentially be a more specific indicator, one with possible positive predictive value to the increased utilization of this format. It should be noted that we did evaluate frequency of game play as a separate independent variable and it was not accepted as a covariate in any of our predictive models.

Figure 5.6.

Summary of Predictive Models in which Gaming was a Covariate

V33. Do you play either single or multiplayer games on the computer?			**Predictive Model Statistics**
V1	(β = .66, *p* = .172)	Interested you	ΔR^2 = .47, *F*(2, 22) = 6.85, *p* = .001***
V2	(β = -.97, *p* = .061)	Interested you	ΔR^2 = .36, *F*(5, 21) = 3.98, *p* = .011**
V5	(β = 1.45, *p* < .001)	Immersed you	ΔR^2 = .57, *F*(3, 26) = 14.04, *p* < .001***
V6	N/A	Immersed you	
V21	(β = .58, *p* = .118)	Applying	ΔR^2 = .24, *F*(3, 25) = 3.91, *p* = 0.20**
V22	(β = .70, *p* = .158)	Applying	ΔR^2 = .17, *F*(3, 25) = 2.97, *p* = .051*

V42. Game Usage-duration			**Predictive Model Statistics**
V1	(β =1.0, *p* = .011)	Interested you	ΔR^2 = .47, *F*(2, 22) = 6.85, *p* = .001***
V2	N/A	Interested you	
V7	N/A	Supported your learning	
V8	(β = .64, *p* = .093)	Supported your learning	ΔR^2 = .25, *F*(4, 22) = 3.12, *p* = .035**
V29	N/A	More VIBE assignments	
V30	(β = .60, *p* = .053)	More VIBE assignments	ΔR^2 = .29, *F*(3, 23) = 4.59, *p* = .012**

Cell phones. We were surprised at how often the covariate, smart phone ownership, appeared in both the AS and AF models. Even more surprising was that when it did appear it always had a negative β value. Students that owned a smart phone consistently ranked this format lower than non-smart phone owners in the following categories as indicated by both the AS and AF data analysis; interest level, engagement, immersion, and changed the way they viewed the topic. Additionally these students ranked both the extension of knowledge and overall satisfaction lower on the AS and provided lower rankings on how this format supported your learning than non-smart phone owners. More research is required to determine what factors may be causing this association however our results indicate that this is potentially important predictive covariate.

Figure 5.7.

Summary of Predictive Models in which Owning a Smart Phone was a Covariate

V35. Do you have a smart phone?			**Predictive Model Statistics**
V1	(β = -.57, p = .078)	Interested you	ΔR^2 = .47, $F(2, 22) = 6.85$, p = .001***
V2	(β = -.49, p = .215)	Interested you	
V3	(β = -1.02, p = .007)	Engaged you	ΔR^2 = .25, $F(3, 28) = 6.00$, p = .007***
V4	(β = -.86, p = .047)	Engaged you	ΔR^2 = .20, $F(3, 27) = 3.53$, p = .028**
V5	(β = -.90, p < .001)	Immersed you	ΔR^2 = .57, $F(3, 26) = 14.04$, p < .001***
V6	(β = -.60, p = .13)	Immersed you	ΔR^2 = .17, $F(2, 27) = 3.96$, p = .031**
V7	N/A	Supported your learning	
V8	(β = -.93, p = .041)	Supported your learning	ΔR^2 = .25, $F(4, 22) = 3.12$, p = .035**
V9	(β = -.81, p = .027)	Extended your knowledge	ΔR^2 = .25, $F(4, 22) = 3.12$, p = .016**
V10	N/A	Extended your knowledge	
V11	(β = -.77, p = .037)	Changed view of topic	ΔR^2 = .31, $F(4, 25) = 4.25$, p = .009***
V12	(β = -1.11, p = .003)	Changed view of topic	ΔR^2 = .34, $F(3, 26) = 5.87$, p = .003***
V23	(β = -.83, p = .013)	*overall satisfaction*	ΔR^2 = .34, $F(3, 25) = 5.89$, p = .003***
V24	N/A	*overall satisfaction*	

Self-perceived interest in using technology. As expected, the students self-perceived interest in using technology was the highest frequency covariate, emerging as a positive predictive indicator for half of the total dependent variables (15 of 30) and appearing in over half (60%, 15 of 25) of the accepted predictive models ($\Delta R^2 \geq .10$, $p < .10$). This covariate was identified as an important predictor related to the initial exposure to the VIBE format with seven appearances in AS models. However, it appeared to be an even stronger predictor of attitudes associated with repeated exposure to the assignment format as indicated by the nine AF model appearances. In many cases this covariate is found in both the AS and AF models of a specific dependent variable, such as engagement. However it also appears exclusively in the AF model of several important dependent variables such as supported your learning, overall learning value, and desire to complete more VIBE assignments. These results indicate that repeated exposures to a format may be necessary for students to recognize the learning value of a new technology, even students with a high interest in using technology.

Figure 5.8.

Summary of Predictive Models in which Self-Perceived Interest in Using Technology was Identified as a Covariate

V43. Indicate your self-perceived interest in using technology.			**Predictive Model Statistics**
V3	(β = .61, *p* = .024)	Engaged you	ΔR^2 = .25, $F(3, 28) = 6.00$, $p = .007$***
V4	(β = .54, *p* = .091)	Engaged you	ΔR^2 = .20, $F(3, 27) = 3.53$, $p = .028$**
V5	N/A	Immerse you	
V6	(β = .73, *p* = .016)	Immersed you	ΔR^2 = .17, $F(2, 27) = 3.96$, $p = .031$**
V7	N/A	Supported your learning	
V8	(β = .60, *p* = .058)	Supported your learning	ΔR^2 = .25, $F(4, 22) = 3.12$, $p = .035$**
V11	(β = .61, *p* = .019)	Changed view of topic	ΔR^2 = .31, $F(4, 25) = 4.25$, $p = .009$***
V12	(β = .61, *p* = .018)	Changed view of topic	ΔR^2 = .34, $F(3, 26) = 5.87$, $p = .003$***
V13	(β = .72, *p* = .003)	Memorizing	ΔR^2 = .41, $F(3, 23) = 6.90$, $p = .002$***
V14	(β = .78, *p* = .002)	Memorizing	ΔR^2 = .61, $F(4, 22) = 10.96$, $p < .001$***
V17	(β = .45, *p* = .003)	Synthesizing and Organizing	ΔR^2 = .51, $F(3, 25) = 10.79$, $p < .001$***
V18	N/A	Synthesizing and Organizing	
V19	(β = .51, *p* = .013)	Evaluating	ΔR^2 = .26, $F(2, 26) = 5.99$, $p = .007$***
V20	(β = .44, *p* = .176)	Evaluating	ΔR^2 = .19, $F(2, 26) = 4.19$, $p = .027$**
V21	(β = .44, *p* = .046)	Applying	ΔR^2 = .24, $F(3, 25) = 3.91$, $p = 0.20$**
V22	(β = .44, *p* = .128)	Applying	ΔR^2 = .17, $F(3, 25) = 2.97$, $p = .051$*
V25	N/A	Overall learning value	
V26	(β = .67, *p* = .031)	Overall learning value	ΔR^2 = .13, $F(1, 27) = 5.15$, $p = .031$**
V29	N/A	More VIBE assignments	
V30	(β = .46, *p* = .071)	More VIBE assignments	ΔR^2 = .29, $F(3, 23) = 4.59$, $p = .012$**

Viability of the VIBE Format

When determining the relative usefulness of any higher education educational technology one has to consider not only the effectiveness of the tool, but also its potential viability. We define an educational technology as being viable if the following two conditions are met; the continued utilization of the technology is practical, and the adaption of the technology is financially sustainable.

Continued utilization of the format. Like all educational technologies, the development of VIBE assignments requires an initial input of expertise, time, and money. Although these upfront expenses may be costly, limited resources are required to maintain the use of these tools once developed. Although it could be easily argued that there is a direct relationship between time and money, we will discuss each of these factors separately.

Costs. Monetary expense is an invariable limitation associated with the development and implementation of any educational technology. Each of the three individual components that cumulatively formed the VIBE format were developed using three types of unique software; the videos were produced using Camtasia™, the interactive files were developed using Flash™, and the 3D virtual environment was developed in and hosted by ActiveWorlds EDU™ (http://www.activeworlds.com/edu/awedu.asp, 10/29/11).

Both the Camtasia™ and Flash™ software used in this project was available for use through the department of biology at NCSU. Additionally, the department of biology had previously obtained a multi-year, multi-site, multi-user contract with ActiveWorlds EDU™. The virtual environments developed for this project were completed under this existing contract. Therefore, the VIBE assignments created for this study did not require any

additional funding for new software. However, had this software not been available for use it could have be purchased at the following prices, Camtasia Studio 7.1 version $299.00 (http://www.techsmith.com/camtasia-features.html, 10/29/11), Adobe Flash Professional CS5.5 $699.00 (http://www.adobe.com/products/flash.html, 10/29/11), and a Basic Classroom Package through ActiveWorlds EDU™ for $650.00 per year (http://www.activeworlds.com/edu/awedu_pricing.asp, 10/29/11).

Additional non-essential software used for this project was Dreamweaver™. This software was used to create the associated VIBE instructional webpages provided to guide the students through the VIBE assignment format. These materials were developed in a web format for convenience and could easily be provided to the students in a different format that does not require Dreamweaver™ software if preferred.

The development of all of the VIBE assignment materials was done by the author, Marta Klesath, under the guidance and supervision of Dr. John Meyer, content expert and instructor for the ENT 425 course. Therefore no developmental costs were required to create the VIBE components utilized in this study. This cost would be significant if "for hire" work were necessary to develop future assignments. Although we were able to develop these assignments without a budget, the lack of funds was restrictive in that only free, preexisting 3D virtual items could be used to populate our virtual world. This created a challenge when building some of the more unique objects required for this project. For example, rather than being able to pay someone to develop a virtual replica of the boll weevil monument we had to create a representative version by combining a variety of unrelated, free objects which were placed together creatively.

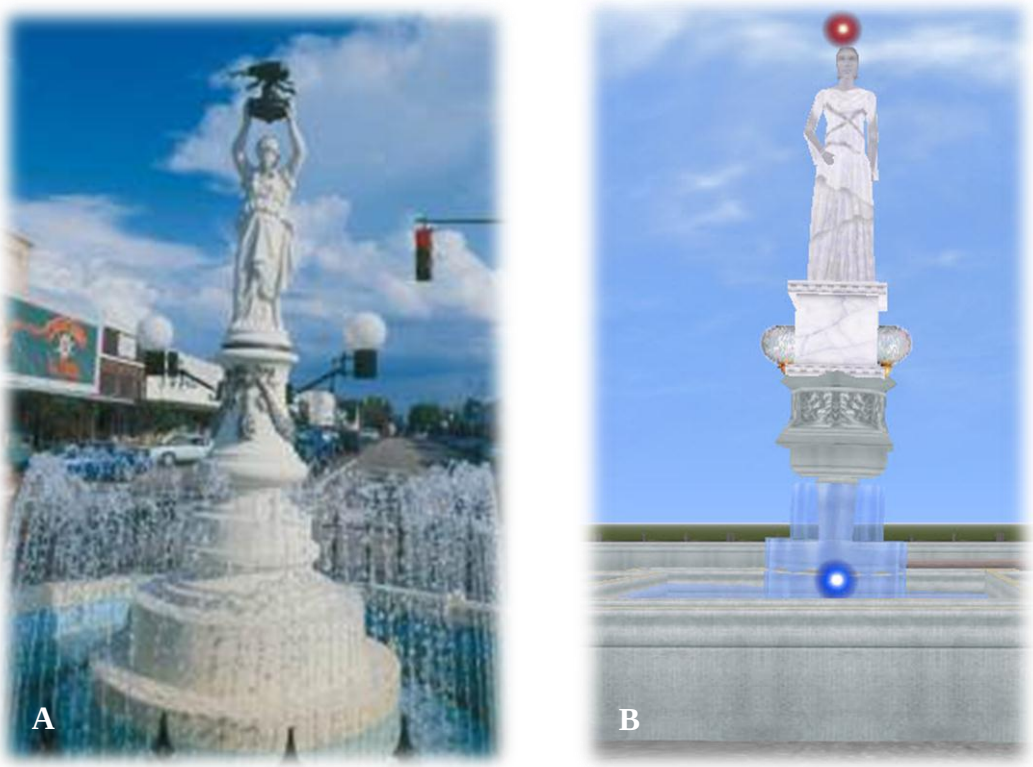

Figure 5.1. Images of the boll weevil monument. Comparative images between the actual boll weevil monument found in Enterprise, Alabama (A) and its virtual representation in ActiveWorlds EDU™ (B). The virtual representation was composed of several individualized virtual pieces which were placed together to represent this monument in the virtual environment.

When determining the overall expense related to the VIBE assignments, it is important that the initial development costs are considered separately from costs incurred to support the technology. Developmental costs vary and may be significant, but they are one time expenses. The cost of supporting the technology, such as hosting fees and providing technical support, would likely be minimal in comparison but is a continued expenses.

Time. The three specific VIBE assignments used for this study took approximately six months to develop. The development time required to complete such a project depends upon a multitude of factors including the time required to define the assignment topic and convert it to an appropriate format, the expertise level of the developer, and the availability of "for hire" work if required. In this study a variety of factors contributed to both increases and decreases in the required development time for this project.

Table 5.9.

Factors Impacting The Development Time for this Project

Factors that Decreased Development Time	Factors that Increased Development Time
• The developer had previous experience creating videos using Camtasia™software • The developer had previous experience building virtual environments in ActiveWorld EDU© and was able to utilize a previously built environment as a template for this project • The content expert had identified three previously used assignments which could modified and enhanced using the VIBE format	• The developer had no experience or training using Flash™, a software that required a fairly large learning curve • No university funded individualized training or developmental guidance was available to the author for the technologies used in this project

Specific development time required for future projects would vary. For example, the time required identifying quality assignment content suitable for conversion into the VIBE format may be negligible or may take several weeks to develop. As previously discussed how adept the developer is at using Camtasia™, Flash™, and ActiveWorlds EDU™ (or another virtual building software) would impact the time required. However, this timeframe may be reduced through collaboration of individual experts in utilizing each of the three required software.

Scalability

Our ultimate goal in developing VIBE was to create a format that would allow us to continue to develop high quality, engaging, interactive assignments that were flexible in both their implementation and their utilization. Additionally, we wanted to create a format that could be integrated effectively into higher education life sciences courses of practically any size.

For this study, the VIBE assignments were utilized as out of class, online asynchronous activities. This type of utilization is ideal for larger courses (>50 students enrolled). Potentially course content provided in this manner could be utilized by literally hundreds of students a semester with the only additional expense being related to the purchase of additional student access through the virtual software provider. Even this cost could be reduced if students were able to use universal log in information to access the assignment. It is important to emphasize that assignments can be linked from the virtual world to a learning management system such as Moodle™. Therefore even if several students were using the same log in information to enter the world, they would use their individual log in information to access their assignment ensuring that their grades could be tracked. Of course increased utilization of any technology inevitably results in a greater need for technical assistance. This is an often overlooked cost which applies to all educational technologies which are implemented.

These VIBE assignments format was designed for flexibility. Although we utilized these assignments asynchronously, they could have easily been assigned as a synchronous activity. This type of utilization would be ideal for smaller calsses (<50 students enrolled).

This utilization would also allow for real time student to student collaboration and/or instructor led instruction.

While developing the VIBE format we purposefully kept the assignment content separate from the assessments associated with the assignments. We achieved this by deep-linking related assessments in Moodle™ to specific virtual scenes within each VIBE assignment. This design allows us maximum flexibility on both the utilization and assessment of the content. For example, one instructor may utilize VIBE as a collaborative synchronous assignment and assess the provided learning outcomes through the evaluation of a student essay while another instructor may have the students complete the assignment asynchronously and assess the students through a series of multiple-choice questions. We could provide many additional scenarios demonstrating the various combinations of utilization and assessments, but clearly the possibilities are almost limitless. The flexibility of this format is important factor contributing to the potential long term use and viability of the VIBE format.

Potential Implications on Science Teaching and Learning

This study contributes to the educational research literature in a variety of ways. The development of the novel VIBE assignment format has potential implications in the expansion of technology-rich assignment in higher education courses. We argue that the relatively inexpensive developmental and maintenance costs of this educational technology combined with its instructional versatility makes the VIBE format both viable and adaptable for utilization in most any higher education life science course.

In most design based research, data concerning the educational value of a new technology is often collected after a single exposure to that technology. Our findings indicated that students' attitudes towards the VIBE format became more positive with increased usage. Although the exploratory nature of this study limits its generalizability of this "digital veil" effect, our results highlight the potential importance of evaluating for such an effect in future studies. Our results indicate that repeated exposures may be necessary in order to fully identify an accurate picture of the pedagogical significance and perceived learning value of any new educational technology. Previous researchers have suggested that novel technologies may enhance learning gains due to the students' excitement in using the new technology (Ferguson, Weir & Wilson, 2003). This has been referred to as the "novelty effect". Historically, it has been argued that the novelty effect exaggerates the value of educational technologies. Our results indicate the opposite, that learning potential may not be fully ascertained by a single exposure. We have termed this effect the "digital veil" referencing its temporary and incomplete masking of the full learning value associated with the novel tool. Caruso and Kvavik (2005) reported that college students are comfortable

with a set of mainstream technologies but that they are less comfortable when utilizing technology that is novel to them. This research supports our hypothesis that the presence of a learning curve associated with the usage of a novel technology may initially taint or mask the full educational potential of the design.

Although the predictive models identified through our research are specific to both our design and this group of participants, the most frequently identified covariates used within our models should be further analyzed as potential predictors for other educational technologies. Additionally the differences among the predictive models for both the initial (AS) and repeated (AF) exposures further support our repeated measures findings. Cumulatively, our results imply that the students' initial experience with a novel educational technology may not be the best indicator of the perceived pedagogical value of that technology.

The overall results of this study add to the increasing amount of education research related to students' preferences and uses of various technology-mediated tools as applicable to specific learning tasks. Kennedy, Judd, Churchward, Gray, and Krause (2008) argue the importance of such research in the following excerpt.

> As university educators we must be attuned to the ever changing and often diverse characteristics of our student cohorts. Evidence of who our students are must remain an important factor in informing how we use the array of technological tools at our disposal to design rich and engaging learning experiences for all students (p.120).

As we continue to develop this scaffolding of information we should be able to better define how these tools contribute to the overall sociocultural construct within higher education courses. I believe that Vygotskian ideas may act as the underlying theoretical framework, providing us with a more complete picture of how to best integration these tools in order to promote the development of the sociocultural framework as it applies to student learning.

Limitations of the Study

The limitations of this study have been categorized as those related to either data collection, utilization of the technology, or methodology.

Data collection. Inconsistencies in the students' completion of the VIBE assignments and associated surveys drastically reduced the available data for statistical testing. Out of the 65 students in the course, only about half (n=33-36 depending upon specific question item) completed at least two VIBE assignments and associated assignment surveys. Out of this group even fewer (n=23-30 depending upon specific question item) completed the technology survey. Therefore the n values were lower than expected for both the repeated measures and predictive modeling portion of this study.

Although all participants were enrolled in the same entomology course, a great deal of flexibility existed in how each student interacted with the course content. The majority of the course content was housed online, however optional live lectures related to this content were also available. We were unable to track which students utilized which resources or to what degree. This information may have allowed us to better define students learning preferences and analyze for potential differences in attitudes towards the VIBE format based on differential learning experiences that occurred throughout the semester. These potential differences emerged in the interviews as demonstrated by the following comment.

> Well, I know for myself personally being a distant ed student it was nice having the interaction that I don't normally get because I'm not in the classroom…all of our learning material, beside short ten minute videos at the beginning of each lecture, was all reading, so this was a really nice change.

Utilization. Several factors impacted the ease to which students were able to download and view the VIBE assignments. The most pressing were related to both the ActiveWorlds EDU™ and Adobe Flash™ Players incompatibility with Macintosh operating systems (iOS). One way around this issue is to run Mac computers in PC emulation mode. Since not all Macs have this internal capability, separate PC emulation software such as Parrallels Desktop 7 (http://www.parallels.com/landingpage/dskd77-2/?source=g_us&gclid=CJGqhtvNn6wCFY9V7AodbWt6Bw, 10/29/11), Guest PC (http://www.lismoresystems.com/en/, 10/29/11), or iEmulator (http://www.iemulator.com/, 10/29/11) may be downloaded allowing ActiveWorlds EDU™ to load and run iOS systems. Alternately various Flash™ conversion software exists such as AVS video converter 8.1 (http://www.avs4you.com/AVS-Video-Converter.aspx?type=GoogleAdWordsSearch&gclid=CIja16nLjqwCFQPs7QodYVvHog, 10/29/11) and Macvide FlashVideo Converter (http://www.macvide.com/Macvide-FlashVideo-Converter/, 10/29/11). However these conversion products all impact the interactive interface of the files to some degree. Currently there are not any similar products that would allow students to complete the VIBE assignments utilizing either an iPad or iPhone device.

In order to ensure that all students had the opportunity to complete the VIBE assignments, a computer preloaded with the appropriate software was provided at scheduled times throughout the semester. The students that utilized the provided computer were tracked within the study to determine if potential differences existed among this group of students.

Methodology. The exploratory nature of this study limits the overall generalizability, but not the value, of our results. Limitations inherent to the pragmatic nature of design based research apply to this study. These include the inability to account for or control exogenous design components within the study (O'Donnell, 2004). Additionally, the pre-experimental research design employed in this study was limiting in that we did not have a control group (Creswell, 2009).

Conclusions and Future Studies

The design and evaluation of technology-rich assignment formats, like the VIBE format described within this study, is a time consuming and daunting task. However our study indicates that the educational rewards associated with the perceived pedagogical value of this tool is promising. Since the focus of this study was to develop, utilize, and assess the perceived pedagogical values associated with the VIBE format, no data was collected pertaining to specific learning gains. Clearly identifying potential learning gains associated with the VIBE format is an important piece of missing information which should be addressed in future studies.

Our results indicate that the VIBE format has potential educational value. Students' responses from the Assignment Survey had reported means ranging from 2.76 to 3.17 on a 5-point Likert scale. The lowest scoring item (M = 2.76) related to the students reported interest level in the assignment. This reported mean fell between a reported low level of interest (2) and moderate level of interest (3). The highest scoring item (M = 3.71) related to the reported learning value of the VIBE assignments. This indicated an average response between moderate (3) and high value (4). These results demonstrate that a direct relationship does not exist between interest and perceived value since students indicated a greater degree of education value (M = 3.71) than would be expected based on their reported interest level (M = 2.76). Overall this data is promising, however continued research on the pedagogical affordances of the VIBE format is also necessary. Future studies should evaluate the potential effect that gender differences may have on the perceived pedagogical value of this

format. Additionally, variations in the utilization of this format (i.e. asynchronous versus synchronous) should be evaluated to determine how utilization specifically impacts the pedagogical affordances associated with the VIBE format.

The positive shift in student attitudes towards the VIBE format after repeated exposure is an important finding, one with implications further reaching than this study. These results indicate that the newness of an educational technology may initially mask the full reported value of the design, a phenomenon we are referring to as the "digital veil". Therefore, multiple exposures to a new educational technology may be necessary to accurately define pedagogical value. Future studies are necessary in order to determine the generalizability of our results. Additional studies should also be designed which evaluate if the "digital veil" effect impacts potential learning gains of a novel educational technology.

This exploratory study also provides initial results supporting a relationship between students' current technology usages and perceived value of technology-rich assignments. Future studies should be designed to further explore the potential value of our most frequently determined covariates. Although no one covariate, or specific group of covariates, was identified in all models, the covariate "self-perceived interest in using technology" appeared most often. This covariate appears to be of particular predictive importance since it applied to both initial (AS) and repeated exposure (AF) models. Future studies will help determine to what degree our results may be generalized to other newly developed educational technologies.

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APPENDICES

Appendix A

VIBE Video Narration Scripts

Virtual Vignette A: "Sharing" the story of the Boll Weevil

I'm Samuel, a tenant on this farm. My family has been working this land for three generations-planting cotton. My granddaddy worked these fields in the 1880's-before the boll weevil made its way here. My daddy started working these fields next and worked them until the day he died, back in 1925. He lived just long enough to see the beginning of the devastation that the boll weevil brought on. I always suspected that I'd work here until I died too-but I'm not sure if I can make a living any more growing cotton. I'm an old man now and I've seen a lot of changes in my lifetime.

Here in the south, there was a time when cotton was king. A family could make a living working the fields-and some of them, the landowners and the merchants, could even get rich. But we weren't the only ones that depended on the cotton for our survival-the boll weevil needed a home too-and they choose our cotton fields. I guess I understand the need for a home, being a landless sharecropper myself, but these cotton fields aren't big enough for the both of us. It's a battle now-man against bug.

Seems like it wouldn't be any contest-but the little weevil turned out to be a lot tougher than we thought. Chemicals were our weapons. First we used calcium arsenate.

You could carry it in a flour sac and dust it right on the cotton plants. Mostly we walked through the fields, spreading the chemical dust by hand-sometimes we even got to ride a mule while doing it. Some farmers, in other areas of the south, actually mixed the chemicals with molasses and mopped the sticky mixture right on the plant.

Now a days' we use crop dusters. We started spraying arsenic, but after WWII we switched to DDT and a whole variety of chemicals they call organochlorines. We applied pounds of the stuff to each field, sometimes over and over again. The stuff worked too. A little too good-it killed the good bugs along with the weevil-causing a whole new bunch of problems. But we kept at it, and just when it seemed like we were winning the fight those weevils recovered.

Sure at first we were killing them, but then they got tolerant. Somehow they had become resistant and we had to rethink everything. That's when we started adding organophosphates to the mix. We just kept mixing and mixing until we found a better combination of chemicals. Mostly we use methyl parathion. They told us to be careful with the stuff. That's why when we were flagging we'd use the umbrellas to protect us from the clouds of pesticides coming down.

Virtual Vignette B: The Boll Weevil Blues

When the weevil came the whole south was effected-though here in the Delta we didn't have it as bad. Sure we had weevils, but every fall they took shelter in our low lying forests. When they flooded, most of weevils drowned before they could come out of hibernation. This kept the weevil numbers down and our production up. The soil here in the delta is rich and fertile. This allows for the cotton to mature early so we can harvest sooner than other regions in the south. Our geography, and the weevil's biology combined meant that our plantations could make a profit in spite of the weevil.

That's why the sharecroppers headed to the delta-we were one of the only areas that wasn't ruined by the weevil. Our populations grew as all kinds of people flocked to the region. People were actually doing pretty good here. They were making a living and there was even enough money floating around that you could make some playing music. People would pick cotton by day and perform by night. Some of them, such as Tommy Johnson and Pinetop Perkins, became something of a legend doing just that.

The different styles of music mixed and grew until the blues were born. The blues were a way of communicating, a way of expressing both information and feelings. People sang about what they knew-and the boll weevil was sure something they knew about. A number of songs about the insect sprang up such as the "Mississippi Bo Weevil Blues", the "Boll Weevil Song", and the "Ballad of the Boll Weevil".

Virtual Vignette C: The Monumental Impacts of the Weevil

This is the famous Boll Weevil monument of Enterprise Alabama, likely the first bug monument in the United States. This monument was dedicated on December 11, 1919 a few years after the boll weevil first reached this region and destroyed our cotton crops.

Before the weevil, cotton was the only real cash crop for the south. It was like money in the bank-it could be stored and could always be traded both locally and internationally. Other crops were grown but they weren't as profitable or as dependable. Sweet potatoes couldn't be stored and trade wasn't as good. Plus, sweet potatoes were also susceptible to a whole variety of insects.

Crops such as watermelon, peaches, and cantaloupe were also grown on a small scale but you had to live close to the city market in order to sell that kind of produce. The combination of the damp climate and the sandy, red soils of the region made it tricky to find a crop other than cotton that would thrive.

When the weevil devastated the cotton crops people had no choice but to find something else-some crop that would allow them to make enough money to live. People knew their livelihood was in danger. That's when the peanut took off. Luckily Coffee County moved on pretty quickly to the peanut. The peanut wasn't a very valuable crop, but it was a crop, and a useful one at that. Not only did people eat it but they made lots of stuff out of it such as flour meal, cleaners, laundry soap, and even medicines.

The shift to the peanut kept these people alive. People weren't getting rich but they weren't starving like lots of other regions in the south. George Washington Carver played a major role in the success of this crop. He helped people understand how the peanut actually

enriched the soil. He also discovered different uses for the peanut, producing over 300 products. The peanut crop helped keep this community going by changing our economy so that it wasn't solely dependent on cotton.

Virtual Vignette D: Human Migration

Welcome to the Temple B'nai Isreal-home of Mississippi's oldest Jewish congregation. This temple was built in 1905- a time when Natchez prospered. Natchez used to be home to 450 Jewish residents, mostly merchants, now there are just a handful of us. Just two years after the temple was built the weevil crossed the Mississippi River-and that is what changed everything. The weevil devastated the cotton crop-the basis of our economy. We had nothing to sell and no one to sell it to. People had to leave to survive. And leave they did, emptying both the town and the synagogue.

The fabulous homes that had been built went into disrepair or were abandoned. No new homes were built. As land prices fell, and the banks failed, everything collapsed. It wasn't just the sharecroppers who planted the fields who faced ruin. The whole town including gin operators, railroad workers, and merchants-went broke.

People had no choice but to leave. Most moved north away from the weevil. Small towns emptied and the cities such as Memphis grew. It's hard to imagine how much a little insect changed our town. Before the weevil destroyed our community all of our 250 seats were full-now there are just a handful of us left. I fear that the day will come, in the not too distant future, when there won't be any of us left and the synagogue will be empty.

Virtual Vignette E: The evolution of DELTA

You had to fight the weevil with pesticides-it was the only way. The trick was getting the stuff applied fast and even across the whole field and the best way to do that was with my crop duster plane.

Now it took special skills to fly one of them things, but it was good money-if you could do it. I was one of the first pilots for Huff-Daland Dusters. Back in the twenties the company had over 60,000 acres under contract all over the south-more than all of its competitors combined. Even the federal government stepped in to help control them pesky weevils by donated some WWI planes and giving some money.

In 1928 some investors bought out Huff-Daland and changed the name to Delta Air Service. By 1930 Delta was getting into the passenger business-but just 5 customers at a time-so they weren't making any money. If it wasn't for us crop dusters they wouldn't have been flying at all. But today when you hear Delta nobody thinks about the weevil-but that's what started it all. Beginning from a dirt airstrip in Louisiana, Delta's grown into one of the largest airlines in the country.

Virtual Vignette F: The Hazard from the Help

The first step in trying to stop the weevil was to better understand their biology. We already knew how they caused their damage. Females chew holes in cotton squares, or buds, and insert fertilized eggs. As the wormlike grubs hatch and began feeding, the squares, which would otherwise develop into blossoms and then bolls containing cotton lint, fall off the plant and die. The weevils spend much of their time inside the buds or bolls. And this is problematic because this is where their protected from insecticides. Therefore it is only the adult stage of the insect that you can affect by spraying. The weevil was targeted with 1/3 of all insecticides used in the nation, including millions of pounds of some of the most toxic compounds ever produced. Upto 94% of the DDT used in the nation, along with more than 80% of the methyl parathion and toxaphene rained down on cotton fields each year.
A 1957 guide published by the Memphis based National cotton council recommended that growers use up to 4 pounds of toxaphene and 2 pounds of DDT per acre to control the weevils. Several applications at 4-5 day intervals were recommended . As a result, cotton farmers were using upwards of 30million pounds of toxaphene and 20 million pounds of DDT annually.

After decades of use the environment impacts of the pesticides started to become clear. In LA brown pelicans had essentially vanished by the early 1960s. Officials investigating the decline found evidence it was caused by enderin which had been used extensively against weevils in the state. Just as the pelicans began disappearing, fish began dying in huge numbers in the Mississippi River. A particularly large fish kill in the fall of

1963 led to congressional hearings the following spring. In testimony by agency officials, the PHS cited the Memphis Vesicol plant as one particular source of enderin pollution. In the common practice of industries at the time, Vesicol dumped its waste untreated into Cypress creek and later into an industrial sewer that connected with a municipal sewer running parallel to the Wolf River. From there, the discharges poured into the Mississippi.

Rachel Carson's famous book Silent Spring outlined the effects of DDT. In particular she looked at how it accumulated in the fatty tissue of animals, including human beings, and how it could cause cancer and genetic damage. The environmental and health concerns scientists raised over the use of DDT eventually resulted in its ban by the United States government. Scientists looked for new ways to control the weevils, ones that didn't require pesticides.

The federal boll weevil laboratory established at Mississippi SU collected and studied 100 pounds of boll weevil fecal matter in an effort to identify the insect's pheromones, or sex attractant. Through trial and error, scientists were able to isolate a pheromone that was extremely effective in attracting the female boll weevils. They were able to utilize this pheromone to create traps. In the late 1970's the National Boll Weevil Eradication Program was launched by USDA's Animal and Plant Health Inspection service. The program later expanded into other southeastern states, followed by Southwestern Arizona, southern California and a portion of Northwest Mexico. Later programs were launched in Oklahoma, New Mexico, the mid-south and Texas.

In the years since the eradication effort began cotton acreage has recovered dramatically. Georgia producers are now are planting more than 1 million acres while NC

has begun growing more than 800 thousand acres during most years. Chemical usage is way down too. Between 1994 and 2005 the amount of insecticide sprayed on cotton dropped by nearly 3 million pounds even as the area planted in the crop grew by 2.4 million acres.

Virtual Vignette A: Chemical Ecology

Monarch butterflies are sometimes referred to as "Milkweed Butterflies" due to their dependency on their host plant the milkweed. Female Monarchs lay their eggs on the underside of the milkweed plant leaves. This provides a ready source of food for the emerging larva, or caterpillar. Larvae typically emerge from the eggs in three to twelve days depending upon the environmental conditions. As these caterpillars eat and grow must molt to allow for their tremendous expansion in body size. The time between molts is called an "instar" and Monarchs go through 5 instars while munching down on their host plant. The larval stage typically takes about two weeks and results in a plump caterpillar about 2 inches long.

The milkweed plant is an unusual choice of food because it contains a potent heart poison, cardiac glycosides that makes the plant distasteful to lots of other organisms. Not only are the Monarch caterpillars able to tolerate the poison in milkweed leaves, but they actually sequester it within their own bodies, making themselves unpalatable to many potential predators.

When a caterpillar reaches its full size, approximately 2 inches and very plump, it finds a nice quiet twig and attaches itself head down, sheds their outer skin, and transform

into the pupal stage or chrysalis. The outer chrysalis has a distinctive shiny-jade colored appearance that progressively lightens and clears over this two week process. The chrysalis becomes almost completely transparent about 1-2 days before the butterfly emerges.

The transformation into the brightly colored adult is astounding and the newly emerged butterfly needs to adjust to its new body. It inflates its wings using a pool of blood stored in its abdomen and waits for them to stiffen and dry before it can take flight.

This bright coloration is more than show. It is a warning to potential predators that the butterfly has a store of toxins in its body that makes it an unappealing source of food. In fact this warning coloration works so well that it is mimicked in the non-toxic Viceroy Butterfly.

Subtle differences exist between the wing patterns of the male and female Monarchs the most notable of which is the presence of an additional black "spot" on the inner vein of the male's hind wing. This variation is more than decorative, it is a functional "scent gland" with pheromones that attract mates, allowing the life cycle to continue!

Virtual Vignette B: The Great Migration

North American Monarch butterflies accomplish an astonishing annual migration. Monarchs in Eastern and Central North America (the majority of the North American Population) travel in the fall to the Sierra Madre Mountains of Mexico while Monarchs in Western North America overwinter on the Pacific Coast. The smaller Western population Monarchs roost in eucalyptus, Monterey pines, and Monterey cypresses in California. That leaves the majority of Monarchs navigating up to 2000 miles to a very specific location in and around Michoacan, Mexico. Here the butterflies gather in large clusters, covering groves of alpine fir trees in Central Mexico.

These overwintering sites in the oyamel forest provide an ideal microclimate for the butterflies. This relatively small area, cumulative about 300 square miles, was unknown to science until the 1970's. Here Monarchs cover the trees, clustering together to stay warm. Thousands of butterflies are capable of covering a single tree and the cumulative weight can cause breakage of the trees limbs.

The high concentration of these butterflies within these overwintering sites makes them especially vulnerable. Harsh weather conditions can wipe out a large percentage of the population in any given year. The more persistent threat however is the shrinking habitat of this already concentrated region due to humans. In this economically deprived area residents are financially pressured to log their land for profit. Sanctuaries have been established to preserve the overwintering grounds but there is little or no financial incentive for the local people to preserve the forest rather than log it.

Butterflies that are able to find a suitable overwintering site are in diapause so they are reproductively inactive. Here they wait out winter until warmer temperatures and longer days signal that the time is right to mate, and fly northward completing the reverse migration back to North America. Successive generations will continue the journey, each progressing more northerly than the other. Typically three to four generations will be required to reach the Northern US and Southern Canada. This migratory pattern, where one generation travels to the southern overwintering site and subsequent generations continue the northern migration back, means that the individual butterflies migrating south in fall are heading to a location that was last visited by their great, great grandparents!

The success of the multigenerational northern migration each spring also depends upon the availability of appropriate habitats. Urban sprawl, pesiticides, and the use of herbicide resistant crops have resulted in a loss of the butterfly's natural habitat in North America. Because milkweed and adult nectaring plants are vulnerable to herbicides the butterfly oases are dwindling. In addition, the population is at risk because the Monarchs and their larvae are susceptible to many commonly used pesticides and BT (a natural caterpillar control).

Various programs have been developed in order to counterbalance this loss of habitat. The basis of these programs is to create restorative areas, from small "butterfly gardens" to large preserves, which will provide appropriate habitat to support the Monarch's life cycle throughout North America.

Virtual Vignette C: Navigating the Trip

The success of the Monarch's migration depends upon their ability to determine two very important things; *when* to migrate and *which* direction to fly. Together, these two clock/compass functions allow the Monarch's to navigate their annual southward flight in the fall, followed by a northern springtime return.

Scientists discovered that the biology behind this butterfly's innate ability to migrate was as complex as the behavior itself. The first discovery, that the Monarchs have a biological clock in their brain, was exciting but somewhat predictable. Researchers better defined this process, concluding that only a specific type of light, UV light, was detected by sensors in the butterfly's eye and linked to their brain's circadian clock essentially telling the butterfly "its fall….time to start flying".

That explained part of process, addressing the "when" to migrate part of the equation, but failed to explain how the butterfly knew where "south" was. Where was this compass located? Scientists assumed that it would also be found in the brain. A logical, but incorrect hypothesis.

Further investigations uncovered a huge surprise, that the antennae played a major role in the navigation process. They essentially act as a biological GPS, integrating the time of day with the positional change of the sun to continually orient themselves. This "time-compensated sun compass" was determined to be critical in establishing directional cues related to flight migratory flight patterns.

Scientists found that coating a butterfly's antennae with an opaque, black paint caused it to lose its sense of direction. Essentially, their "compass" was no longer able to

find north or south and therefore it was ineffective. Butterflies that had their antennae coated with clear paint were used as a control and as expected the clear paint did not alter navigational abilities.

VIBE 3: Grasshoppers on Steroids

Virtual Vignette A: The Great Locust Mystery

The Rocky Mountain locust, *Melanoplus spretus*, once found in abundance in the US is now extinct. This species was one of the twelve migratory grasshopper species found in North America, and the only locust native to the region.

Between 1873 and 1877, swarms of these locusts caused millions of dollars in crop damage to the mid-west. Huge numbers of these locusts traveled throughout Nebraska, Colorado, and surrounding regions indiscriminately chowing down an anything green they could find as well as plenty else. In Kansas, settlers claimed that swarms of hungry insects devoured saddles, gnawed on ax handles, and even ate laundry as it was drying on the line. More outrageous claims circulated stating that locust swarms chewed the wool right off sheep as they grazed!

The largest swarm in history was documented in 1874. It flew over Nebraska for 10 days starting on July 20. A local physician telegraphed points east and west to determine the outer edges of the cloud passing overhead. Based on the swarm's width and its rate of movement, he calculated that it covered an area of 198,000 square miles (twice the size of Colorado) and contained at least 12.5 trillion insects with a total weight of 27.5 million tons. The doctor, stunned by his own calculations, wrote that the sight was “utterly incredible”. To

this day the swarm event is remembered by it record breaking status in the Guinness book of records as the “Greatest Concentration of Animals” ever documented.

Given the dire situation it is not surprising that the federal government declared the Rocky Mountain locust the "most serious impediment to the settlement of the West". Shockingly, the pest actually brought trains to a halt: as the tracks became too slick for passage with squished bug bodies.

A farmer in Colorado Springs described what it was like to be caught in the swarm stating "...They circle in myriads about you, beating against everything animate or inanimate, driving into open doors and windows, heaping about your feet ... their jaws constantly at work."

This tremendous force of nature seemed unbeatable. Then suddenly, in the space of about 30 years, the species disappeared. Shockingly the Rocky Mountain Locust became the first endemic pest ever driven to extinction.

"I've called this the greatest ecological mystery of all time," said Jeffrey Lockwood, a University of Wyoming entomologist. "Extinction's like a murder. So we've got this 100-year-old murder. And there are no witnesses left."

For years, entomologists assumed that such a prolific species could have been wiped out only by some powerful environmental force. Dr. Lockwood argues that this wasn’t that case, and now a new theory has taken wing, one that regards the locust's extinction as something akin to a freak farm accident. According to Lockwood, the Achilles heel of the Rocky Mountain locust can be traced to its pattern of swarming for a period, then retreating to fertile alluvial soils where it could breed successfully. It was at that moment, when the

population had collapsed back into its indigenous range, that pioneer farmers began digging up that same ground to plant crops. Stories of plows bringing up thousands of locust eggs at this time seem to bolster his claim. "Western agriculture and the Rocky Mountain locust collided in time and space," Lockwood said. "Through one of the most spectacular coincidences in agricultural history, early agriculture basically destroyed the permanent breeding ground of the locusts."

The extinction of this species has left North America as the only continent in the world without migratory locusts. Although the frozen bodies of dead locusts have been found in the ice of western glaciers where they were preserved for decades, the last living specimen was found back in 1902. Because no one expected such a ubiquitous creature to become extinct, very few samples were ever collected leaving fewer than 300 pinned specimens left today.

While no one may have mourned the extinction of the Rocky Mountain locust, the loss of the numerous insects had ecological consequences. In the web of life, there are always strings attached! One string attached to the Rocky Mountain locust was a migratory bird called the Eskimo Curlew. Often considered a shore bird, the Eskimo Curlew completed a tremendous annual migration extending over 600 miles. Its summer breeding grounds were in the far northern reaches of the Arctic tundra. In late summer, immense flocks migrated east along the northern shore of Canada before heading south over the Atlantic Ocean toward their winter resting grounds near the southern tip of South America. In early spring, they headed back north following a more westerly track over Mexico and the American mid-west.

It was during the spring migration, when the Curlews passed through the American Great Plains that they fed on the egg pods and nymphs of the Rocky Mountain locust. This rich source of fat and protein was essential to the successful migration of the Curlews since it was available at a critical point in the bird's journey.

Unfortunately, this species fate appears to have followed that of the locust, its food source. The Curlews, a once common sight along the New England coastline in the 1800's disappeared from the US by the mid nineteen hundreds. A population once as large as 2-3 million birds was severely impacted by the locust's extinction. In addition to the loss of one of their main food sources, the Curlews faced a significant loss of available habitat as the tall-grass prairie was cultivated into farmland.

These factors, coupled with unregulated hunting of the birds during their peak, resulted in their change of status from a common sight to a rarity throughout the early 1900's. The last reliable sighting of an Eskimo Curlew in the US occurred in Galveston Texas in 1962. The lack of reliable records of the species anywhere in the last several years has led scientists to believe that the Curlew may have followed the locust into extinction.

Virtual Vignette B: Don't Crowd Me

Although scientists determined that the physical stimulation to the locust's hind legs triggered their Jekyll and Hyde like transformation from a solitary to a gregarious species, the precise physiological triggers responsible for this dramatic physical and behaviorial change hadn't been identified until recently.

The key to prompting this cascade of events has now been identified as serotonin-a brain chemical found in the central nervous system and gastrointestinal tract of animals.

Serotonin is a well known neurotransmitter found in humans where it has profound influences on human behavior through its modulation of anger, aggression, body temperature, mood, sleep, sexuality, appetite, and metabolism. In fact many antidepressant drugs work by keeping the serotonin levels high in humans.

It appears that high levels of serotonin have a different impact on locusts, one that directs the locusts to abandon their solitary existence and aggregate and transform into a dense swarm. Researchers were able to identify this process by manipulating serotonin levels in the insects. They were able to keep locusts in their solitary form with low serotonin levels while triggering locusts to transform into their gregarious form in response to high serotonin levels. Further testing determined that it was the initial serotonin surge, rather than continually monitored levels that were critical in prompting the domino of effects that resulted in this dramatic change in the population.

APPENDIX B

Technology Survey

Category 1 Questions

1A: Which of the following selections best describes the **COMPUTER** that you normally use?

- A desktop PC that I own
- A desktop mac that I own
- A laptop PC that I own
- A laptop mac that I own
- Both a desktop and laptop PC
- Both a desktop and laptop mac
- A desktop PC that I don't own (a friends, from the library, etc.)
- A desktop mac that I don't own (a friends, from the library, etc.)
- Other

1B: Indicate your normal COMPUTER (desktop or laptop) USAGE by selecting the most appropriate response to complete the sentence below.

I typically use a COMPUTER (desktop or laptop) _____.

- At least once a day
- At least once a week but less than once a day
- At least once a month but less than once a week
- Very limited use – a few times a year but less than once a month
- No use

1C1: Respond by "yes" or "no" to indicate if you use your computer to:

COMPLETE COURSE WORK

- Yes
- No

1C2: Respond by "yes" or "no" to indicate if you use your computer to:

SEND/RECEIVE E-MAIL

- Yes
- No

1C3: Respond by "yes" or "no" to indicate if you use your computer to:

RESEARCH THE INTERNET

- Yes
- No

1C4: Respond by "yes" or "no" to indicate if you use your computer to:

USE A SOCIAL NETWORK SITE (FACEBOOK, ETC.)

- Yes
- No

1C5: Respond by "yes" or "no" to indicate if you use your computer to:

VIEW VIDEOS (You tube, movie trailers, full episodes of TV shows, etc.)

- Yes
- No

1C6: Respond by "yes" or "no" to indicate if you use your computer to:

PLAY SINGLE USER GAMES

- Yes
- No

1C7: Respond by "yes" or "no" to indicate if you use your computer to:

PLAY MULTI-USER GAMES (WORLD OF WARCRAFT, ETC.)

- Yes
- No

1C8: Respond by "yes" or "no" to indicate if you use your computer to:

PARTICIPATE IN A VIRTUAL ENVIRONMENT (such as SecondLife, Farmville, Activeworlds, etc.)

- Yes
- No

1C9: Respond by "yes" or "no" to indicate if you use your computer to:

DOWNLOAD/PLAY MUSIC

- Yes
- No

1D: How many hours a WEEK would you estimate you spend on the COMPUTER?

- 40 hours
- 30-40 hours
- 20-30 hours
- 10-20 hours
- <10 hours

Category 2 Questions

2A: Do you regularly use a **CELL PHONE**? If so, what type of phone?

- I use a cell phone but it is NOT internet enabled
- I use a blackberry
- I use a droid phone
- I use an i phone
- I use a different type of smart phone (internet enabled) than those mentioned
- I don't use a cell phone

2B: Indicate your normal CELL PHONE usage by selecting the most appropriate response to complete the sentence below.

I typically use a CELL PHONE _____.

- At least once a day
- At least once a week but less than once a day
- At least once a month but less than once a week
- Very limited use – a few times a year but less than once a month
- I don't use a cell phone

2C1: Respond by "yes" or "no" to indicate if you use your cell phone to:

MAKE PHONE CALLS

- Yes
- No
- I don't use a cell phone

2C2: Respond by "yes" or "no" to indicate if you use your cell phone to:

SEND/RECEIVE TEXT MESSAGES

- Yes
- No
- I don't use a cell phone

2C3: Respond by "yes" or "no" to indicate if you use your cell phone to:

SEND/RECEIVE E-MAIL

- Yes
- No
- I don't use a cell phone

2C4: Respond by "yes" or "no" to indicate if you use your cell phone to:

ACCESS THE INTERNET

- Yes
- No
- I don't use a cell phone

2C5: Respond by "yes" or "no" to indicate if you use your cell phone to:

DOWNLOAD/PLAY MUSIC

- Yes
- No
- I don't use a cell phone

2C6: Respond by "yes" or "no" to indicate if you use your cell phone to:

PLAY GAMES

- Yes
- No
- I don't use a cell phone

2D: How many hours a WEEK would you estimate you spend on a CELL PHONE?

- 40 hours
- 30-40 hours
- 20-30 hours
- 10-20 hours
- <10 hours

Category 3 Questions

3A1: Respond by "yes" or "no" to indicate if you use the following game device.

Wii

- Yes
- No
- I don't use any gaming devices (combined)

3A2: Respond by "yes" or "no" to indicate if you use the following game device.

DS system

- Yes
- No
- I don't use any gaming devices

3A3: Respond by "yes" or "no" to indicate if you use the following game device.

X box

- Yes
- No
- I don't use any gaming devices

3A4: Respond by "yes" or "no" to indicate if you use the following game device.

PLAYSTATION

- Yes
- No
- I don't use any gaming devices

3A5: Respond by "yes" or "no" to indicate if you use the following game device.

COMPUTER AS A GAMING DEVICE

- Yes (7); 14%
- No
- I don't use any gaming devices

3A6: Respond by "yes" or "no" to indicate if you use the following game device.

CELL PHONE AS A GAME DEVICE

- Yes
- No
- I don't use any gaming devices

3A7: Do you use "other" gaming devices NOT specified in this survey?

- Yes
- No

3B: Indicate your normal GAMING USAGE by selecting the most appropriate response to complete the sentence below.

I typically play games on some sort of **GAMING DEVICE** _____.

- At least once a day
- At least once a week but less than once a day
- At least once a month but less than once a week
- Very limited use – a few times a year but less than once a month
- No use

3C: How many hours a WEEK would you estimate you spend using a GAMING DEVICE?

- 40 hours
- 30-40 hours
- 20-30 hours
- 10-20 hours
- <10 hours

Category 4 Questions

4A: Indicate your self-perceived INTEREST in using technology.

- Very High level of interest
- High level of interest
- Moderate level of interest
- Low level of interest
- No interest

4B: Indicate which statement best describes your ATTITUDE towards the use of technology in higher education courses.

- I strongly agree in the incorporation of technology in higher education courses
- I agree in the incorporation of technology in higher education courses
- I am ambivalent on the use of technology in higher education courses
- I strongly disagree in the incorporation of technology use in higher education courses

APPENDIX C

Assignment Survey

Category 1 Questions

1A. Please indicate the level to which this assignment INTERESTED YOU.

- Very High level of interest
- High level of interest
- Moderate level of interest
- Low level of interest
- No interest

1B: Please indicate the level to which this assignment ENGAGED YOU.

- Very High level of engagement
- High level of engagement
- Moderate level of engagement
- Moderate level of engagement
- Low level of engagement

1C: Please indicate the level to which this assignment IMMERSED YOU IN THE ACTIVITY.

- Very High level of immersion
- High level of immersion
- Moderate level of immersion
- Low level of immersion
- No immersion

1D: Please indicate the level to which this assignment SUPPORTED YOUR LEARNING.

- Very High level of support
- High level of support
- Moderate level of support
- Low level of support
- No support

1E: Please indicate the level to which this assignment EXTENDED YOUR KNOWLEDGE.

- At a Very High Level
- At a High Level
- At a Moderate Level
- At a Low Level
- At No Level

1F: To what extent has this assignment CHANGED THE WAY YOU ORIGINALLY VIEWED THE TOPIC COVERED.

- At a Very High Level
- At a High Level
- At a Moderate Level
- At a Low Level
- At No Level

Category 2 Questions

2A: To what extent has this assignment emphasized the mental activity listed below?

Memorizing *facts, ideas or methods from your course and readings so you can repeat them in almost the same form*

- At a Very High Extent
- At a High Extent
- At a Moderate Extent
- At a Low Extent

2B: To what extent has this assignment emphasized the mental activity listed below?

Analyzing *the basic elements of an idea, experience or theory such as examining a specific case or situation in depth and considering its components*

- At a Very High Extent
- At a High Extent
- At a Moderate Extent
- At a Low Extent
- At No Extent

2C: To what extent has this assignment emphasized the mental activity listed below?

Synthesizing and organizing ideas, information, or experiences into new, more complicated interpretations and relationships

- At a Very High Extent
- At a High Extent
- At a Moderate Extent
- At a Low Extent
- At No Extent

2D: To what extent has this assignment emphasized the mental activity listed below?

Evaluating *the value of information, arguments, or methods such as examining how others gathered and interpreted data and assessing and accuracy of their conclusions*

- At a Very High Extent
- At a High Extent
- At a Moderate Extent
- At a Low Extent
- At No Extent

2E: To what extent has this assignment emphasized the mental activity listed below?

Applying *theories and/or concepts to practical problems or in new situations*

- At a Very High Extent
- At a High Extent
- At a Moderate Extent
- At a Low Extent
- At No Extent

Category 3 Questions

3A: How would you rank your overall satisfaction with this assignment?

- Extremely satisfied
- Highly satisfied
- Moderately satisfied
- Low level of satisfaction
- No satisfaction

3B: How would you rank the overall learning value of this assignment?

- Very High Value
- High Value
- Moderate Value
- Low Value
- No Value

3C: Please indicate how strongly you agree with the following statement.

I believe it is worthwhile to continue to develop these types of assignments.

- Very Strongly Agree
- Strongly Agree
- Agree
- Strongly Disagree
- Very Strongly Disagree

3D: Please indicate how strongly you agree with the following statement.

I would like to see more of these types of assignments integrated into my courses at NCSU.

- Very Strongly Agree
- Strongly Agree
- Agree
- Strongly Disagree
- Very Strongly Disagree

APPENDIX D

Informed Consent

What are some general things you should know about research studies?
You are being asked to take part in a research study. Your participation in this study is voluntary. You have the right to be a part of this study, to choose not to participate or to stop participating at any time without penalty. The purpose of research studies is to gain a better understanding of the student's attitudes on the learning value associated with virtual assignments through semi-structured interviews. You will be awarded a $10 gift card for being in a study as compensation for your time.

Research studies also may pose risks to those that participate. In this consent form you will find specific details about the research in which you are being asked to participate. If you do not understand something in this form it is your right to ask the researcher for clarification or more information. A copy of this consent form will be provided to you. If at any time you have questions about your participation, do not hesitate to contact the researcher(s) named above.

What is the purpose of this study?
This exploratory study is designed to provide information on student attitudes on the learning value associated with virtual assignments. The purpose of this study is to better inform instructor/online course designers on what student preferences are and the value they place on existing activities within this course.

What will happen if you take part in the study?
No additional work will be required as a result of your participation in this study! You will be asked to participate in a short semi-structured interview on campus. If you agree to participate in this study then your unidentified responses may be used as part of a scholarly article related to the virtual format. After the entire course is complete and all of your individual data is compiled, a code will be assigned to you and will replace any identifying characteristics associated with your data (Unity ID, name, etc. will be removed).

Risks and Benefits
No specific risks or benefits have been identified with your participation in this study, although this study may help to increase the effectiveness of future courses.

Confidentiality
The information in the study records will be kept confidential to the full extent allowed by law. Data will be stored securely in locked offices and secure computers. As stated above, after all of your course work is compiled identifiers will be removed and replaced with a code number. No reference will be made in oral or written reports which could link you to the study.

What if you have questions about this study?
If you have questions at any time about the study or the procedures, you may contact the researcher:

Marta Klesath
Marta_klesath@ncsu.edu
Department of Biology
114 David Clark Lab
(919) 513-3062

What if you have questions about your rights as a research participant?

If you feel you have not been treated according to the descriptions in this form, or your rights as a participant in research have been violated during the course of this project, you may contact Deb Paxton, Regulatory Compliance Administrator, Box 7514, NCSU Campus (919/515-4514).

Consent To Participate in Interviews:

"I have read and understand the above information. I have received a copy of this form. I agree to participate in this study with the understanding that I may choose not to participate or to stop participating at any time without penalty or loss of benefits to which I am otherwise entitled. I understand that participation in this study is not a course requirement, and my participation in this study, or lack thereof will not affect my grades or standing in this course."

SIGN HERE TO PROVIDE CONSENT TO USE YOUR DATA IN THIS EDUCATIONAL RESEARCH STUDY.

Please note that this study is only available to students age 18 or over.

Name:_____

Consent To Videotaping of Interviews:

"I have read and understand the above information. I have received a copy of this form. I agree to have my interview videotaped for transcript purposed. No identifying information will be included on the transcripts. I participate in this study with the understanding that I may choose not to participate or to stop participating at any time without penalty or loss of benefits to which I am otherwise entitled. I understand that participation in this study is not a course requirement, and my participation in this study, or lack thereof will not affect my grades or standing in this course."

SIGN HERE TO PROVIDE CONSENT TO USE YOUR DATA IN THIS EDUCATIONAL RESEARCH STUDY.

Please note that this study is only available to students age 18 or over.

Name:_____

SIGN HERE TO ACKNOWLEDGE THAT YOU WERE PROVIDED WITH A GIFTCARD IN THE AMOUNT OF $___ AS COMPENSATION FOR YOUR TIME.

Name:_____

APPENDIX E

Interview Protocol

First Tier Questions: Background Information

- Can you briefly describe your previous experiences in taking online courses and/or using online supplements for other NCSU courses?

- What computer did you use to access this information throughout the semester? Were you able to use this same computer to access the virtual assignments?

- How would you describe your overall technology skills? Explain

- Could you describe your previous experiences using gaming devices? Explain

Second Tier Questions: Attitudes towards the VIBE format:

A computer will be set up with access to the virtual assignments in case students need to review information and/or require clarification on assignments.

- How many of the three virtual assignments did you attempt to access and how many were you able to complete?
    - If technical issues are discussed probing will occur to determine the exact cause and extent of the technical difficulty encountered

- Each virtual assignment contained three components; a virtual scene, an embedded informative video, and an embedded interactive flash file.
    - What did you think of this overall combined format for the virtual assignments?
    - What do you think about each of these three separate components?
        - Virtual World, Video, Interactive Flash File

- Each of these assignments was developed using a series of articles on the topic. Do you think you would have preferred to read this series of articles in lieu of completing this virtual assignment?
    - "No"
        - Why do you think the virtual format is preferable?
    - "Yes"
        - What do you think the advantage of reading the articles would have been for you?

Third Tier Questions: Perceived educational value of the VIBE format:
Cards will be provided for the students that provide definitions of terms as previously presented in the completed surveys.

- What do you think the purpose of these assignments was?
    - Do you think that these assignments fulfilled that purpose?
    - Overall, do you think you learned a lot from these assignments? Please explain.

- On the surveys you were asked several questions concerning your perceived levels of engagement and immersion. How would you describe engagement and immersion?
    - How did the overall engagement/immersion of the virtual assignments compare to that of the other types of assignments provided in this course?

- There are different types of learning. You were asked about some of these particular types in the survey (show students the classifications as listed on the survey as a reminder). Which types of learning do you think were supported by the virtual assignment?
    - Probing to occur on each positive response-"how"

Fourth Tier Questions: Comprehensive impression of the usability of the VIBE format:

- If another student asked you what you thought about these virtual assignments what would you tell them?

- Do you think that the use of the technology for these assignments helped or hindered your learning of the target content? Explain

- **Would you like to see more of these types of assignments integrated into my courses at NCSU?**
    - **"No"**
        - **Specifically why do you believe this?**
        - **Do you think there are any changes that could be made to this format that would change your opinion?**
    - **"Yes"**
        - **Specifically why do you believe this?**
        - **Does any one reason stand out to you that makes these assignments of value to you?**
        - **Do you think there are any changes that could be made to this format that would make it more effective?**

APPENDIX F

Interview Coding Rubric

Coding responses which may be used for any category:
x. Indifferent or unique response, comments don't align with any of the available options
z. No answer provided or question omitted during the interview

First Tier Questions: Background Information

1.10

- Can you briefly describe your previous experiences in taking online courses and/or using online supplements for other NCSU courses.

CONCLUSION:	COMMENTS TO SUPPORT:
a. No Experience	
b. Limited Experience-No Online Courses/Supplemental Course Use Only	
c. Some Experience-Taken 1-2 Courses Online	
d. Experienced-Taken more than 2 courses online	
e. Other-Courses at other institutions	

ADDITIONAL COMMENTS OF INTEREST:

1.20

- What computer did you use to access this information throughout the semester?

CONCLUSION:	COMMENTS TO SUPPORT:
a. PC Desktop-owned	
b. Mac Desktop-owned	
c. PC Laptop-owned	
d. Mac Laptop-owned	
e. Other-Public Computer/Borrowed/PC/Mac?	

ADDITIONAL COMMENTS OF INTEREST:

1.30

- Were you able to use this same computer to access the virtual assignments?

CONCLUSION:	COMMENTS TO SUPPORT:
a. Yes	
b. No	
c. Other-Sometimes	

ADDITIONAL COMMENTS OF INTEREST:

1.40

- How would you describe your overall technology skills? Explain

CONCLUSION:	COMMENTS TO SUPPORT:
a. Low	
b. Average	
c. High	
d. Other-Explanation ambiguous or varies	

ADDITIONAL COMMENTS OF INTEREST: SPECIFICALLY HOW DID STUDENT DEFINE THIS?

1.50

- Could you describe your previous experiences using gaming devices? Explain

CONCLUSION:	COMMENTS TO SUPPORT:
a. No Experience	
b. Limited Experience-Occasional Use	
c. Some Experience-Moderate Use	
d. Experienced-Consistent Use	
e. Other-Changes in Pattern, etc.	

ADDITIONAL COMMENTS OF INTEREST: SPECIFICALLY TYPE OF GAMING DEVICES, ETC.

Second Tier Questions: Attitudes towards the VIBE format:
A computer will be set up with access to the virtual assignments in case students need to review information and/or require clarification on assignments.

2.10

- How many of the three virtual assignments did you attempt to access and how many were you able to complete?

CONCLUSION	SUPPORTIVE COMMENTS
a. None	
b. One	
c. Two	
d. All Three	
e. Other-Partial completion, etc.	

ADDITIONAL COMMENTS OF INTEREST:

2.20

- If technical issues are discussed probing will occur to determine the exact cause and extent of the technical difficulty encountered

CONCLUSION	SUPPORTIVE COMMENTS
a. User Error Starting (forgot password, etc.)	
b. Technology Error (couldn't load)	
c. User Error Completing (couldn't find world, couldn't figure out what to do in world, etc.)	
d. Other	

ADDITIONAL COMMENTS OF INTEREST: SPECIFICALLY ADDRESS INSTRUCTIONAL ISSUES THAT MAY HAVE IMPACTED STUDENT SUCCCESS:

2.30

- Each virtual assignment contained three components; a virtual scene, an embedded informative video, and an embedded interactive flash file.
    - What did you think of this overall combined format for the virtual assignments?

CONCLUSION	SUPPORTIVE COMMENTS
a. Very Positive-Liked Format a Lot	
b. Somewhat Positive	
c. Ambiguous	
d. Somewhat Negative	
e. Very Negative	
f. Mixed Response	

ADDITIONAL COMMENTS OF INTEREST:

2.40

- What do you think about each of these three separate components?
  - Virtual World, Video, Interactive Flash File

VIRTUAL WORLD (SEPARATE)

CONCLUSION	SUPPORTIVE COMMENTS
a. Very Positive-Liked Format a Lot	
b. Somewhat Positive	
c. Ambiguous	
d. Somewhat Negative	
e. Very Negative	

ADDITIONAL COMMENTS OF INTEREST:

2.41

VIDEO (SEPARATE)

CONCLUSION	SUPPORTIVE COMMENTS
a. Very Positive-Liked Format a Lot	
b. Somewhat Positive	
c. Ambiguous	
d. Somewhat Negative	
e. Very Negative	

ADDITIONAL COMMENTS OF INTEREST:

2.42

FLASH FILES (SEPARATE)

CONCLUSION	SUPPORTIVE COMMENTS
a. Very Positive-Liked Format a Lot	
b. Somewhat Positive	
c. Ambiguous	
d. Somewhat Negative	
e. Very Negative	

ADDITIONAL COMMENTS OF INTEREST:

2.43

- Each of these assignments was developed using a series of articles on the topic. Do you think you would have preferred to read this series of articles in lieu of completing this virtual assignment?
    - "No"
        - Why do you think the virtual format is preferable?
    - "Yes"
        - What do you think the advantage of reading the articles would have been for you?

CONCLUSION	SUPPORTIVE COMMENTS
a. Yes	
b. No	
c. Unsure	

ADDITIONAL COMMENTS OF INTEREST: SPECIFICALLY ID ADVANTAGES/DISADVANTAGES AS COMMENTED UPON.

Third Tier Questions: Perceived educational value of the VIBE format:
Cards will be provided for the students that provide definitions of terms as previously presented in the completed surveys.

3.10

- What do you think the purpose of these assignments was?
    - Do you think that these assignments fulfilled that purpose?

CONCLUSION *Did they identify the purpose as relating to ecological or economical importance of species?*	SUPPORTIVE COMMENTS
a. Yes	
b. No	
c. Unclear	

ADDITIONAL COMMENTS OF INTEREST:

3.11

CONCLUSION *How well did assignment fulfill student's identified purpose?*	SUPPORTIVE COMMENTS
a. Very Well	
b. Well	
c. Ambiguous	
d. Not Very Well	
e. Other: Unclear	

ADDITIONAL COMMENTS OF INTEREST:

3.20

- Overall, do you think you learned a lot from these assignments? Please explain.

CONCLUSION	SUPPORTIVE COMMENTS
a. Yes	
b. No	
c. Unclear	

ADDITIONAL COMMENTS OF INTEREST: PROVIDE ADDITIONAL COMMENTS ON EXPLANATION AND HOW THEY DEFINED LEARNING

3.30

- On the surveys you were asked several questions concerning your perceived levels of engagement and immersion. How would you describe engagement and immersion?
  - How did the overall engagement/immersion of the virtual assignments compare to that of the other types of assignments provided in this course?

CONCLUSION	SUPPORTIVE COMMENTS
a. More Engaging	
b. Just as Engaging	
c. Not as Engaging	
d. Other: Unclear	

ADDITIONAL COMMENTS OF INTEREST:

3.40

- There are different types of learning. You were asked about some of these particular types in the survey (show students the classifications as listed on the survey as a reminder). Which types of learning do you think were supported by the virtual assignment?

    - Probing to occur on each positive response-"how"

Types	Virtual (V)	Other (O)	Supportive Comments
3.41 Applying	a. Yes b. No c. Maybe	a. Yes b. No c. Maybe	
3.42 Evaluating	a. Yes b. No c. Maybe	a. Yes b. No c. Maybe	
3.43 Synthesizing & Org.	a. Yes b. No c. Maybe	a. Yes b. No c. Maybe	
3.44 Analyzing	a. Yes b. No c. Maybe	a. Yes b. No c. Maybe	
3.45 Memorizing	a. Yes b. No c. Maybe	a. Yes b. No c. Maybe	

Fourth Tier Questions: Comprehensive impression of the usability of the VIBE format:

4.10

- If another student asked you what you thought about these virtual assignments what would you tell them?

CONCLUSION	SUPPORTIVE COMMENTS
a. Very Positive	
b. Somewhat Positive	
c. Ambiguous	
d. Somewhat Negative	
e. Very Negative	

ADDITIONAL COMMENTS OF INTEREST:

4.20

- Do you think that the use of the technology for these assignments helped or hindered your learning of the target content? Explain

CONCLUSION	SUPPORTIVE COMMENTS
a. Helped a lot	
b. Helped Some	
c. Ambiguous	
d. Somewhat Hindered	
e. Hindered Significantly	

ADDITIONAL COMMENTS OF INTEREST:

4.30

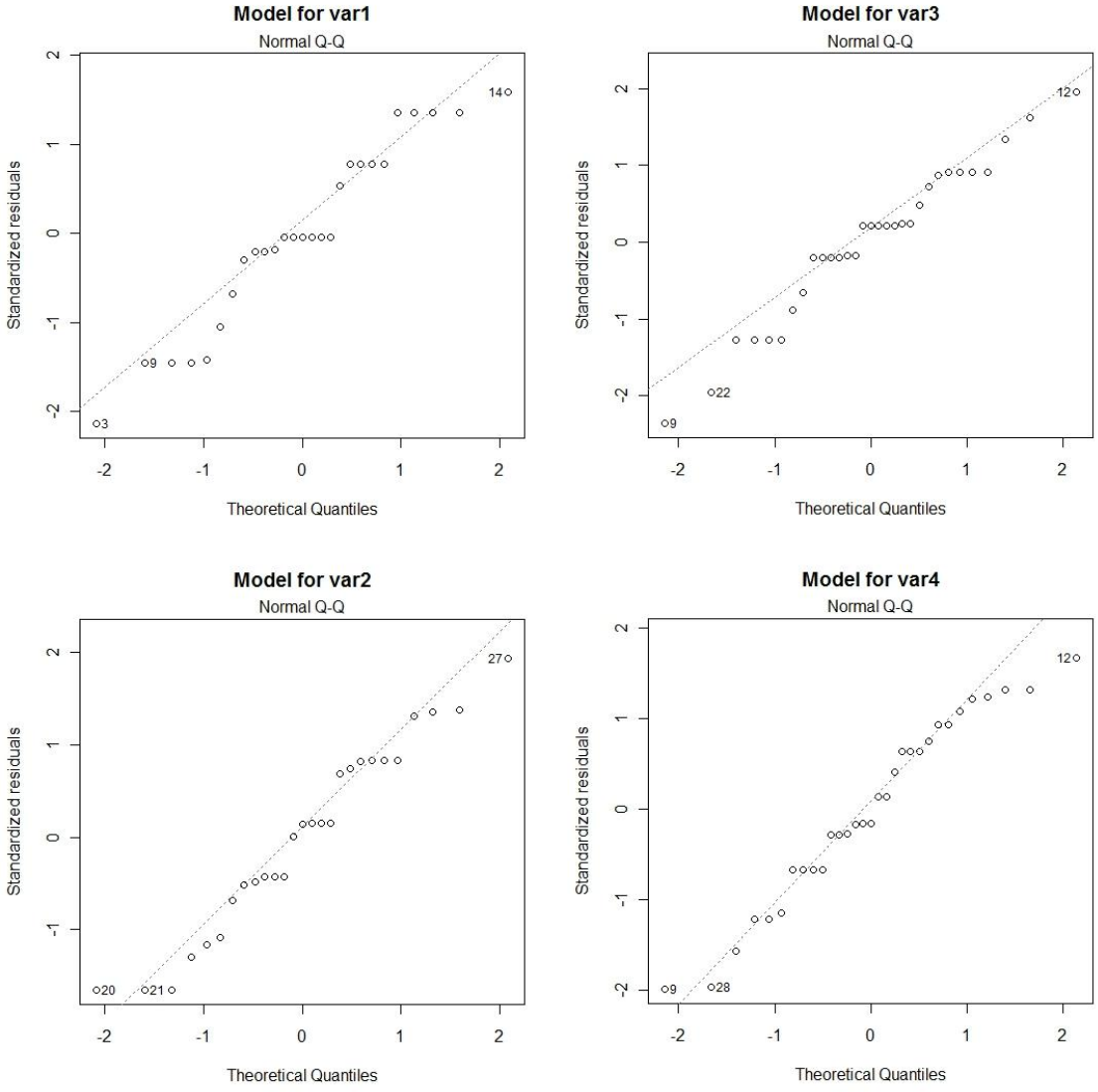
- **Would you like to see more of these types of assignments integrated into my courses at NCSU?**
    - **"No"**
        - **Specifically why do you believe this?**
        - **Do you think there are any changes that could be made to this format that would change your opinion?**
    - **"Yes"**
        - **Specifically why do you believe this?**
        - **Does any one reason stand out to you that makes these assignments of value to you?**
        - **Do you think there are any changes that could be made to this format that would make it more effective?**

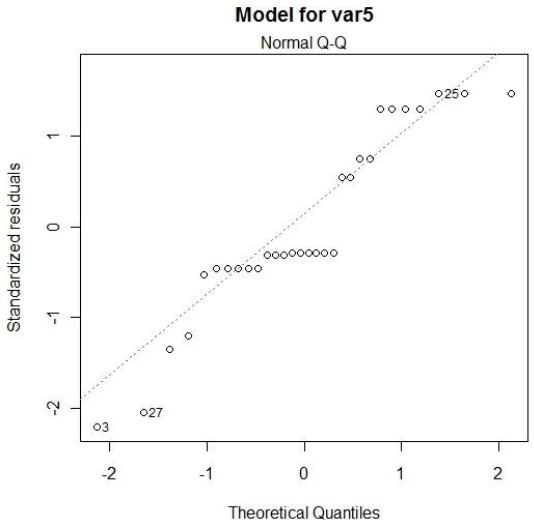
CONCLUSION	SUPPORTIVE COMMENTS
a. Yes	
b. Yes-if changes made as noted	
c. No	
d. Other-Unclear or Conflicting Information	

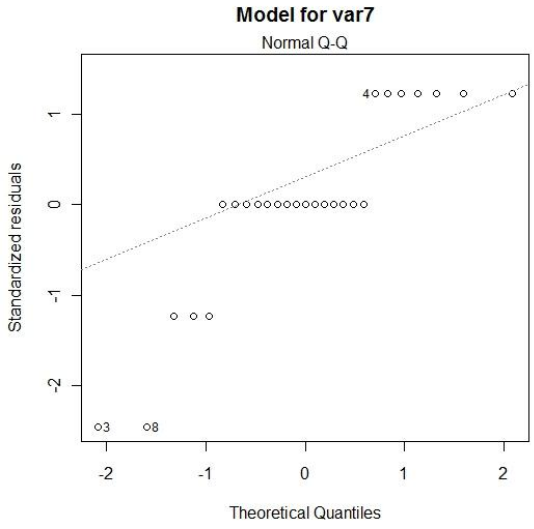
ADDITIONAL COMMENTS OF INTEREST: SPECIFICALLY HIGHLIGHT ENHANCEMENTS SUGGESTED

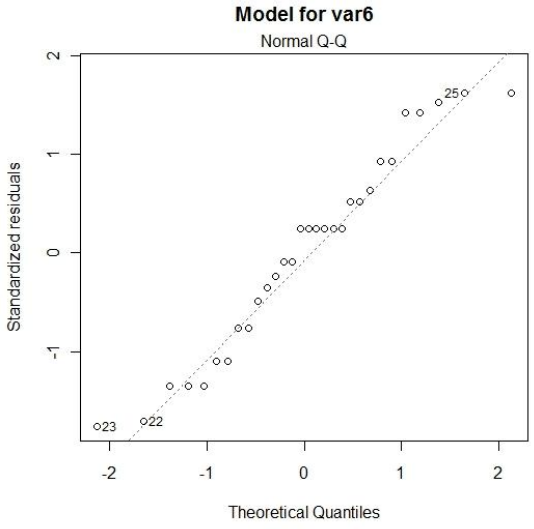
APPENDIX G

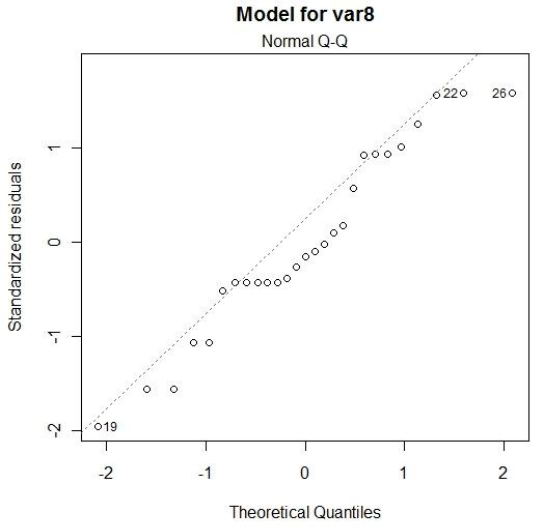
Q-Q Plots

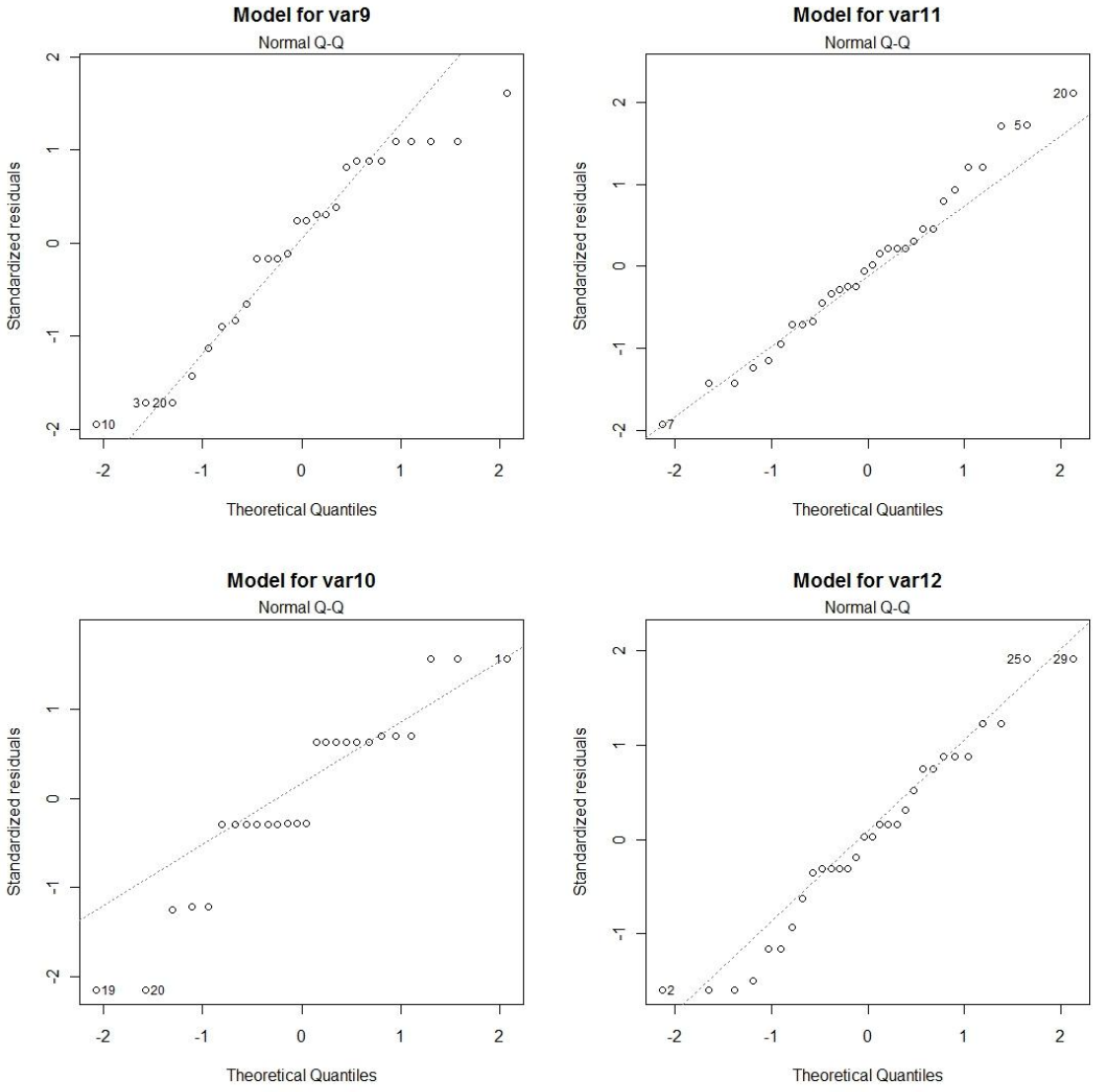


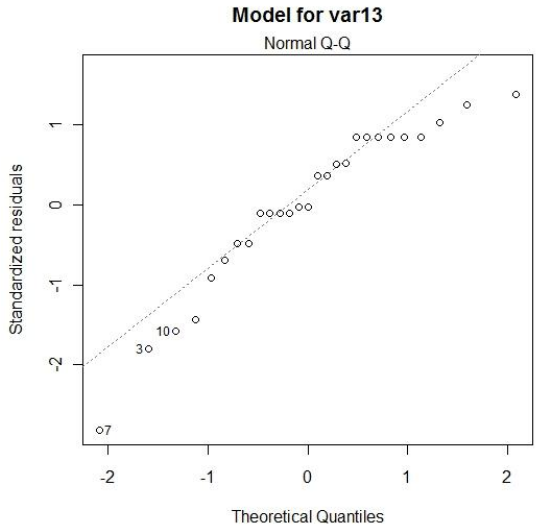

Model for var5
Normal Q-Q
Standardized residuals
Theoretical Quantiles
3
27
25

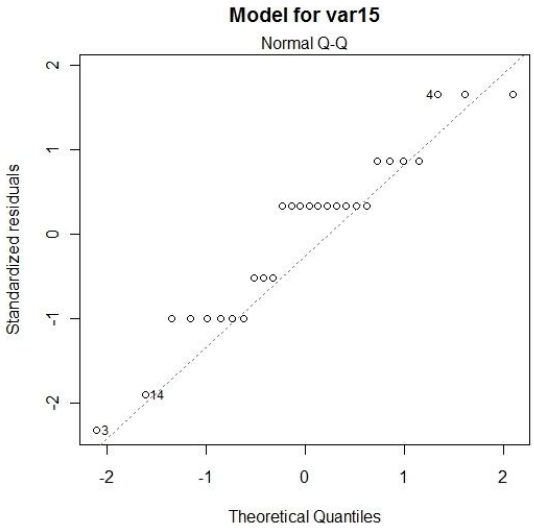

Model for var7
Normal Q-Q
Standardized residuals
Theoretical Quantiles
3
8
4

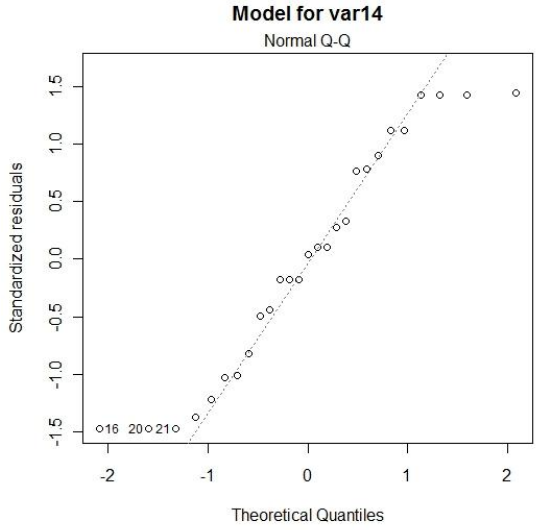

Model for var6
Normal Q-Q
Standardized residuals
Theoretical Quantiles
23
22
25

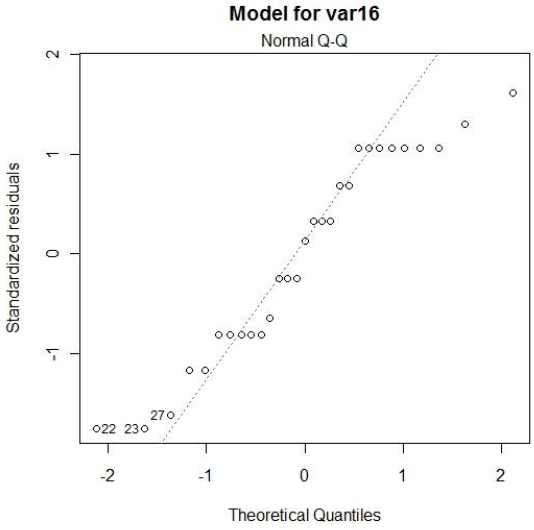

Model for var8
Normal Q-Q
Standardized residuals
Theoretical Quantiles
19
22
26

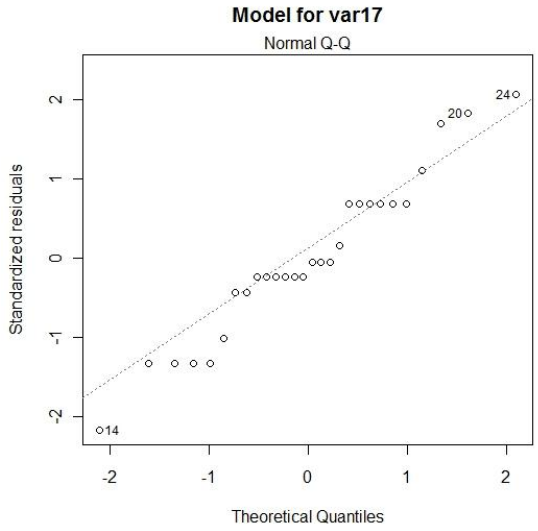

Model for var9
Normal Q-Q
Standardized residuals
Theoretical Quantiles
10
3
20
Model for var11
Normal Q-Q
Standardized residuals
Theoretical Quantiles
20
5
7
Model for var10
Normal Q-Q
Standardized residuals
Theoretical Quantiles
1
19
20
Model for var12
Normal Q-Q
Standardized residuals
Theoretical Quantiles
25
29
2

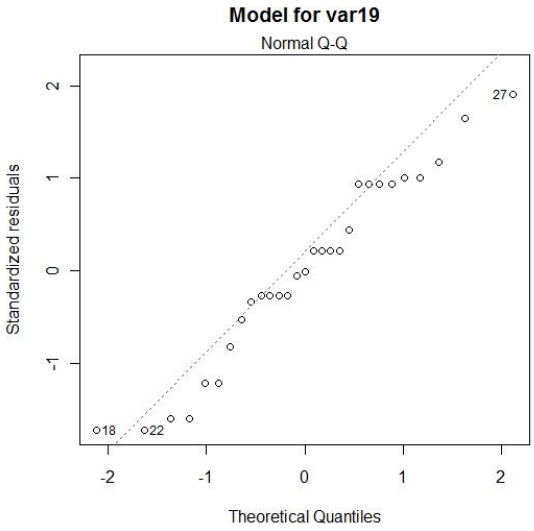

Model for var13
Normal Q-Q
Standardized residuals
Theoretical Quantiles
7
3
10

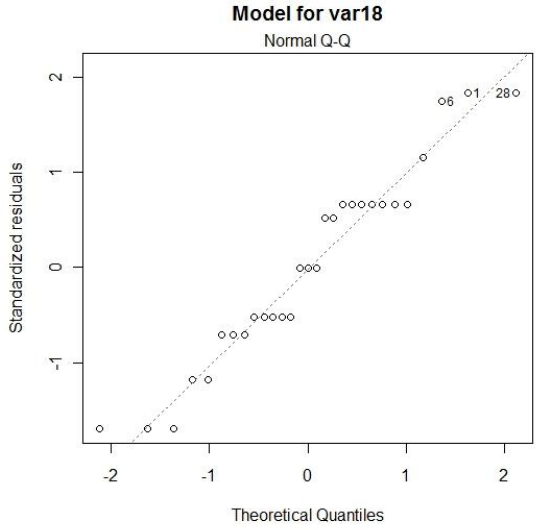

Model for var15
Normal Q-Q
Standardized residuals
Theoretical Quantiles
4
14
3

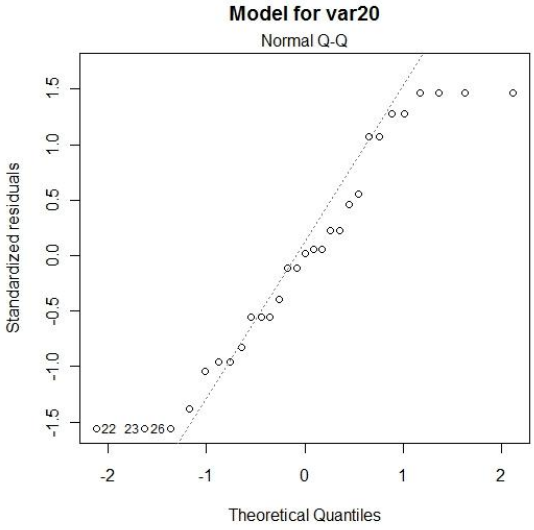

Model for var14
Normal Q-Q
Standardized residuals
Theoretical Quantiles
16
20
21

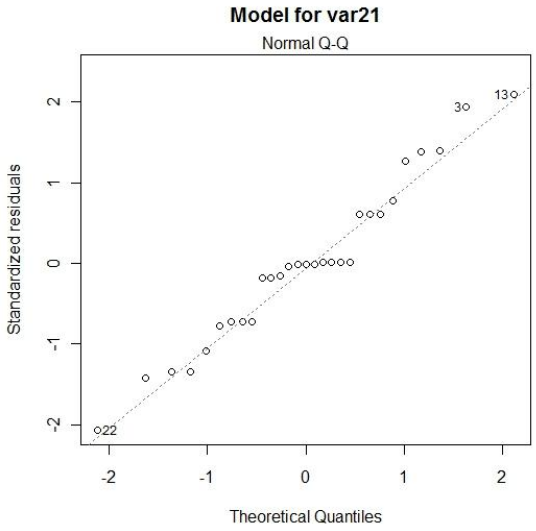

Model for var16
Normal Q-Q
Standardized residuals
Theoretical Quantiles
22
23
27

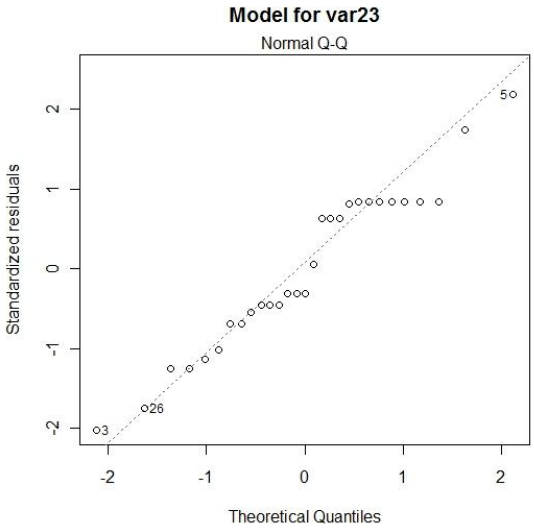

Model for var17
Normal Q-Q
Standardized residuals
Theoretical Quantiles
14
20
24

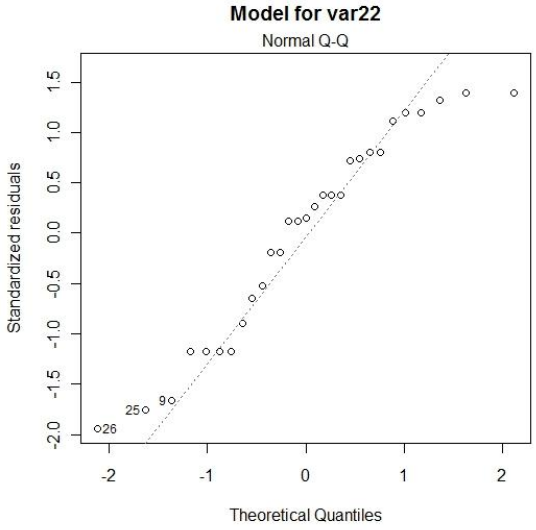

Model for var19
Normal Q-Q
Standardized residuals
Theoretical Quantiles
18
22
27

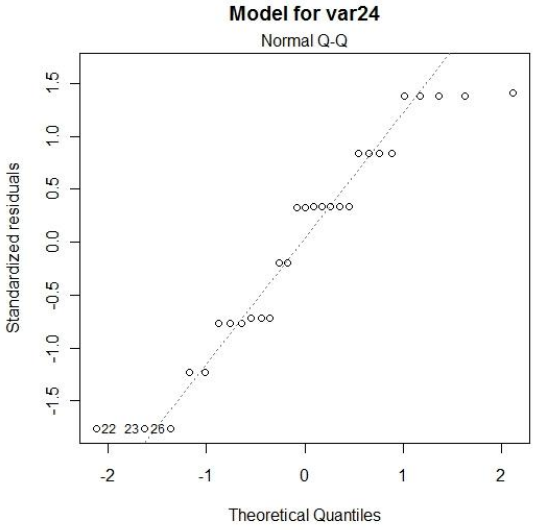

Model for var18
Normal Q-Q
Standardized residuals
Theoretical Quantiles
6
1
28

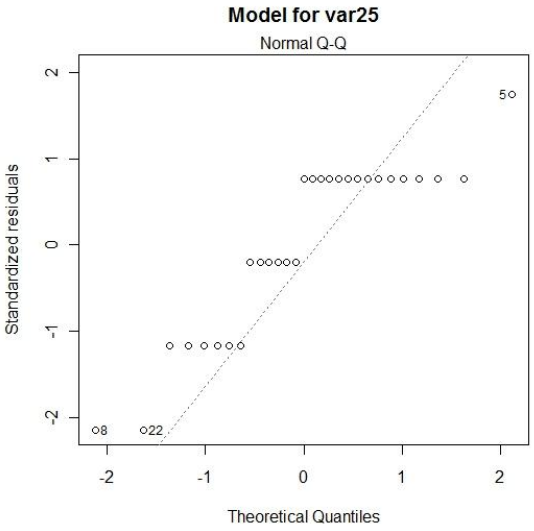

Model for var20
Normal Q-Q
Standardized residuals
Theoretical Quantiles
22
23
26

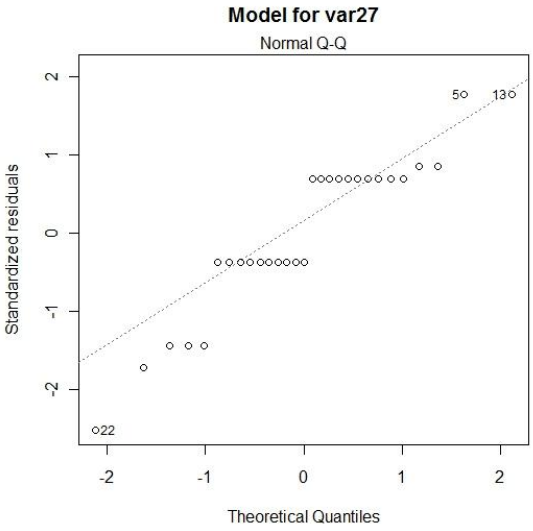

Model for var21
Normal Q-Q
Standardized residuals
Theoretical Quantiles
22
3
13


Model for var23
Normal Q-Q
Standardized residuals
Theoretical Quantiles
3
26
5


Model for var22
Normal Q-Q
Standardized residuals
Theoretical Quantiles
26
25
9


Model for var24
Normal Q-Q
Standardized residuals
Theoretical Quantiles
22
23
26


Model for var25
Normal Q-Q
Standardized residuals
Theoretical Quantiles
5
8
22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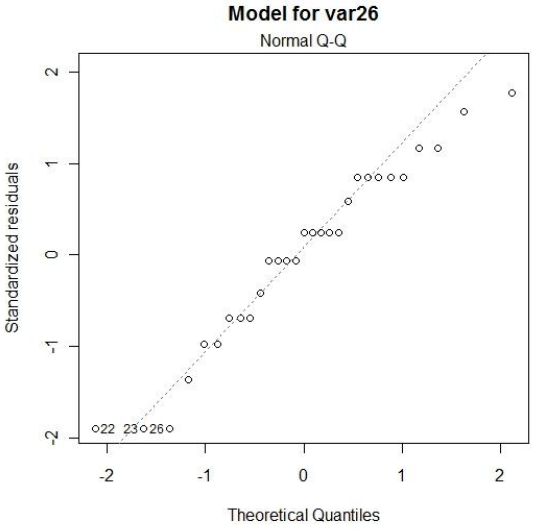
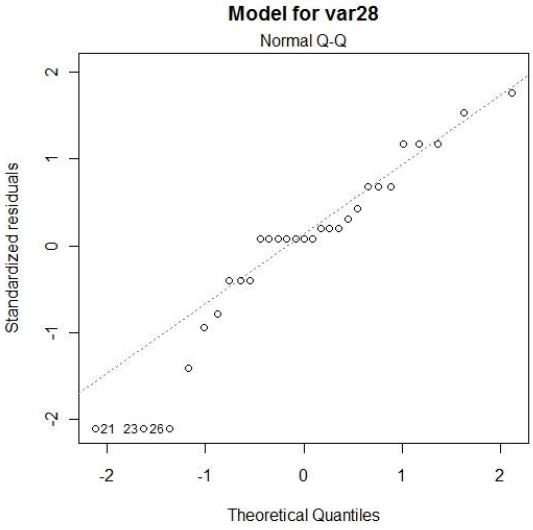
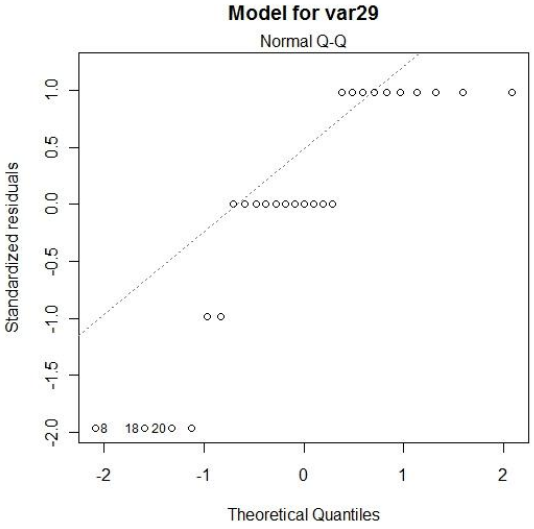
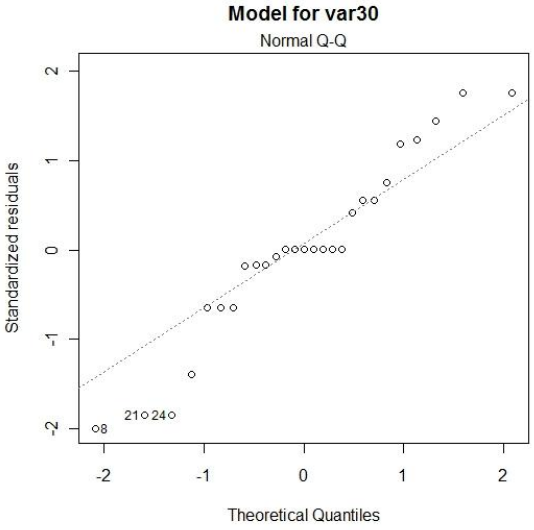
Standardized residuals
Theoretical Quantiles
5
13
22


Model for var26
Normal Q-Q
Standardized residuals
Theoretical Quantiles
22
23
26


Model for var28
Normal Q-Q
Standardized residuals
Theoretical Quantiles
21
23
26


Model for var29
Normal Q-Q
Standardized residuals
Theoretical Quantiles
8
18
20


Model for var30
Normal Q-Q
Standardized residuals
Theoretical Quantiles
8
21
24