EXPLORING THE POTENTIAL OF VIRTUAL OFFICE HOURS FOR ONLINE SCIENCE STUDENTS

by

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ABSTRACT

To improve instruction in an online science course, a weekly virtual office hour (VOH) pilot program was offered at an online high school. Lack of student interest did not allow full implementation of the pilot program, but a similar program was implemented over five weeks of instructional time with high school students enrolled in blended learning physical science and chemistry courses. Data collection included a pre-intervention survey and post-intervention survey, including Likert-like items. Other data sources were an analysis of the quality and quantity of asynchronous discussion posts, student and instructor interviews, a VOH journal, and VOH artifacts. In addition, to identify the reasons why students did not participate in the pilot program, a follow-up survey was sent to the initial group of students.

Findings showed that the virtual office hours successfully increased student engagement and were overall a well-received addition to the course. Conditions needed for successful implementation of future virtual office hour programs were described, including the need to consider technical and logistical concerns, and the need to consider the specific goals of the program. To support all the observed benefits of implementing virtual office hours, ideal conditions for success are a well-informed instructor, asynchronous discussion forums supporting the development of student questions.

INTRODUCTION AND BACKGROUND

For high school students, online courses provide a new way to learn when a traditional high school setting is not meeting their needs. However, many students who turn to online learning aren't having their needs fully met in these alternative settings, either. Those of us who work with online students need to do a better job of helping them achieve the best outcome possible for the time, expense and effort they put into their classes. With this project, I worked with two very different groups of students to explore the potential of virtual office hours (VOH) as an addition to an online course.

I am currently an online science instructor at the University of Texas at Austin Online High School (UTHS). UTHS is a public school that has been authorized by the Texas Board of Education to award credit and high school diplomas since 1998. Students choose an online high school like UTHS for wide variety of reasons. According to their website, "Our diverse student body includes students engaging in professional careers, competing in national level athletic events, being home-schooled, living in remote locations, taking courses to accelerate their education, and participating in school at an older age. Our program provides the flexibility for students to earn their diploma in a way that meets their personal needs" (http://www.utexas.edu/ce/k16/ut-high-school/overview/). Not all students are "degree" students, exclusively enrolled in online classes; UTHS also allows students to take classes for credit towards a degree at a traditional high school. These students coordinate their schedules through their school's guidance counselors, and often choose UTHS for credit recovery purposes. UTHS also offers an international partnership program, whereby students of participating schools can

earn U.S. high school credit for online classes. Finally, the Migrant Student Graduation Enhancement Program provides a range of free services to aid migrant students in earning a Texas high school diploma. At any given time, the makeup of students in my courses are likely to be a mix of participants in all of these programs.

The biology and chemistry courses I teach at UTHS were developed by the University of Texas K-12 Education Center, and are part of the Acquire and Self-Regulate Knowledge in a Multimedia Environment (ASKME®) portfolio of math and science courses (http://www.utexas.edu/ce/k16/cbe-ea/askme/overview/). These courses are textbook-free, and use animations and storylines to deliver content to keep students engaged. Students complete online tutorials, submit between twelve and eighteen graded assignments, and eventually take exams to earn credit for a one semester class. Course work is asynchronous, meaning that there is no real-time interaction between student and teacher. Students may enroll at any time they choose, and have 150 days to complete their course at their own pace. The learning management system (LMS) used for course delivery, Speedway, does not provide forums or other means for students to have direct contact with each other, though teachers and students can communicate via an internal messaging system. When grading assignments, there is an option for the teacher to provide comments on individual questions and request redos on incomplete or incorrect work as needed.

My initial intervention, aimed at having students participate in virtual office hours, involved working with students enrolled in my Chemistry A section at UTHS, a first-semester high school chemistry course. However, due to the highly structured

nature of the courses offered by UTHS, and my limited ability as an instructor to modify them, I was unable to require my students to sign up for or attend virtual office hours. My hope was that at least some of my students, many of whom regularly request additional help on assignments, would voluntarily sign up to receive that help via weekly virtual office hours. However, this did not happen. Of 82 students invited to register to participate in weekly virtual office hour sessions, only two completed the sign up process, and neither of those students ever logged in to Canvas, the LMS I had planned on using to host the sessions. After extending the deadline to sign up several times, I saw that I either would need to abandon my project or seek out an alternate setting to explore the potential of virtual office hours to improve an online high school science class. A complete description of the pilot intervention is included in Appendix A.

Fortunately, I was able to continue my research, by partnering with Dr. John Graves, who is a professor with the MSSE program and a volunteer teacher at EMERGE, a small private school in Bozeman, Montana. While aspects of my project evolved to better match the changed setting, the overall theme of exploring the potential of virtual office hours unifies my work at UTHS with the research I ended up conducting, also virtually, with the assistance of Dr. Graves and his students at EMERGE.

EMERGE markets itself as an alternative to homeschooling for middle and high school students (http://www.emergemt.com/). They offer a range of classes, from science to foreign language to literature, which meet in person once a week. During the interim, students are expected to continue working on their course material independently. Some students are taking a full complement of classes through

EMERGE, while others are only enrolled in one or two courses. The content difficulty and need for weekly lab work make supplemental science courses particularly attractive for students who would otherwise be homeschooled in the traditional, independent manner.

Dr. Graves teaches two classes at EMERGE, chemistry and physical science, using a blended learning model. Also sometimes referred to as a hybrid model of online learning, this means classes include both a face-to-face and an online component. The online component is supported with a web-based LMS, Classcraft™, which also functions as a role playing game for students (http://www.classcraft.com/). In a traditional face to face classroom, Classcraft™ can be used to track behavior and motivate students - by awarding points to users for things like correctly answering a question in class, helping out a classmate, or handing in an assignment on time. Those points lead to rewards within the game play itself, like enhanced customization of avatars. Classcraft™ also has a classroom content section, including an asynchronous discussion forum and a place to post weekly homework assignments. While designed for face-to-face classrooms, the discussion forum feature makes this free website a very useful tool for instructors implementing a blended learning model on a budget. Dr. Graves introduced Classcraft™ to his courses at week 14, and used the game component of the website to award points for on-time assignment submission and participation on the discussion forums.

The in-person component of these classes is held every Wednesday, where for 60 minutes Dr. Graves introduces new topics, conducts laboratory exercises, and addresses

student questions on the previous week's assignment. By Thursday, the Classcraft™ content page is updated with the next week's homework assignment. Homework varies from week to week, but often includes a podcast by Dr. Graves, along with activities or supplemental resources reinforcing concepts that were introduced in the previous class. Sometimes students will have lab reports to complete and hand in during the next class section, or will need to set up and complete their own lab activity at home. While the exact content varies, each week the overall structure is the same, with students expected to work independently between class sessions.

I joined both classes as a teaching assistant in week 21 of the 26 week classes. At that point, use of the discussion forums had declined dramatically. Neither class had utilized the discussion forum since week 17. Dr. Graves reported that students did not seem engaged in class sessions when they did meet in person. This provided the opportunity to see if implementing weekly virtual office hours could have a positive impact on the class as a whole. While working with a blended model is not an exact match to what I was doing with UTHS, there is enough in common between these two groups of students to view my work with EMERGE as a continuation of what I started with UTHS, and as something that can inform course design decisions for UTHS.

With this new project, my focus question became: Are virtual office hours a meaningful addition to an online or blended learning course? To answer this, I wanted to explore how, if at all, adding virtual office hours impacted a student's experience of their science course. I also specifically wanted to look closely at engagement, as this was the main parameter that I saw as lacking in my UTHS students, and it was also something

that Dr. Graves mentioned needed work in his ENGAGE classes. Finally, particularly because my UTHS intervention did not go as planned, I wanted to explore what conditions are needed in order to successfully implement virtual office hours at a school or with a group of students. This led to my three primary research questions:

1) How does adding virtual office hours change student's experience of their science course?
2) How does adding virtual office hours impact student engagement in their science course?
3) What has this project taught me about the conditions needed for successful implementation of virtual office hours?

CONCEPTUAL FRAMEWORK

What works best in a traditional classroom might not translate to a virtual classroom, so in order to obtain the best results for online students, research into best practices is vital. There has been significant research on high school distance learning trends, as well as some research on upper level distance learning, that is applicable to this action research project. This literature review is organized into: An overview of the state of online learning in high school education, an introduction to The Community of Inquiry and The Teacher Engagement Frameworks, and finally a discussion of the specific role VOH can play in supporting this framework and enhancing student engagement.

Online Learning Overview

Online learning opportunities have blossomed in recent years, mostly at the post-secondary level. According to the U.S. Department of Education publication, *Enrollment*

in Distance Education Courses (2014), in the fall of 2012, 25% of undergraduate students and 30% of graduate students were taking at least some of their classes online, for a total of about 5.5 million post-secondary online students. For K-12 education, the numbers are more modest, with only about 1.8 million students enrolled at least part time in online classes in 2009, though 75% of school districts surveyed offered online classes. A further 74% of those schools planned on expanding offering over the next three years. Though the distance learning landscape is still dominated by post-secondary programs, high school distance learning is on the rise. This is reflected in the literature, with the majority of studies focusing on older students, but a growing body available that explores best practices at the high school level.

There are several trends apparent in distance learning at the high school level. A study by the National Center for Educational Statistics found that 75% of schools with students enrolled in distance education courses did not develop the courses themselves (Queen & Lewis, 2011). It also found that while independent contractors and state-wide virtual schools were also frequent sources of distance education courses, 50% of school districts surveyed had their students taking classes through a postsecondary school, such as the University of Texas. While asynchronous, synchronous and hybrid courses were all reported, finding also revealed that, "the internet with asynchronous instruction [is] the most widely used technology for instructional delivery" (Queen & Lewis, 2011, p.14).

Initial excitement about distance learning in the high school setting included the potential for it to play a role in the school reform movement (Picciano, Seaman, Shea &

Swan, 2012). It was felt that distance learning could be used to "bridge the gap" between high school and college, allowing high school students to earn college credit by taking advanced classes online (Picciano et al., 2012, p. 134). In reality, within traditional schools that offer some online courses, the most common type of online course offered was credit recovery (Picciano et al., 2012; Queen & Lewis, 2011). This trend has raised concerns amongst high school administrators, as many felt "that students need maturity, self-discipline, and a certain command of basic skills (reading and mathematics) in order to succeed in these courses. Many of the students who need to recover credits are those who may not have these characteristics" (Picciano et al., 2012, p. 134). This emphasizes the need to investigate how to implement high school online programs for all students, not just for the more self-motivated who typify upper level online enrollment.

Science education presents unique challenges for designers and instructors of online courses. The teaching of science encompasses both content and science and engineering practices, and the most common setting for learning about scientific practices is the laboratory environment. The supervised lab activities conducted in one or two classroom periods that typify high school science courses do not translate well to online learning. To identify best practices for laboratory work in an online setting, researchers evaluated the laboratory components of three distance learning science courses, looking at both the experiments presented and student work (Mawn, Carrico, Charuk, Stote & Lawrence, 2011). Effective alternatives to traditional lab work include kitchen chemistry experiments (utilizing common household chemicals), computer simulations and field-based activities. Their evaluation of student submissions for science process skills led

them to conclude "it is clear that these online students engaged in the processes of science, even though they were not in a physical laboratory setting. [S]tudents participated in investigations that led to predictions, observations, data collection and analysis, and communication of findings" (Mawn et al., 2011, p.144). In fact, "online students have the opportunity to conduct investigations that are not limited by time and space, constraints often associated with a traditional laboratory setting" (Mawn et al., 2011, p.144). This only serves to illustrate the point that online and in person instructional practices need to be evaluated separately in terms of best practices.

Community of Inquiry and Teacher Engagement Frameworks

To explore the role of teachers in online high school student success, it is helpful to have a framework from which to view the literature. In 1999, Garrison, Anderson and Archer developed the Community of Inquiry (CoI) framework, summarized in Table 1. Using a constructivist theoretical approach, they hypothesized that three interrelated elements, cognitive presence, social presence, and teacher presence, are key to achieving effective computer-mediated instruction in higher education. At UTHS, the social presence element is virtually absent, as students have no contact with each other through the LMS in use. A blended learning model of online education, like the one used at EMERGE, allows students to get to know each other and their instructor in a face to face setting, enhancing both the social presence and teaching presence aspects of this model.

This framework has been well received, both being validated by other studies and serving as a basis for further research into best practices (Garrison et al., 2010). For example, a 2010 study of undergraduate and graduate students surveyed students to

measure instructor immediacy and instructor presence. They found a positive correlation between the two values, and between instructor presence and affective learning, cognition, and motivation (Baker, 2010). In 2002, researchers designed a "Classroom Community Scale" that looked for correlations between self-reports on the sense of community that asynchronous online students felt with perceived cognitive learning. A positive correlation was found, where those students who felt that they were working together with a group of peers as opposed to toiling alone did better in their online courses (Rovai, 2002). This lends weight to the "social presence" element of the framework, and supports a move towards encouraging more online collaboration among students both at UTHS and EMERGE.

Table 1.
Community of Inquiry Coding Template

Elements	Categories	Indicators (examples only)
Cognitive Presence	Triggering Event	Sense of puzzlement
	Exploration	Information exchange
	Integration	Connecting ideas
	Resolution	Apply new ideas
Social Presence	Emotional Expression	Emotions
	Open Communication	Risk-free expression
	Group Cohesion	Encouraging collaboration
Teaching Presence	Instructional Management	Defining and initiating discussion topics
	Building Understanding	Sharing personal meaning
	Direct Instruction	Focusing discussion

(Garrison, Anderson & Archer, 1999, p.89)

However, a limitation of the CoI framework for someone who teaches at the high school level is that it deals specifically with higher education. Researchers working with the Open High School of Utah elaborated on the CoI by developing a more in-depth analysis of the role of teachers in K-12 online learning environments, "where students

tend to be less autonomous than adults and have more difficulty succeeding online" (Borup, Graham & Drysdale, 2014, p.793). This construct, called the Teacher Engagement Framework, more accurately reflects the significant role teachers have in high school settings. It has six key components; facilitating discourse, designing and organizing, nurturing, instructing, monitoring, and motivating. The study's authors provided examples of what each of these components might look like, by interviewing successful online teachers and doing a literature review (Table 2).

Table 2.
Teacher Engagement Framework

Category	Indicators (examples only)
Facilitating Discourse	Contacting low-performing students
	Checking in with students
	Providing office hours
	Sharing teaching strategies with other teachers
Designing and Organizing	Personalizing lessons
	Setting deadlines
Instructing	Providing feedback
	Tutoring students
	Teaching study skills
	Teaching technological skills
Nurturing	Developing caring relationships
Motivating	Using positive praise
	Helping students to reach mastery
	Increasing students' situational interest
Monitoring	Monitoring student understanding
	Identifying dishonesty

(Information collected from Borup, Graham & Drysdale, 2014, p. 798-802)

It is important to note that not all components are relevant for all online teachers, depending on the "grade level they teach and the model of e-learning they follow" (Borup et al., 2014, p.795). Indicators included in Table 2 reflect those components of the

framework that apply in my specific teaching situation. Of note is the inclusion of "providing office hours" under the "facilitating discourse" category.

Within the literature, there is support for the fundamentals of this framework. A 2011 study "Success in Online High School Biology" found a correlation between teacher comments and student success on EOC exams, showing "students with more teacher comments tended to perform better than those receiving fewer comments" (Cavanaugh & Liu, 2011, p.50). In this same study, a survey of science teacher's perceptions of difficulties with online learning named interaction between students and teachers as the most important instructional strategy to effectively deliver science instruction online (Cavanaugh & Liu, 2011). Implementing strategies that support more interactions between students and teachers might be a way to improve engagement and enhance the quality of an online or blended learning course. Previously cited research on instructor immediacy found that it is significantly higher for synchronous versus asynchronous courses, prompting researchers to comment on the "necessity of incorporating synchronous activities into the online learning environment" (Baker, p.21). VOH are one strategy for doing this, which will be explored further in the next section.

Virtual Office Hours

Office hours are a familiar concept to undergraduate and graduate students, though they are not seen as often in high school settings. An opportunity for students to seek help outside of class, this conventional form of student-instructor interaction has been shown in a number of studies to positively correlate with higher academic achievement (Guerrero & Rod, 2013). Within the Teacher Engagement Framework,

providing office hours is explicitly mentioned as a means of facilitating discourse with students (Borup et. al., 2014). However, even on traditional campuses, office hour participation can be low, in particular for students who need a large amount of help (Edwards 2009). To address this, the familiar concept of office hours have been adapted into virtual office hours, either supplementing or replacing traditional office hours to the approval of most students (Edwards 2009). For professors and TAs, opinions of virtual office hours are favorable as many appreciate the higher student participation rates and prefer having a fixed time to field student questions rather than feeling the need to be always available via email (Wallace & Wallace, 2001).

There are many different ways to implement virtual office hours, depending on instructor and student preference, but a few stand out as possibly effective for my teaching situation. Text-based conferences were found to be an appropriate solution for when students and teachers would otherwise be engaged in a back-and-forth email conversation trying to resolve a question (Wallace & Wallace, 2001). In public chat sessions, students can read each other's questions and responses, versus sessions where the communication between student and teacher is private. As many students have similar questions, group session are a more efficient method to address all the concerns of the class. In addition, for students in online asynchronous classes, one of the benefits of virtual office hours is they allow for "increased opportunity…to directly communicate with the teacher and/or with other students," (Wallace & Wallace, 2001, p. 196). Group text-based conferencing can also support learning by allowing for a discussion to develop

between students, and even by allowing for passive participation, or "lurking", also shown to have educational value (Hooper, Pollanen & Teismann, 2006).

An alternative to text-based conferencing that increases the sense of instructor immediacy is video conferencing. Students respond well to the visual that a "real" person is involved in the conference, though allowing students the opportunity to include video of themselves can be a distraction (Wallace & Wallace, 2001). Perhaps the best combination is where the instructor is connected by video, and students can ask questions and communicate via text. This also allows the teacher an additional level of control over the topics, hopefully allowing the session to be "more structured than the verbal free-for-all of a group discussion" (Wallace & Wallace, 2001, p. 202). As one strategy for successful implementation of office hours is to offer theme-based office hours, being able to set the topic and keep control of the direction of the conversation is important (Jackson & Knupsky, 2015). For classes that are otherwise asynchronous, offering office hours with video and text communication simply gives teachers another tool with which to support student learning.

There are many programs that have become widely available in recent years that allow for a combination of text-based and video-conferencing. However, in choosing an appropriate platform for a science class, there is another factor to consider. As I have experienced while trying to explain a concept over email, "a number of subjects, like mathematics, engineering, or chemistry, rely heavily on symbols, visuals aids, and other non-textual communication, with the result that communication over the Internet can be a

slow and frustrating process" (Hooper et.al, 2006, p. 188). This would suggest that virtual office hours are simply not appropriate for all subjects.

One solution for this is to utilize programs that include a whiteboard feature, which allows the instructor to draw symbols and equations on the computer that are directly visible to the student. This eliminates some of the confusion and miscommunication that happens when trying to express those ideas in a line of simple text. Undergraduate math instructors who implemented virtual office hours with a whiteboard feature found overwhelming student support of the platform, and instructors themselves felt having a whiteboard "dramatically increases both the efficiency and effectiveness of our use of the time" (Hooper et. al, 2006, p.190). Because of this, I chose BigBlueButton, a feature of Canvas LMS, to implement office hours with my UTHS students, and Adobe Connect for EMERGE students. Both these platforms include the option to communicate via text or video, and have a whiteboard features, among other web conferencing tools. Both these platforms had the tools I felt were necessary to create an environment that promotes student learning and increase engagement for students.

In conclusion, findings from this literature review confirm that there are unique challenges facing students and instructors in online high school environments that are deserving of further study. They also support the notion that instructor engagement is key to success of online high school students. Virtual office hours are one way to support teacher engagement, by opening up the lines of communication between students and teachers. If implemented using a system that supports the content being taught and the

needs of students, synchronous virtual office hour could be a valuable addition to an online high school science class.

METHODOLOGY

To explore the potential of virtual office hours as an addition to an online course, I was able to work with two groups of students. As described in the introduction, my intervention with the first group, students enrolled in my online Chemistry A course through UTHS, did not go as planned because of lack of participation. I was able to continue exploring my question by working with a second group, students enrolled in blended learning science courses at the EMERGE school. This follow-up intervention yielded more data sources, and allowed me to address my research questions more fully. Taken together, both interventions shine light on my focus question: Are virtual office hours a meaningful addition to an online or blended learning course?

Participants

The participants in my primary intervention with EMERGE are high school students enrolled in blended learning classes in two subject areas: chemistry and physical science. The classes meet for sixty minutes of face-to-face instruction once a week, on Wednesday mornings. There are four students enrolled in the chemistry class and ten in the physical science class, all between the ages of thirteen and eighteen. The two boys and two girls in chemistry are all in grades ten and eleven, while the four boys and six girls in physical science are mostly in grades nine and ten, with one in twelfth grade. Of these fourteen students, seven have never taken a course with an online component prior

to this one, five have taken between one and three classes with an online component, and two have taken more than four classes with an online component.

Intervention

I was introduced to this class as an online teaching assistant on March 2nd, during their 20th week of class, and remained involved with the group through their 26th and last day of class, April 20th. For my actual intervention I moderated discussions and held evening virtual office hours using Adobe Connect in weeks 21 through 25.

Each Thursday, after the prior day's class session, Dr. Graves would post on Classcraft™ the homework assigned for completion prior to the next week's session. I would then follow that up by posting a discussion prompt relating to the homework on the Classcraft™ asynchronous discussion board (Appendix B). Students were asked to make an initial post by Saturday at 5:00 PM, and then to make a follow up post by Monday at 5:00 PM. We would then hold virtual office hour webinar sessions either Monday or Tuesday evening. Spring break occurred between weeks 21 and 22, so the lead up for week's 22 class session occurred over a two week period. There were no asynchronous class discussions or office hour sessions leading up to the last day of class, so that I could wrap up post-intervention data collection during week 26. The flow of events for these weeks is described in the intervention calendar (Appendix C).

VOH sessions were facilitated using Adobe Connect, a web-based conferencing platform that allows for multiple modes of communication. In our sessions, I was visible and audible to students, but students primarily communicated with me and with each other via text-based chat. Occasionally I would activate the microphone for a student so

they could contribute a question or answer audibly, but at no point were student webcams activated. Adobe Connect has a white board function, and the option to upload documents to create a slide show presentation. Initially, all virtual office hours were scheduled for Tuesday evenings. However, in an effort to increase participation among the Chemistry students, the Chemistry sessions were moved to Monday for two weeks. When that did not result in any more students participating, the sessions were moved back to Tuesday nights. The length of the office hours varied, with the longest session running 45 minutes and the shortest about 10 minutes.

Participation in the asynchronous online class discussions and in the virtual office hour sessions was not required, though there were some weeks that the homework assignment did ask students to post in the asynchronous thread as part of the assignment. For all weeks, participation in the discussions and in the office hour sessions earned students points on Classcraft™. These points had no impact on student grades, but did allow students to advance to higher levels within the game based LMS. Students who were unable to attend live sessions were still able to earn these Classcraft™ points by emailing me a question instead of logging into our Adobe Connect sessions. At the end of each week, all students, both those who participated and those who did not, were required to submit a graded discussion rubric using Google Forms to Dr. Graves outlining their contributions of the week (Appendix D).

Data Collection

Data were collected from multiple sources in order to fully explore my three primary research questions: 1) How does adding virtual office hours change students'

experience of their science course? 2) How does adding virtual office hours impact student engagement in their science course? 3) What has this project taught me about the conditions needed for successful implementation of virtual office hours? Together these three questions help me answer my focus question: Are virtual office hours a meaningful addition to an online course?

As a first assignment leading up to week 21, students were asked to complete a pre-survey using Google Forms, which served as a point of comparison once the intervention was complete (Appendix E). Likert-type questions were accompanied with a scale from 1 (strongly disagree) to 5 (strongly agree) and included a neutral choice. All questions were positively oriented, so that a higher value indicated a more desirable student response. A post survey assigned as homework leading up to week 26 also included additional stand-alone follow up questions (Appendix F).

With a sample size of fourteen for this study, my options for making statistical comparisons pre and post treatment were limited. When interpreting my Likert-type questions, rather than using a statistical test I looked at the frequencies of different responses to questions on the pre survey and the post survey. I grouped both "strongly agree" and "agree" responses together, and "strongly disagree" and "disagree" responses together. I also looked at the mode response for each question and the range of student responses. When comparing the pre-survey with the post-survey, I looked at how frequently individual student's responses shifted categories. If an individual's response changed within category, for example from a "strongly agree" to an "agree", that did not register as a change in response.

Archived asynchronous discussion posts from weeks prior to the intervention served as second source of baseline data when compared with those from the weeks of our virtual office hour sessions. This data set was first evaluated by looking at the frequency and range of discussion posts for each student each week. I then coded responses into seven categories, A) non-contributing, B) one word or sentence fragment response, C) agreement without elaboration, D) direct answer to prompt, E) other post or comment than moves the discussion forward, F) help seeking and G) help providing. This coding system allowed me to better evaluate increased engagement through the discussion posts, as I could monitor not just a change in number of responses but also a change in the quality of responses. I classified response types A-C as reflecting low engagement, D as reflecting mid-level engagement, and E-G as reflecting higher engagement.

The remainder of my data sources did not involve making a comparison between before and after the intervention, but were still highly valuable. VOH artifacts, in the form of recorded sessions and archived chat discussions within Adobe Connect, helped me identify similarities and differences between the various sessions and link them to trends. Student virtual interviews done at the completion of the intervention shed light on all my research questions, and were of assistance when interpreting survey answers (Appendix H). I requested interviews with all fourteen students, hoping to select a representative sample from those who agreed to participate. In the end I held six interviews, with the only six students who responded to my requests, two chemistry students and four physical science students. Five of these interviews were two-way audio

communications held on Adobe Connect and recorded for later playback, while the remaining physical science student completed his interview over email. Because I was not present for the in-person portion of the class, and was not involved with the class prior to the start of my intervention, an instructor phone interview with Dr. Graves was also an essential source of data (Appendix I). Finally, a VOH journal helped me keep track of my impressions of what did and didn't work well each week of the intervention.

Table 3.
Data Triangulation

Focus question: Are virtual office hours a meaningful addition to an online or blended learning course?	Pre and Post survey comparison	Stand-alone post intervention survey questions	Asynchronous discussion artifacts	VOH artifacts	Student interview	Instructor interview	VOH Journal	UTHS student survey
1. How does adding VOH change student's experience of their science course?	X	x			x	x		
2. How does adding VOH impact student engagement in their science course?			x		x	x		
3. What has this project taught me about the conditions needed for successful implementation of VOH?		x	x	X	x	x	x	x

An exemption for the research methodology utilized for this project was received from Montana State University's Institutional Review Board and compliance for working with human subjects was maintained.

DATA AND ANALYSIS

With so many data sources, it made the most sense for me to organize my data by research question, pulling from different data collection instruments as needed to provide evidence for my claims. Where appropriate, tables and figures have been included to further illustrate any trends apparent in the data.

Impact of virtual office hours on student's experience of their science course

A comparison of the pre-intervention and post-intervention surveys did not reveal many changes in student's perceptions of their course, in part because students already strongly agreed with most survey items before the intervention began (Figure 1, Figure 2).

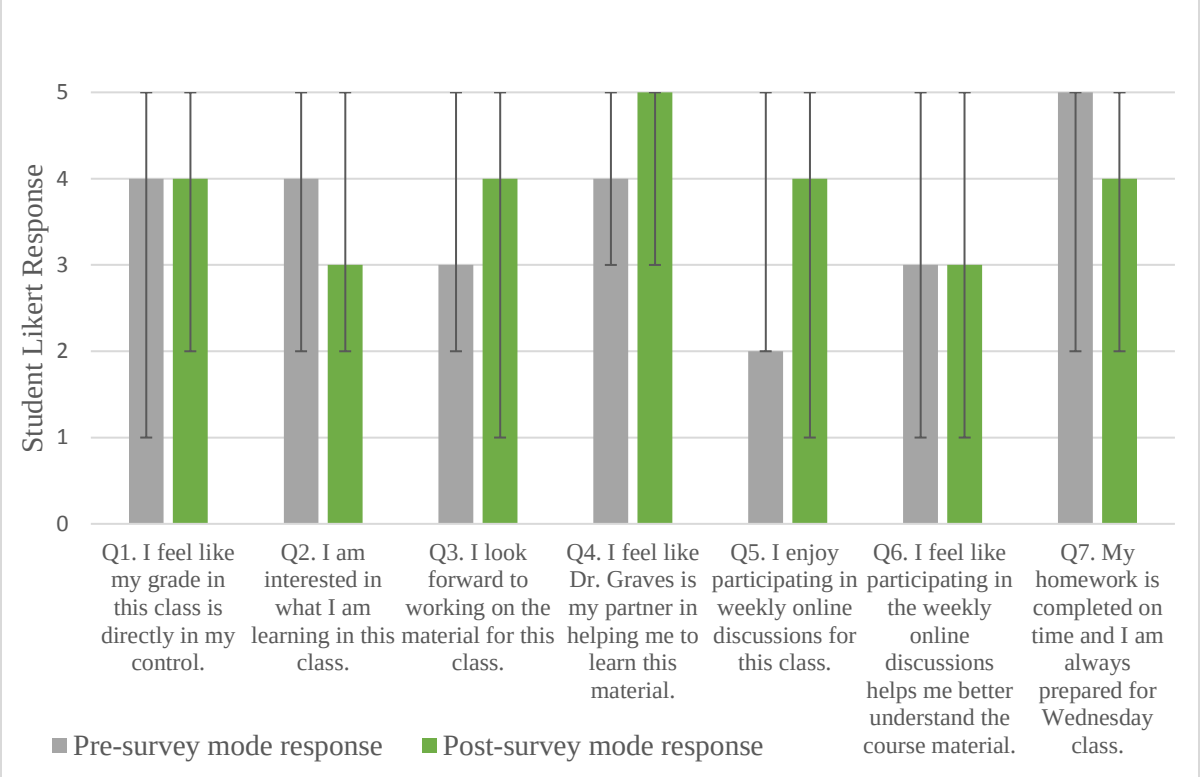


Figure 1. Mode and range comparison for pre-survey and post-survey questions, (*N*=14).

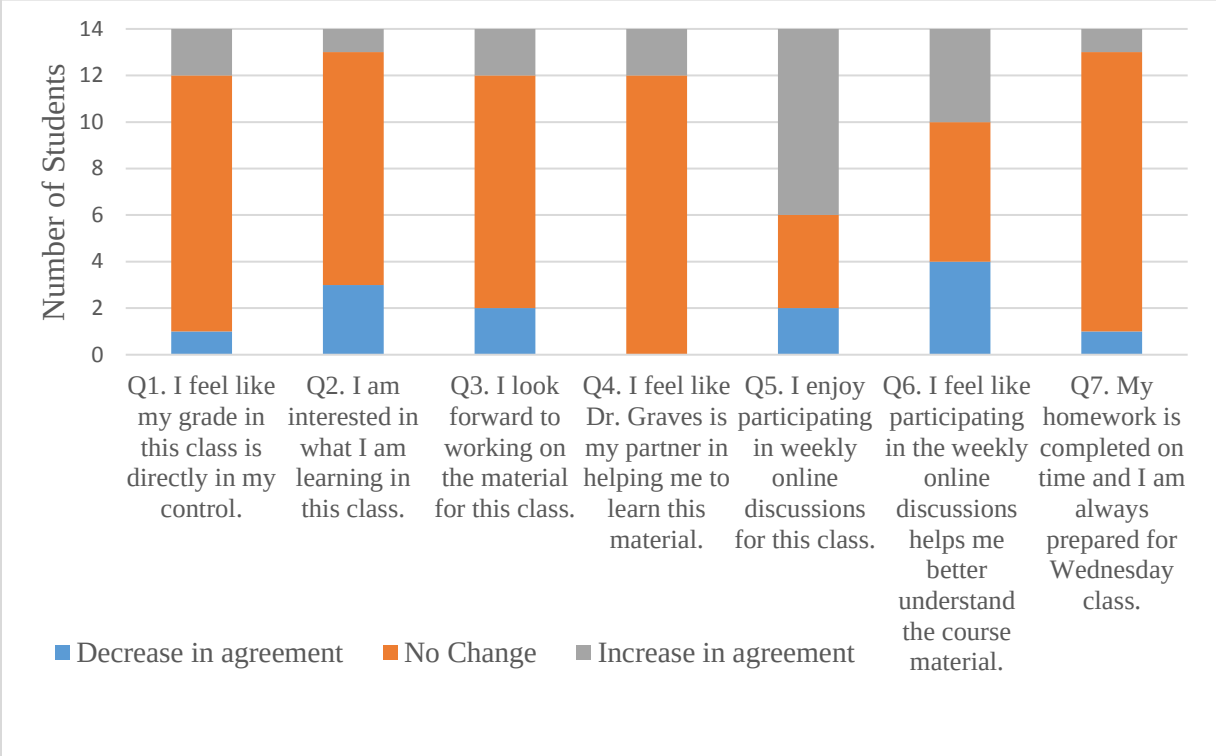


Figure 2. Frequency of a change in student response from pre-survey to post-survey, (*N*=14).

The one notable change between the data sets was for the Likert-like question "I enjoy participating in weekly online discussion for this class", with eight students moving towards a more positive response after the intervention, two students moving towards a more negative response, and four students showing no change (Figure 2). Overall, the mode response for this question went from "disagree" pre-intervention to "agree" post intervention (Figure 1). Attempts to sort responses by course taken (chemistry vs. physical science), number of office hour sessions attended (five vs. two/three) and experience taking online courses (new to online vs. had previous online experience) did not yield significant results with such a small sample size.

Responses to additional post-survey Likert-like questions were also predominantly positive (Table 4). In the post-survey, the virtual office hour sessions were referred to as "webinars" to prevent confusion between them and the asynchronous discussions. Unfortunately, none of the students with negative responses on survey questions agreed to participate in follow up interviews. There was one student in particular who almost exclusively disagreed or strongly disagreed with the post-survey Likert-like questions. She shared in the additional comments section of the survey "I had a hard time understanding the homework some weeks…working in groups didn't help. I felt like a lot of the time I was lost. The webinars were semi-helpful. But…I did learn some things."

Table 4
Additional Post-Survey Likert-Like Questions

	Mode	Range
I feel like Heather is my partner in helping me to learn this material.	5	2-5
Overall, I'm glad my family and I chose this class, over other options that were available.	5	2-5
I enjoy participating in the webinars.	5	1-5
I feel like participating in the webinars helps me better understand the course material.	5	1-5
Even if there were no Classcraft™ point bonuses, I would still participate in weekly online discussions.	4	1-5
Even if there were no Classcraft™ bonus points, I would still participate in the webinars.	5	1-5

Note. 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree. *(*N=*14).*

It was notable that on the post-survey, more students agreed or strongly agreed with the statement "I feel like participating in the webinars helps me better understand the course material" as compared to "I feel like participating in the weekly online discussions

helps me better understand the course material" (Figure 3). During the student interviews I asked participants to elaborate on their responses to these questions. The one participant who had selected a neutral response for both questions indicated that "I already felt I understood well before the discussions and webinars". Of the other five, one mentioned being able to have questions answered right away in the virtual office hour sessions, and the other four indicated more time to talk about the topic or more time talking with classmates as the reason they felt the office hours improved their understanding of course material more than the asynchronous discussions. As one student put it, "I learn best by discussing stuff, so it was really helpful to talk to other kids. I don't get to talk to them much outside of class except through the discussion forum, and sometimes it is hard to communicate that way." In contrast, during the asynchronous discussions, one said "I had a harder time deciding what to say" and another "the discussions raised the questions that we answered in the webinars".

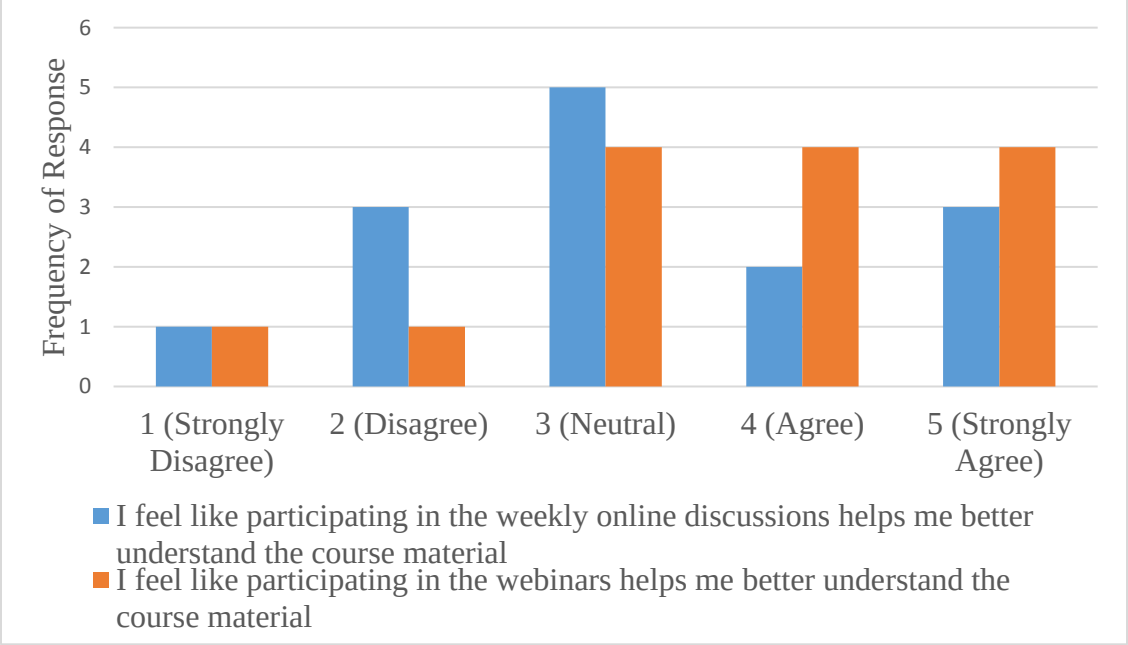


Figure 3. Student perception of discussion versus webinar effectiveness, (*N*=14).

During the design of my intervention, I had planned to use student grades to further inform the impact of the office hours on student's course experience. However, during the instructor interview, Dr. Graves shared that student grades were not significantly different after the intervention for the most part, and in some cases dropped slightly due to students failing to submit their weekly discussion rubrics (Appendix J). In the course of the interview he also shared that he did not notice an improvement in submitted work after the intervention had started, but observed rather a more generalized improvement in student understanding of the material as evidenced in higher quality weekly classroom discussions. This observation is more closely examined with the next research question.

Overall, all students who were interviewed expressed that adding virtual office hours for the final weeks of their course was a positive experience. One student said "You guys should totally do that again next year", and another shared "I really really appreciated having the discussions and the webinars. I wish I could have made it to more of them!" In addition, all six interviewed students felt participating in virtual office hours helped them get more out of their Wednesday class sessions.

Impact of virtual office hours on student engagement

The number and nature of student asynchronous discussion posts during the intervention weeks reflected a higher degree of engagement in the course work as compared to before the virtual office hours were implemented. The average number of discussion posts physical science students contributed each week went from 1.2 pre-intervention, with a range of 0 to 3, to 2.0 during the intervention, with a range of 0 to 6.

The average number of discussion posts chemistry students contributed each week went from 0.8 pre-intervention, with a range of 0 to 4, to 2.1 during the intervention, with a range of 0 to 5.

All student posts for the weeks prior to the intervention and the weeks of the intervention were classified based on their contribution to the overall quality of the online discussion (Appendix K). For the ten physical science students, most of the 36 posts that preceded the intervention were of poor quality. Only 33% of responses were those that contributed to the discussion positively, all of those directly referencing something in the discussion prompt (Figure 4).

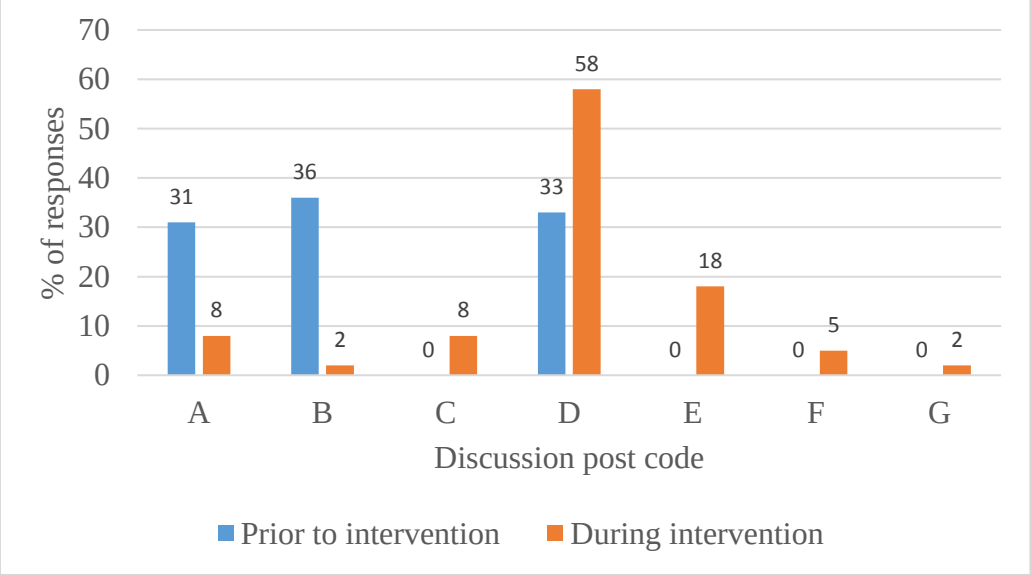


Figure 4. Changes in the quality of physical science students' discussion posts. A = non-contributing response, B = incomplete response, C = agreement without elaboration, D = direct answer to prompt, E = other post or comment that moves the discussion forward, F = help seeking, G = help providing. *(N*=10*).*

During the weeks of the intervention, physical science students contributed 97 posts on the discussion boards. The frequency of those posts responding directly to the discussion prompt went up to 58%. We also saw our first posts that moved the

discussion forward without directly responding to the prompts (18%), and our first help seeking (5%) or help providing posts (2%). Students were encouraged to ask any questions they had about the material, or to respond to one another's questions, and these posts did count toward the two-post minimum for full Classcraft™ credit. However, these types of posts require more engagement with the material than simply responding to an instructor-generated discussion prompt. The rise in these categories from not present to making up collectively 25% of all posts in the physical science forums shows increased engagement.

The chemistry students had collectively fewer but higher quality posts overall during the pre-intervention period, perhaps reflecting greater familiarity with discussion boards or higher overall maturity (Figure 5).

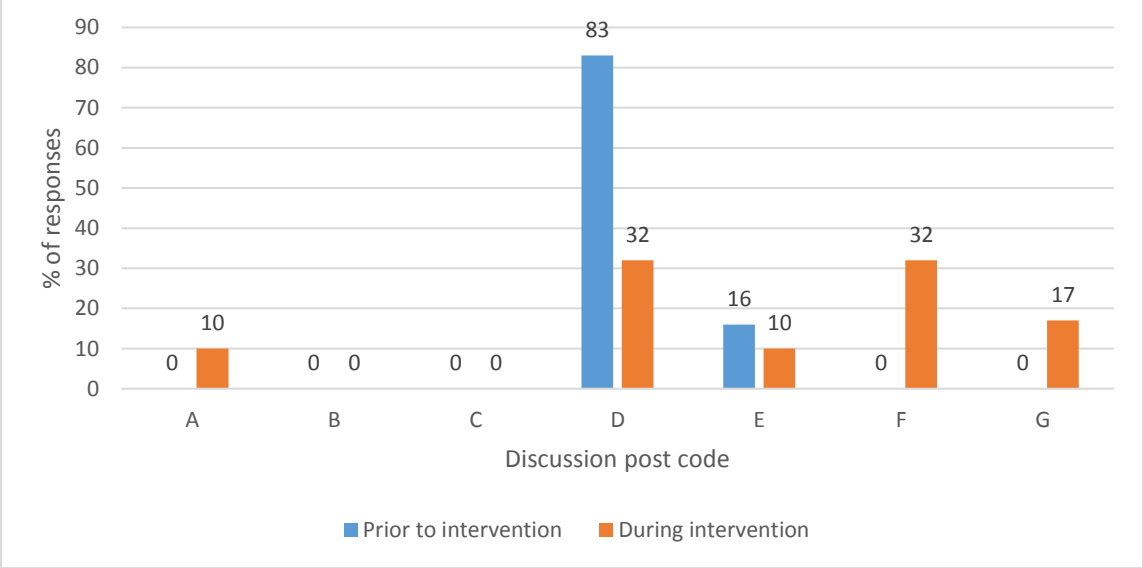


Figure 5. Changes in the quality of chemistry students' discussion posts. A = non-contributing response, B = incomplete response, C = agreement without elaboration, D = direct answer to prompt, E = other post or comment that moves the discussion forward, F = help seeking, G = help providing. (*N*=4).

All twelve posts the four chemistry students made in initial weeks were on topic, but they only consisted of direct responses to the initial prompt (83%) or other quality posts that moved the discussion forward in some way (16%). In contrast, during the intervention, almost half of the 41 total posts chemistry students made were either students seeking help (32%) or providing help in response to a classmate (17%). Of the remaining, the bulk were direct responses to initial prompts (32%) with four non-contributing responses (10%). All four of those non-contributing responses were unrelated to the weekly discussion topic, but related to the course as a whole, for example referring to something within Classcraft™ or confirming the time for the office hour session.

Student and instructor interviews both support the claim that student engagement went up with the implementation of virtual office hours. When asked to describe any changes in the in-class discussions after the intervention had started, Dr. Graves shared "Students became more engaged, the depth of the discussion was greater. The rigor around the discussions was better, students were generally more informed and therefore more confident, and had more things to talk about." During student interviews, all six students responded "Yes" to the question "Do you think webinars helped you get more out of the actual Wednesday class sessions?" Three of the six students specifically felt more confident and/or prepared for Wednesday class because of the virtual office hour sessions, sharing for example that they "helped me decide what to say in class", and "going over everything one more time made me feel more prepared for the class sessions."

Elsewhere during the instructor interview, Dr. Graves shared that "having them (students) directly interacting with you and each other connected the weeks more than just watching the video or podcast. That combination…kept them mentally in the class for more time". The student interviews also supported this perspective, with all six interviewed students mentioning more time to discuss the material outside of limited class hours and/or more contact with classmates as benefits of the intervention. As one student put it, the virtual office hours gave them "as a group the chance to dig more into the curriculum. One hour a week isn't enough to get everything discussed." Another shared "In the webinars we got to address questions that we normally had to address in class. That way we could just keep moving forward once we got to class."

Conditions needed for successful virtual office hour implementation

From the student interviews I identified four factors relating to this question that warranted a closer look: the role of other students, the role of the asynchronous discussions, my role as an outsider to the class, and technical or logistical concerns (Table 5). I then looked to my other data collection instruments to further inform the data surrounding each of those trends.

All students interviewed found the virtual office hours to be beneficial, but they differed somewhat in what aspects of the sessions they found the most helpful. Every student surveyed indicated that having other students present during the office hours was helpful, with five of the six interviewed students indicating that other students directly helped them by answering questions or contributing a different perspective to discussions, and four of the six students indicating classmate's questions were helpful.

Table 5
Trends in Responses for Student Interview Questions

Theme	Number	Example
Role of other students		
Students helped answer my questions or shared different perspectives in the discussions	5	"We were able to help each other." "It was nice to talk with other students about how they understood things."
Students asked questions I hadn't thought of or that I forgot to ask	4	"Sometimes people would say things that I'd never even thought of and that gave me more of a view on the subject we were learning." "It was useful to have other students there to ask questions that maybe you hadn't thought of asking."
Role of discussion threads		
The discussion threads directly led to questions for the webinar, which was helpful	4	"The discussion helped a lot because it got everyone thinking about more things than just the homework that was assigned. And that carried over to the webinar, too."
My role as an outside teacher		
The pictures, examples, or way Heather explained was different from Dr. Graves	4	"Sometimes the way you explained it made more sense to me and sometimes the way Dr. Graves explained it made more sense to me." "I liked the pictures and examples concerning what we're talking about"
Logistic and technical concerns		
The timing of the VOH was hard to fit into my schedule	3	"It was hard to do in the evenings - I would have preferred days or more flexibility"
The chat function was hard to use - I wish we could have just had a live discussion	2	"Typing is annoying"

Note. (N=6)

Responses for how important it was that other students were present did differ between students enrolled in physical science versus chemistry. All of the physical

science sessions had nine of ten students in attendance each week, while the chemistry sessions were less well attended. Of the five offered chemistry sessions, three had two students, one had just a single student, and one was not attended by any students. The physical science students all felt strongly that it was important to have other students present for the sessions, so that they could add their questions and perspectives to the discussion. As one said, "The more the better". In contrast, the two chemistry students interviewed were more flexible on the subject. While both felt that, when present, other students added to the discussion, they also felt the smaller sessions were useful. The chemistry student who attended a solo session shared, "there was nothing bad about it being small. It was helpful in a different way. It was nice to have all my questions thoroughly answered".

Somewhat surprisingly, when reviewing the transcripts and recordings for the sessions, there were more questions asked and answered in the chemistry sessions as compared to the physical science sessions, despite having many fewer chemistry student participating (Appendix K). Over four sessions, chemistry students had thirteen specific questions that they wanted addressed, while over five sessions, physical science students collectively had only eight. The majority (eleven) of those questions were asked during the first two chemistry sessions, which covered acids and bases and the first of two weeks spent on heat. That might have been a reflection of the chemistry classes covering a greater breadth of material, or the chemistry students having a greater need to slow down and cover the material in more depth at the time that the intervention started. Dr. Graves shared in our interview that the physical science students may have been disengaged by

the end of the year, as he ended up spending most of the course on motion rather than covering a variety of topics as the chemistry class did.

Four of the six students felt that the asynchronous discussions played an important role in preparing students to get the most out of the virtual office hours, while two others didn't see them connecting as much with the live sessions. For all the chemistry virtual office hour sessions and for three of the five physical science sessions, specific questions were asked during the asynchronous discussion sessions that either served as a starting point or informed the bulk of our group conversation (Appendix L). I recorded in my VOH journal that I felt much better prepared and more in tune with what students needed to talk about after having read through the student asynchronous discussion posts, particularly when they shared specific questions (Appendix M). The sessions where students had asked questions in the asynchronous forums ahead of time just felt more productive from my perspective. In our instructor interview, Dr Graves also identified the cyclical effect of the asynchronous discussions leading to the virtual office hours leading to the in-class sessions and back again to the asynchronous discussions as being key to the success in building engagement and enhancing student understanding of the material.

Four of the six students saw value in the unique contribution an outside teacher brought to the office hours, in the form of different examples or explanations for class concepts. In general, students generally agreed with both the statement "I feel like Dr. Graves is my partner in helping me to learn this material" (mode = strongly agree, range = 2-5) and "I feel like Heather is my partner in helping me to learn this material" (mode =

strongly agree, range = 1-5). In my VOH Journal, I had noted less confidence in my ability to contribute in a meaningful way to the physical science class, as I have less experience teaching physical science but significant experience teaching chemistry. However, there was no notable difference in how chemistry or physical science students responded to these Likert-like survey questions or the open ended interview questions. One student did note in his interview that he wished the asynchronous discussion prompts correlated with the homework more, adding "I always looked at the discussion instead of the homework at the start of the week". Any disconnect between these two aspects of the course probably originated from the fact that the homework was assigned by Dr. Graves while I composed the discussion prompts.

As far as the logistics of implementing the virtual office hours, most students did not encounter problems using Adobe Connect, and did not comment either negatively or positively on it. However two students did express during the student interviews that they found it frustrating to communicate via chat, and would have rather used voice or webcams for students. Three students mentioned during their interviews that the time of the sessions was what kept them from participating in more of them. In addition, three other students who were not interviewed mentioned in the asynchronous discussion forums that they would not be attending the office hours for a given week because of work, sports, or other commitments. One student specifically mentioned that scheduling the sessions during the day would have been better for her.

In terms of the instructor impact, my total time commitment in preparing for and holding the office hours and moderating asynchronous discussion sessions for EMERGE

was about two hours a week per class. When asked if he would consider adding virtual office hours to any future classes, Dr. Graves indicated that he would, with his only hesitancy being time to implement and access to the appropriate technology. I found Adobe Connect an ideal tool for implementing these sessions, but was surprised that the imbedded whiteboard feature was not as useful as I had anticipated. Instead I used an actual whiteboard along with my webcam when I needed to balance a chemistry equation or write out a math formula. My access to Adobe Connect was generously provided through the MSSE program, and during my pilot study, my access to the Canvas LMS with web conferencing capabilities was through UTHS. Google Connect does provide some of these same functionalities for smaller groups for free, but I am unaware of free platforms that provide all the functionalities of Adobe Connect or BigBlueButton for larger groups.

EMERGE students weren't offered extra credit for participating in the virtual office hour sessions, but there was external motivation in the form of Classcraft™ points. However, students indicated on their post-survey questions more agreement than disagreement with the statements "Even if there were no Classcraft™ point bonuses, I would still participate in weekly online discussions" (mode = agree, range = 1-5) and "Even if there were no Classcraft™ point bonuses, I would still participate in the webinars" (mode = strongly agree, range = 1-5). This suggests that, once students had experienced the benefits of participation for themselves, many no longer needed external motivators to convince them to attend virtual office hour sessions.

INTERPRETATION AND CONCLUSION

My first research question is difficult to definitively answer with the data I collected. How does adding virtual office hours change student's experience of their science course? The Likert-like comparison questions did not detect a noticeable change in student perceptions of or satisfaction with their course. However, those students who did participate in interviews communicated that the sessions were a positive addition to the course. Dr. Graves also felt that they enhanced the quality of the course. It may be that the survey questions were a poor fit for my actual research questions. Frequent changes in my intervention and in my research questions, coupled with the restraints of having the IRB committee approve any survey instrument changes, led to a less than perfect match between my questions and the research instrument. There were many superfluous questions in the survey that did not apply to any of my three final research questions, and others that were noticeably absent come data analysis time. Straight forward Likert-like questions that directly address this first research question, such as "I am satisfied with this course," "I understand this material well," and "I'm glad the virtual office hours were added to the course" were conspicuously absent. Alternately, if the student survey participants were more representative of the group as a whole, rather than self-selecting as those with more favorable attitudes to the process as a whole, the results might have been a bit different. Despite these limitations, I feel confident in saying that most students at EMERGE felt their courses was enhanced by the implementation of virtual office hours.

For the second research question, the data more strongly supports a definitive answer to the research question. How does adding virtual office hours impact student engagement in their science course? The data supports a conclusion that the virtual office hours led to increased engagement. An analysis of the quantity and quality of student discussion posts supports that the class was more engaged online during the intervention weeks than they were in prior week. Dr. Graves strongly felt that students were more engaged in class during the intervention weeks than they had been in prior weeks. And during the interviews, students expressed that they spent more time thinking about the material and were more confident during class discussion after the intervention had started. Both Dr. Graves and several of the students emphasized that more time spent on the material between classes led to higher quality in-class discussions. The three components of the class, the in-person class sessions, asynchronous virtual discussions, and synchronous virtual office hour sessions, together helped to build an environment of more engaged learners.

My final research question was the most open-ended, and therefore the most complicated to answer. What has this project taught me about the conditions needed for successful implementation of virtual office hours? I learned of a few basic conditions that are needed or at least strongly advised for implementing office hours, as well as others that depend more on the goals for a particular program.

For basic conditions, successful implementation of virtual office hours depends first adequately communicating what they are and what students will get out of them. This should be attempted by describing them fully to students, but motivating students to

attend a session to experience them first hand should also be a priority. This could be facilitated by either requiring attendance to a certain number of sessions a semester, or by giving extra credit or some other type of external motivator, like Classcraft™ points, for attendance. If the attitudes of EMERGE students are any indicator, once students experience virtual office hours for themselves, those who would continue to benefit from them may choose to attend more sessions without any external motivator needed.

Based on my literature review, I was expecting to find the integrated whiteboard a more essential feature. However a basic, secure webinar setting without extra features like integrated whiteboards is probably sufficient for most situations. Lack of access to more sophisticated options should not prevent the development of an effective virtual office hour program. In terms of timing, an ideal situation would include offering sessions at different hours each week, so that students could choose the time that best meets their needs. Perhaps surveying students as to when they are available could assist in selecting the best time for a given group. However, time constraints for instructors must also be considered, as offering multiple time slots for office hours increases their work load.

Beyond that, I detected two primary functional benefits of the sessions, 1) providing content support for students, and 2) providing a virtual place for students to communicate with each other. The conditions needed to support these two benefits vary somewhat, and are described in Table 6. A program that aims to achieve both these end goals should attempt to match as many of these conditions as possible.

Table 6
Essential Conditions Needed to Support Primary Benefits of VOH

	Providing content support	Providing a place for student-student virtual communication
Role of instructor	Essential to have either the instructor or an informed TA facilitating sessions.	Not essential. Someone in authority needs to facilitate, but content knowledge is less important.
Role of other students	Not essential, but can be helpful to have other students present.	Essential to have critical mass – one or two students present is not sufficient.
Role of asynchronous discussion forums	Recommended to help generate questions and assist the facilitator in preparing for the session, but not essential.	Recommended to further support student-student communication in between sessions, but not essential.

If asked to advise others on the implementation of a virtual office hour program, my tips for success are first that it is ideal but perhaps not essential to have group sessions rather than private or semi-private sessions. I found asynchronous discussion forums valuable for preparing both students and the facilitator for participation, and recommend using them. I also found that having the teacher of the class as the facilitator might not be necessary, and externally motivating students to participate might not be necessary. However, it is advisable to have a plan to jump-start participation, to avoid the low enrollment problem I encountered with my UTHS students. This could take the form of extra credit or an external motivating system, like Classcraft ™. Alternately, requiring attendance at one or two sessions at the start of a new course could work. In general, lowering barriers for participation, by integrating office hours into existing courses, should help get students in the "door" and experiencing virtual office hours for

themselves. Once this happens, those who benefit from virtual office hours might return on their own without additional recruiting effort by the facilitator or the school.

While virtual office hours are specifically mentioned as a means of "facilitating discourse" within the Teacher Engagement Framework, providing content support by using virtual office hours encompasses other core practices of the framework, too (Borup et. al., 2014). They also serve as a means to monitor student understanding, and to provide feedback and group tutoring to students. The Teacher Engagement Framework was originally conceived to help account for the more significant role that teachers play in the successful design of online high school classes. However, I found it interesting that one of the two primary benefits I detected, providing a place for virtual student-student interaction, is only supported within the traditional framework for designing online courses, the Community of Inquiry model (Garrison et al., 2010). Within this model, Social Presence, including the support of student-student discourse, is given equal weight alongside Cognitive Presence and Teacher Presence. A blended learning course would be expected to have both higher Teacher Presence and Social Presence over an online-only course. I was surprised, therefore, to realize that students at EMERGE still strongly valued the virtual office hours for their ability to enhance Social Presence. For completely online, asynchronous courses, like those at UTHS, I would imagine that impact would be even greater.

Overall, my focus question was, "Are virtual office hours a meaningful addition to an online or blended learning course?" The data does support that they were a meaningful addition to the EMERGE chemistry and physical science courses that I was

involved with. I continue to believe that they could also be a meaningful addition to UTHS online science courses, by building engagement and providing more opportunities for synchronous student-teacher and student-student communication. Implementing virtual office hours successfully with UTHS would have its challenges, but could be done successfully with the right support. A follow up attempt to implement virtual office hours with this group, using lessons learned from my experience with EMERGE, would be a great next step towards establishing them as part of the school culture.

VALUE

As a result of this study I have a renewed appreciation for the potential of online education to meet the needs of students in high school settings. I have seen many students come through my classes who turned to the online setting because traditional school did not meet their needs, but watching them struggle has led me to believe that many of these students are not having their needs met in online schools either. There are some students for whom asynchronous, self-paced, online classes are a great fit, but there are many others who are falling through the cracks due to low self-regulatory skills or lack of engagement. As an adult, I have greatly appreciated being able to pursue my educational goals in the flexible learning environment provided by the MSSE program, but many high school aged children are still developing the skills needed to succeed in such an environment. I was starting to question my role in participating in online high schools at all.

In considering what I could do to improve outcomes for my UTHS students, I did extensive research on aspects relating to high school students and online learning that did

not make it into this final capstone. All that research has helped me tremendously in approaching my present role with new eyes, as I have learned to appreciate the influence that I have as an instructor in helping students work through their program. The human connection that is built between teacher and student in a traditional classroom also needs to be nurtured in a virtual classroom, and building a place for that to happen into the design of an online course should be a priority. I have also seen our school working, under new leadership, to implement many of the best practices and new ideas that I have been reading about, and am excited to be a part of improving our program for our students. It was disappointing when low student interest stalled my efforts to pilot virtual office hours for our school, but my ideas were warmly received by our administration and may yet find a place in some of our courses. Finishing out this process by implementing my ideas with EMERGE students was an unexpected twist, and one that gave me yet more insight into how creative implementation of online learning can meet the needs of diverse groups of students.

REFERENCES CITED

Baker, C. (2010). The Impact of Instructor Immediacy and Presence for Online Student Affective Learning, Cognition, and Motivation. *The Journal of Educators Online, 7*(1), 1-30.

Borup, J., Graham, C., & Drysdale, J. (2014). The Nature of Teacher Engagement at an Online High School. *British Journal of Educational Technology, 45*(5), 793-806.

Cavanaugh, C., & Liu, F. (2011). Success in Online High School Biology: Factors Influencing Student Academic Performance. *The Quarterly Review of Distance Education, 12*(1), 37-54.

Classcraft Studios Inc. (2004). *Classcraft Overview*. Retrieved from http://www.classcraft.com/

Edwards, J.T. (2009). Undergraduate Millennial Students' Perceptions of Virtual Office Hours. *International Journal of Instructional Technology & Distance Learning, 6*(4), 45-54.

EMERGE Bozeman Homeschool. (n.d.). *EMERGE*. Retrieved from http://www.emergemt.com/

Espasa, A., & Meneses, J. (2010). Analyzing Feedback Processes in an Online Teaching and Learning Environment: an Exploratory Study. *Higher Education, 59*(3), 277-292.

Garrison, D.R., Anderson, T. & Archer, W. (1999). Critical inquiry in a text-based environment: Computer conferencing in higher education. *The Internet and Higher Education, 2*(3), 87-105.

Garrison, D.R., Anderson, T. & Archer, W. (2010). The First Decade of the Community of Inquiry Framework: a Retrospective. *The Internet and Higher Education, 13*(1), 5-9.

Guerrero, M., & Rod, B. (2013). Engaging in Office Hours: A Study of Student-Faculty Interaction and Academic Performance. *Journal of Political Science Education, 9*(1), 403-416.

Hooper, J., Pollanen, M., & Teismann, H. (2006). Effective Online Office Hours in the Mathematical Sciences. *MERLOT Journal of Online Learning and Teaching, 2*(3), 187-194.

Jackson, L.E. & Knupsky, A. (2015). "Weaning off of Email": Encouraging Students to

Use Office Hours over Email to Contact Professors. *College Teaching, 63*: 183-184.

Mawn, M., Carrico, P., Charuk, K., Stote, K., & Lawrence, B. (2011). Hands-on and Online: Scientific Explorations Through Distance Learning. *Open Learning, 26*(2), 135-146.

Morris, L., Finnegan, C., & Wu, S. (2005). Tracking Student Behavior, Persistence, and Achievement in Online Courses. *Internet and Higher Education, 8*(3), 221-231.

Picciano, A., Seaman, J., Shea, P., & Swan, K. (2012) Examining the Extent and Nature of Online Learning in American K-12 Education: The Research Initiatives of the Alfred P. Sloan Foundation. *Internet and Higher Education, 15*(2), 127-135.

Queen, B., and Lewis, L. (2011). *Distance Education Courses for Public Elementary and Secondary School Students: 2009–10* (NCES 2012-008). U.S. Department of Education, National Center for Education Statistics. Washington, DC: Government Printing Office

Ronsisvalle, T., and Watkins, R. (2005). Student Success in Online K-12 Education. *The Quarterly Review of Distance Education, 6*(2), 117-124.

Rovai, A. (2002). Sense of Community, Perceived Cognitive Learning, and Persistence in Asynchronous Learning Networks. *Internet and Higher Education, 5*(4), 319-332.

University of Texas K-16 Education Center (n.d.). *ASKME Courses ® Overview*. Retrieved from http://www.utexas.edu/ce/k16/cbe-ea/askme/overview/

University of Texas K-16 Education Center (n.d.). *UT High School*. Retrieved from http://www.utexas.edu/ce/k16/ut-high-school/overview/

U.S. Department of Education (2014). *Enrollment in Distance Education Courses by State: Fall 2012.* Washington, DC: Author.

Wallace, F.L., & Wallace, S. (2001). Electronic Office Hours: A Component of Distance Learning. *Computers & Education, 37*, 195-209.

APPENDICES

APPENDIX A

UTHS PILOT STUDY

Methodology

My original intervention was meant to be six weeks of virtual office hours, offered twice a week from January 27th through March 3rd. I planned to hold sessions both during morning hours and evening hours to better accommodate student schedules, and had arranged to implement the sessions using BigBlueButton, a webinar hosting feature within the Canvas LMS. UTHS is in the process of moving courses over from Speedway to Canvas, and as such I had access to this program. At the time of my intervention, there were 82 students enrolled in Chemistry A at UTHS, with 29 of those students enrolled in my section and the remaining students divided between two other teachers.

On January 15th, parents of all 82 students were sent information, including a parent consent form, inviting them to register for the free and ungraded "Che A VOH" office hour course. In addition, I sent follow up emails to my 29 students, with repeat messages sent to eleven students I identified as particularly needing extra help. Only two students, both whom were enrolled in my section, signed up for the intervention and received login instructions for the Canvas sessions. Both these students had recently been at the offices of UTHS receiving extra help from the school's science instructional specialist, who further explained how the office hours would work and encouraged them to enroll. However, neither of those students ever signed in to Canvas, which prevented the project from continuing as planned.

On April 19th, a follow up survey was sent using Google forms to the 24 students who were enrolled in Chemistry A in January but had not yet completed their courses and

exited the system. Of those 24 students, four returned surveys, allowing me to collect some basic information as to why students did not choose to participate. This survey became one data source addressing my research question "What are the conditions needed for successful implementation of virtual office hours?" All other data sources originated from my primary intervention, and are discussed in the next section.

Data and Analysis

Of the four students who responded to the Chemistry A VOH Follow Up Survey, one indicated that they did not know about the virtual office hours, and two more indicated that they knew about the sessions but did not understand what they were. A fourth student did not feel they would be valuable for him. All four students indicated they either would not participate in future office hours sessions or were undecided. All four of students indicated that being offered extra credit would make them more likely to participate, with one more also saying if sessions were offered privately that would also make her more likely to participate. This suggests that if UTHS did a better job of informing students about virtual office hour offerings in the future, and provided extra credit of some sort for participating, more students would elect to participate.

Supporting Documents

A. Parent Email Invitation to VOH

Parents of UTHS students enrolled in Chemistry A,

Starting January 27th, all Chemistry A students are invited to participate in a six-week trial of virtual office hours. This is part of a research study on the effectiveness of virtual office hours for online high school students. **If you or your child would like to participate, please print and sign the attached consent form. A scanned, signed form should be sent to heatswan@gmail.com by January 22nd.**

Students who return consent forms by January 22nd will be given a login by UTHS for the Canvas virtual classroom environment. In this environment, they will be able to virtually attend weekly conferences. At these conferences a Chemistry A instructor will present on topics of difficulty and then conduct a live Q&A session where students can receive additional help with Chemistry A topics. These half-hour sessions will take place at 8:00 PM Wednesdays and 10:00 AM Thursdays (CST), between January 27th and March 3rd. Students may participate in some or all of the sessions as they see fit.

During sessions, students will be able to see and hear the instructor, but will not themselves be visible or audible. They will be able to communicate with the instructor and with other participating students using a conference chat room. Use of inappropriate language while in the chat room will result in immediate removal from that virtual office hour session.

Participation is not mandatory and will be in no way linked to grades for the course. Students who participate will be asked to voluntarily complete a pre-survey and post-survey to help evaluate the effectiveness of the office hours, however completing these surveys is not required to participate in the office hours.

The instructor for these virtual office hour sessions is Heather Swanson, a certified teacher and current UTHS instructor who is also a graduate student pursuing a Masters of Science in Science Education. Any questions about these sessions should be directed to her at heatswan@gmail.com.

Please see the attached consent form, and thank you for your time!

B. Subject Consent Form for Participation in Classroom Research

Project Title: The Effectiveness of Virtual Office Hours for Online High School Students

You are being asked to participate in a research study on instructional practices for online students. You have been identified for involvement in this study because you are enrolled as a student in Chemistry A at The University of Texas at Austin High School (UTHS).

Participation is not mandatory and will be in no way linked to grades for the course. Students who participate will be invited to attend weekly virtual office hours with a UTHS instructor. Signing this consent form does not obligate you to participate in the office hours, but it does give you the option to attend any or all of the sessions. Virtual office hour sessions will take place twice a week for six weeks, starting January 27th 2016 and ending March 3rd 2016. You will also be asked to voluntarily complete a pre-survey and post-survey to help evaluate the effectiveness of the office hours, however completing these surveys is not required to participate in the office hours. You may withdraw from the study at any time simply by not attending additional office hour sessions.

There are no foreseen risks associated with involvement in this study. The benefit is having access to additional help with Chemistry A material.

If you have any questions about the nature of this research or want additional information, please contact Heather Swanson at heatswan@gmail.com.

For students over the age of eighteen:

AUTHORIZATION: I have read the above and understand the discomforts, inconvenience and risk of this study. I, _____*(name of subject)*, agree to participate in this research. I understand that I may later refuse to participate and that I may withdraw from the study at any time.

Printed Student Name:_____ Signature: _____Date: _____

For minor students, under the age of eighteen:

AUTHORIZATION: I have read the above and understand the discomforts, inconvenience and risk of this study. I, _____ *(name of parent or guardian),* related to the subject as _____ (*relationship*), agree to the participation of _____ (*name of subject*) in this research. I understand that the subject or I may later refuse participation in this research and that the subject, through his/her own action or mine, may withdraw from the research study at any time.

Printed Parent/Guardian Name:_____ Signature: _____ Date:_____

Printed Student Name:_____ Signature: _____Date: _____

For all students:

CONDUCT AGREEMENT: I understand that this is a group chat forum and requires that I communicate in a professional manner which includes using appropriate and respectful language when communicating with the instructor and students. The instructor reserves the right to deactivate my access to the chat at any time if deemed necessary.

Printed Student Name:_____ Signature: _____Date: _____

Student email (needed for course log-on):_____

C. Chemistry A VOH Follow up Survey

Student Survey Chemistry A Virtual Office Hours
Earlier this year, all Chemistry A students enrolled at UTHS were given the option to participate in Virtual Office Hours. This free service would have allowed you to interact live with a UHTS Chemistry A instructor through your computer to receive extra help learning Chemistry A material. Please take a few minutes to complete this three question multiple choice survey evaluating why you did not choose to participate.

Participation in this research is voluntary and participation or nonparticipation will not affect your grades or class standing in any way.

Question 1
Please indicate which of the following BEST explains why you did not participate in Chemistry A Virtual Office Hours sessions.
Mark only one oval.
I did not know about them.
I knew about them but didn't understand what they were.
I didn't think I needed any extra help in order to pass Chemistry A.
I did think I needed extra help, but I decided to find a tutor outside of UTHS.
I did think I needed extra help, and I found it by using the free science tutoring provided by UTHS.
I did think I needed extra help, but I didn't think the Virtual Office Hours would be helpful for me.
I wanted to participate, but the times they were offered didn't work for me.
I wanted to participate, but my parents didn't want to sign the release form.
I wanted to participate, but I never got around to signing up.
Other:

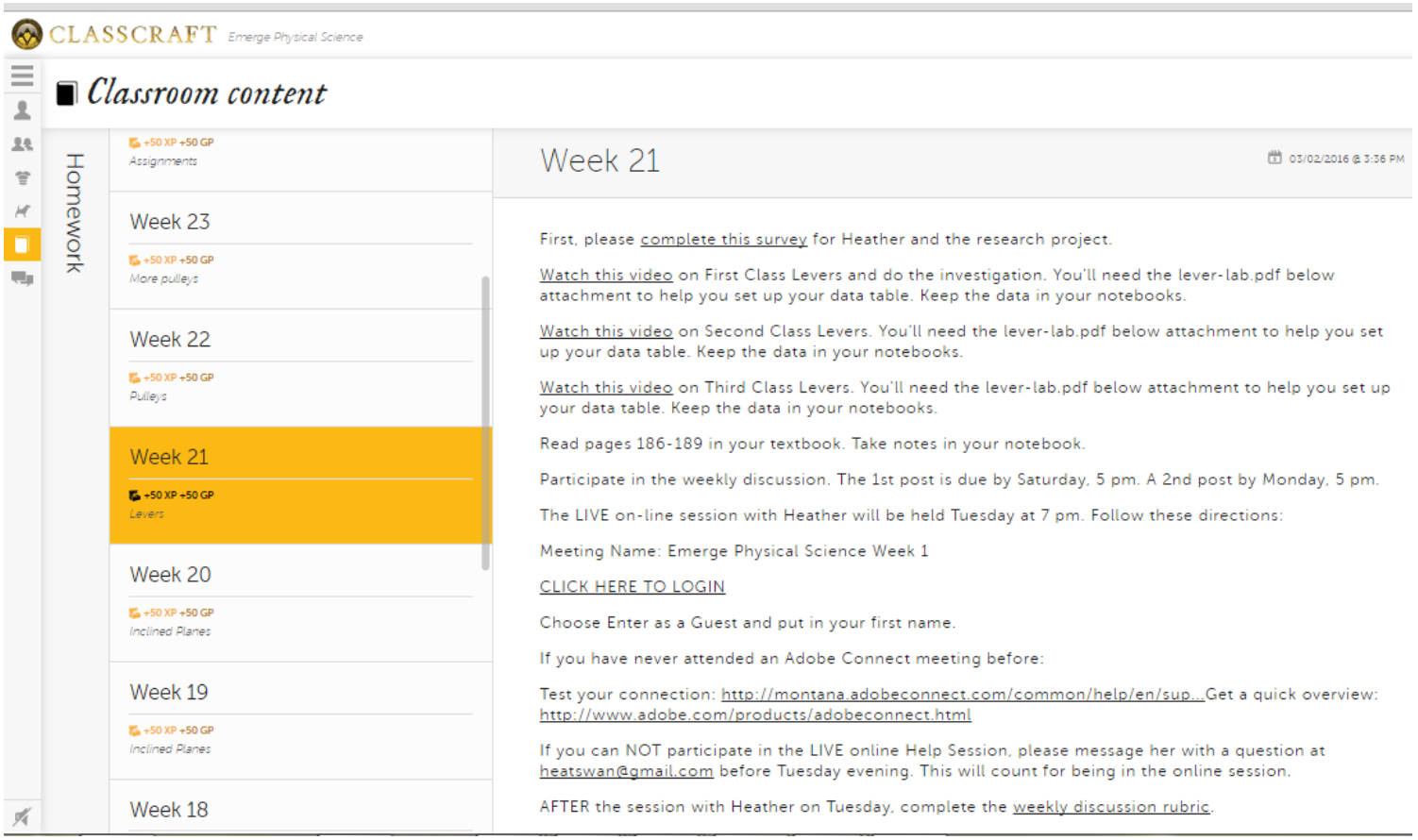
Question 2
If Virtual Office Hours were ever offered again at UTHS:
Mark only one oval.
I would not participate
I would participate
I'm not sure

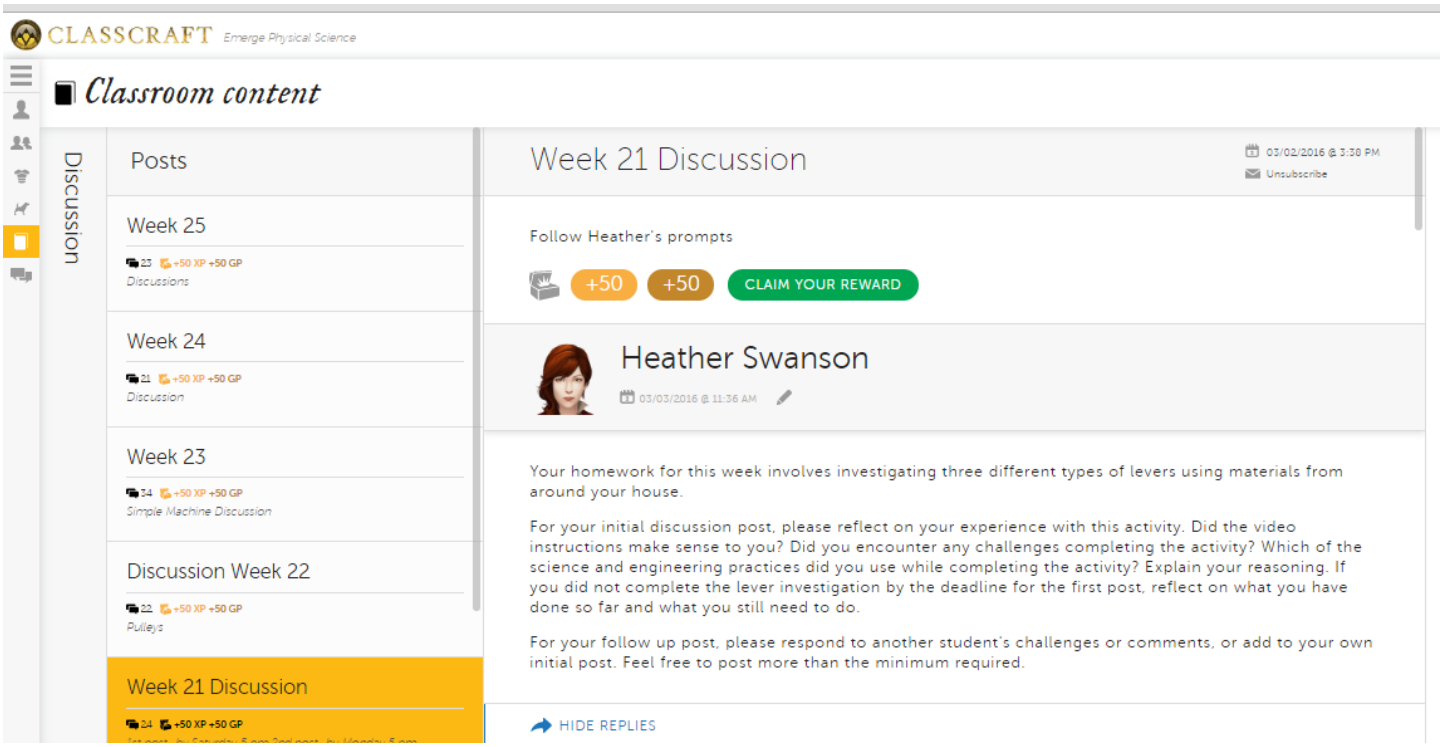
Question 3
If you indicated that you would not participate, or that you were not sure, would any of the following change your mind? You may select more than one answer.
Check all that apply.
If I earned extra credit for attending sessions.
If they were offered at different times.
If they were offered privately instead of in group sessions.
If my parents didn't have to sign a release form.
Not applicable I
said that I would participate.
Other:

Thank you!
Is there anything else you would like me to know?

APPENDIX B

SAMPLE WEEKLY HOMEWORK AND DISCUSSION PROMPTS


CLASSCRAFT Emerge Physical Science
Classroom content
Homework
+50 XP +50 GP
Assignments
Week 23
+50 XP +50 GP
More pulleys
Week 22
+50 XP +50 GP
Pulleys
Week 21
+50 XP +50 GP
Levers
Week 20
+50 XP +50 GP
Inclined Planes
Week 19
+50 XP +50 GP
Inclined Planes
Week 18
Week 21
03/02/2016 @ 3:36 PM
First, please complete this survey for Heather and the research project.
Watch this video on First Class Levers and do the investigation. You'll need the lever-lab.pdf below attachment to help you set up your data table. Keep the data in your notebooks.
Watch this video on Second Class Levers. You'll need the lever-lab.pdf below attachment to help you set up your data table. Keep the data in your notebooks.
Watch this video on Third Class Levers. You'll need the lever-lab.pdf below attachment to help you set up your data table. Keep the data in your notebooks.
Read pages 186-189 in your textbook. Take notes in your notebook.
Participate in the weekly discussion. The 1st post is due by Saturday, 5 pm. A 2nd post by Monday, 5 pm.
The LIVE on-line session with Heather will be held Tuesday at 7 pm. Follow these directions:
Meeting Name: Emerge Physical Science Week 1
CLICK HERE TO LOGIN
Choose Enter as a Guest and put in your first name.
If you have never attended an Adobe Connect meeting before:
Test your connection: http://montana.adobeconnect.com/common/help/en/sup...Get a quick overview: http://www.adobe.com/products/adobeconnect.html
If you can NOT participate in the LIVE online Help Session, please message her with a question at heatswan@gmail.com before Tuesday evening. This will count for being in the online session.
AFTER the session with Heather on Tuesday, complete the weekly discussion rubric.


CLASSCRAFT Emerge Physical Science
Classroom content
Discussion
Posts
Week 25
23 +50 XP +50 GP
Discussions
Week 24
21 +50 XP +50 GP
Discussion
Week 23
34 +50 XP +50 GP
Simple Machine Discussion
Discussion Week 22
22 +50 XP +50 GP
Pulleys
Week 21 Discussion
24 +50 XP +50 GP
Week 21 Discussion
03/02/2016 @ 3:38 PM
Unsubscribe
Follow Heather's prompts
+50
+50
CLAIM YOUR REWARD
Heather Swanson
03/03/2016 @ 11:36 AM
Your homework for this week involves investigating three different types of levers using materials from around your house.
For your initial discussion post, please reflect on your experience with this activity. Did the video instructions make sense to you? Did you encounter any challenges completing the activity? Which of the science and engineering practices did you use while completing the activity? Explain your reasoning. If you did not complete the lever investigation by the deadline for the first post, reflect on what you have done so far and what you still need to do.
For your follow up post, please respond to another student's challenges or comments, or add to your own initial post. Feel free to post more than the minimum required.
HIDE REPLIES

APPENDIX C

IMPLIMENTATION TIMELINE

	Thursday	Friday	Saturday	Sunday	Monday	Tuesday	Wednesday
	3/3	3/4	3/5	3/6	3/7	3/8	3/9
Week 21	Homework and discussion posted		5 PM Initial discussion post due		5 PM 2nd discussion post due	7 PM Physical Science VOH 8 PM Chemistry VOH	Live class session
	3/10	3/11	3/12	3/13	3/14	3/15	3/16
Spring break	Homework and discussion posted						No class
	3/17	3/18	3/19	3/20	3/21	3/22	3/23
Week 22			5 PM Initial discussion post due		5 PM 2nd discussion post due 8 PM Chemistry VOH	7 PM Physical Science VOH	Live class session
	3/24	3/25	3/26	3/27	3/28	3/29	3/30
Week 23	Homework and discussion posted		5 PM Initial discussion post due		5 PM 2nd discussion post due 8:00 PM Chemistry VOH	7 PM Physical Science VOH	Live class session
	3/31	4/1	4/2	4/3	4/4	4/5	4/6
Week 24	Homework and discussion posted		5 PM Initial discussion post due		5 PM 2nd discussion post due	7 PM Physical Science VOH 8 PM Chemistry VOH	Live class session
	4/7	4/8	4/9	4/10	4/11	4/12	4/13
Week 25	Homework and discussion posted		5 PM Initial discussion post due		5 PM 2nd discussion post due	7 PM Physical Science VOH 8 PM Chemistry VOH	Live class session
	4/14	4/15	4/16	4/17	4/18	4/19	4/20
Week 26	Homework posted - no discussion this week						Final live class session

APPENDIX D

WEEKLY DISCUSSION RUBRIC

Discussion Rubric Week 21

* Required

Discussion Rubric Week 21

1. Name *
2. Did I make my 1st post by Saturday, 5 pm? (50 XP)
Check all that apply.
Yes
No
3. Did I make my 2nd post by Monday, 5 pm? (50 XP)
Mark only one oval.
Yes
No
4. Please provide a 1 sentence summary of
your posts. (50 XP)
5. Did I participate in the ASK a SCIENTIST session this week? (50 XP)
Mark only one oval.
Yes
No
6. Did I do all four requirements and earn an additional 100 XP and 100 GP?
Mark only one oval.
Yes
No

APPENDIX E

PRE INTERVENTION SURVEY

Student Pre Survey

Please complete this ungraded, anonymous survey about your study habits and your experience with your science class so far. There are eighteen multiple choice questions, and it should take between five and ten minutes.
Participation in this research is voluntary and participation or nonparticipation will not affect your grades or class standing in any way.
* Required

General Information

1. Name *

2. Class *
Mark only one oval.
Physical Science
Chemistry

3. How many online or blended learning classes have you taken before? *
Mark only one oval.
This is my first online/blended class
I have taken between one and three online classes, not counting this one
I have taken between four and ten online classes, not counting this one
I have taken more than ten online classes already

4. How many hours a week do you currently spend on work for this class, online and offline? *
Mark only one oval.
Usually zero hours
Around 1-4 hours a week
Around 5-9 hours a week
Around 10-15 hours a week
More than 15 hours most weeks

Course Satisfaction

For the next questions, please select the answer that BEST corresponds to the statements that follow.
1 = Strongly Disagree
2 = Disagree
3 = Neutral
4 = Agree
5 = Strongly Agree

5. I feel like my grade in this class is directly in my control. *
Mark only one oval.
1 2 3 4 5

6. I am interested in what I am learning in this class. *

Mark only one oval.
1 2 3 4 5
7. I look forward to working on the material for this class. *
Mark only one oval.
1 2 3 4 5

8. I feel like my instructor is my partner in helping me to learn this material. *
Mark only one oval.
1 2 3 4 5

9. I enjoy participating in weekly online discussions for this class. *
Mark only one oval.
1 2 3 4 5

10. I feel like participating in the weekly online discussions helps me better understand the course material. *
Mark only one oval.
1 2 3 4 5

11. I enjoy using Classcraft™ and am glad it is part of this course. *
Mark only one oval.
1 2 3 4 5

12. I feel that Classcraft™ helps me succeed in this course. *
Mark only one oval.
1 2 3 4 5

Study Habits

For these final questions, please select the answer that BEST corresponds to the statements that follow.
1 = Strongly Disagree
2 = Disagree
3 = Neutral
4 = Agree
5 = Strongly Agree

13. Before I begin an assignment, I carefully read over the assignment so that I am aware of what is required of my performance. *
Mark only one oval.
1 2 3 4 5

14. When I work on my homework, I choose a room where it is quiet and I am not disturbed or distracted. *
Mark only one oval.
1 2 3 4 5

15. My homework is completed on time and I am always prepared for Wednesday class. *
Mark only one oval.
1 2 3 4 5

16. I know what I am doing when I study for most of my schoolwork. *

Mark only one oval.
1 2 3 4 5

17. I do not allow myself to watch TV, chat online, access social media or play games until my homework or studying is completed. *
Mark only one oval.
1 2 3 4 5

18. I am good at estimating how long it will take me to complete an assignment before I start. *
Mark only one oval.
1 2 3 4 5

19. Before I begin my assignments or study period, I will make a list of what I need to do. *
Mark only one oval.
1 2 3 4 5

20. I check or proofread all my assignments before I hand them in to my teacher. *
Mark only one oval.
1 2 3 4 5

APPENDIX F

POST INTERVENTION SURVEY

Student PostSurvey

Please complete this ungraded, anonymous survey about your study habits and your experience with your science class. There are 25 multiple choice questions, plus a few General Information questions, and it should take between five and ten minutes. Participation in this research is voluntary and participation or nonparticipation will not affect your grades or class standing in any way.
* Required

General Information

1. Name *

2. Class *
Mark only one oval.
Physical Science
Chemistry

3. Which of the following options did you and your family consider before deciding to sign up for this science class at EMERGE? (You can choose more than one) *
Check all that apply.
Traditional school five days a week, in person
Online only classes
Home school or self-study, with no teacher outside the home
Working with a private tutor, not a parent
No other options considered
Other:

4. How many hours a week do you currently spend on work for this class, online and offline? *
Mark only one oval.
Usually zero hours
Around 1-4 hours a week
Around 5-9 hours a week
Around 10-15 hours a week
More than 15 hours most weeks

5. How many of the virtual office hour/ Webinar sessions (the live Adobe Connect sessions) did you attend?
Mark only one oval.
None
One
Two
Three
Four
Five

6. If you are open to having me contact you personally to follow up on your answers to this survey and possibly schedule a virtual interview, please include your email address. This is in no way required, but is appreciated! If you prefer I not contact you, just type "no thank you" below. *

Course Satisfaction

For the next questions, please select the answer that BEST corresponds to the statements that follow.
1 = Strongly Disagree
2 = Disagree
3 = Neutral
4 = Agree
5 = Strongly Agree

7. I feel like my grade in this class is directly in my control. *
Mark only one oval.
1 2 3 4 5

8. I am interested in what I am learning in this class. *
Mark only one oval.
1 2 3 4 5

9. I look forward to working on the material for this class. *
Mark only one oval.
1 2 3 4 5

10. I feel like Dr. Graves is my partner in helping me to learn this material. *
Mark only one oval.
1 2 3 4 5

11. I feel like Heather is my partner in helping me to learn this material. *
Mark only one oval.
1 2 3 4 5

12. I feel like Dr. Graves' homework podcasts help me understand the material better. *
Mark only one oval.
1 2 3 4 5

13. When Dr. Graves includes a podcast, I have a better idea of what I am supposed to do for homework than when he just includes the assignment. *
Mark only one oval.
1 2 3 4 5

14. I would prefer it if Dr. Graves included a podcast every week, instead of just sometimes. *
Mark only one oval.
1 2 3 4 5

15. Overall, I'm glad my family and I chose this class, over other options that were available. *
Mark only one oval.
1 2 3 4 5

The next few questions ask about "weekly online discussions". This refers to the forum discussions within Classcraft.

16. I enjoy participating in weekly online discussions for this class. *
Mark only one oval.
1 2 3 4 5
17. I feel like participating in the weekly online discussions helps me better understand the course material. *
Mark only one oval.
1 2 3 4 5

18. Even if there were no Classcraft™ point bonuses, I would still participate in weekly online discussions. *
Mark only one oval.
1 2 3 4 5

The next few questions ask about "webinars". This refers to our weekly live virtual office hour sessions, using Adobe Connect.

19. I enjoy participating in the webinars. *
Mark only one oval.
1 2 3 4 5

20. I feel like participating in the webinars helps me better understand the course material. *
Mark only one oval.
1 2 3 4 5

21. Even if there were no Classcraft™ bonus points, I would still participate in the webinars. *
Mark only one oval.
1 2 3 4 5

The next few questions are specifically about Classcraft

22. I enjoy using Classcraft™ and I'm glad it is part of this course. *
Mark only one oval.
1 2 3 4 5

23. I feel that Classcraft™ helps me succeed in this course. *
Mark only one oval.
1 2 3 4 5

24. I would like it if Classcraft™ was a bigger part of this course overall. *
Mark only one oval.
1 2 3 4 5

25. If I sometimes lost points for things like not completing work, I would still like using Classcraft™. *
Mark only one oval.
1 2 3 4 5

Study Habits

For these final questions, please select the answer that BEST corresponds to the statements that follow.
1 = Strongly Disagree
2 = Disagree
3 = Neutral
4 = Agree
5 = Strongly Agree

26. Before I begin an assignment, I carefully read over the assignment so that I am aware of what is required of my performance. *
Mark only one oval.
1 2 3 4 5

27. When I work on my homework, I choose a room where it is quiet and I am not disturbed or distracted. *
Mark only one oval.
1 2 3 4 5

28. My homework is completed on time and I am always prepared for Wednesday class. *
Mark only one oval.
1 2 3 4 5

29. I know what I am doing when I study for most of my schoolwork. *
Mark only one oval.
1 2 3 4 5

30. I do not allow myself to watch TV, chat online, access social media or play games until my homework or studying is completed. *
Mark only one oval.
1 2 3 4 5

31. I am good at estimating how long it will take me to complete an assignment before I start. *
Mark only one oval.
1 2 3 4 5

32. Before I begin my assignments or study period, I will make a list of what I need to do. *
Mark only one oval.
1 2 3 4 5

33. I check or proofread all my assignments before I hand them in to my teacher. *
Mark only one oval.
1 2 3 4 5

Almost done!

Thank you for allowing me to be a part of your class and for completing this survey! One last question...
34. Is there anything else you would like me to know about the online discussions, webinars, Classcraft™ in general, the class in general... anything? *

APPENDIX G

STUDENT INTERVIEW QUESTIONS

1) What did you like most about the webinar office hour sessions?

2) What did you like least about them?

3) Please elaborate on your answers to the questions “I feel like participating in the webinars helps me better understand the course material” and “I feel like participating in the weekly online discussions helps me better understand the course material”.

4) Do you think the webinars helped you get more out of the actual Wednesday class sessions?

5) Was there any one week or event that stood out to you as being the most helpful?

6) What do you think would have made the webinar sessions better or more useful?

7) How important do you think the weekly online discussions were in making the webinars successful

8) How valuable did you find it to have other classmates present during the virtual office hours?

9) Is there anything else you want me to know?

APPENDIX H

INSTRUCTOR INTERVIEW QUESTIONS

1) Did you notice a change in the in-class discussions after the intervention had started? Please describe.
2) Did you notice a change in requests by students for extra help after the intervention had started? Please describe.
3) Did you notice a change in the overall engagement of students in the class after the intervention had started? Please describe.
4) Did you notice an improvement in submitted work after the intervention had started?
5) Did you notice an overall improvement in student understanding of the material?
6) Were there any differences noticeable to you in how chemistry and physical science students responded to the intervention?
7) Overall, was there anything you particularly liked or disliked about how students responded to the intervention?
8) Will you consider adding virtual office hours to your classes in the future? Why or why not?

APPENDIX I

NOTES FROM INSTRUCTOR INTERVIEW

1) Did you notice a change in the in-class discussions after the intervention had started? Please describe.
    - Response: Yes, Students more engaged, the depth of discussion was greater. The rigor around the discussions was better, students were generally more informed and therefore more confidant, and had more things to talk about.
2) Did you notice a change in requests by students for extra help after the intervention had started? Please describe.
    a. Response: No, not really. Same students who asked for help before were asking for help after
3) Did you notice a change in the overall engagement of students in the class after the intervention had started? Please describe.
    a. Yes, certainly more engaged during the face to face sessions. Having them directly interacting with Heather and each other connected the weeks more than just watching the video or podcast. The combo of required discussion contact and face to face contact with me kept them mentally in the class for more time.
4) Did you notice an improvement in submitted work after the intervention had started?
    a. Not really
5) Did you notice an overall improvement in student understanding of the material?
    a. Yes, mostly discussion, more time → cycle of time, talk, understanding, talk, understanding
6) Were there any differences noticeable to you in how chemistry and physical science students responded to the intervention?
    a. Yeah, PS did better job engaging in online discussions. Easier to get physical mass with more students.
7) Overall, was there anything you particularly liked or disliked about how students responded to the intervention?
    a. Nothing changed for the worse. Wished culture established at start
8) Will you consider adding virtual office hours to your classes in the future? Why or why not?
    a. Yes, hesitancy is time. And technology

Have students be discussion leaders, summarize weekly discussions.

Phys kids might have been bored – ended up spending most of the course on motion, such that they may have felt disengaged by the end by the material.

S – what changed for her from start of year to now? Dr. Graves indicated a much changed/improved attitude

G– suffered socially

Gradebook numbers – before and after the intervention. Grades went down. Assignment submission dates – no change. Impression of Classcraft levels as a measure of engagement – probably ok to do.

APPENDIX J

ASYNCHRONOUS DISCUSSION POST CODING TABLE

Chemistry, before intervention

Type of post	Example	Frequency
Non-contributing response		
One word or sentence fragment response		
Agreement without elaboration to another student's post		
Direct answer to prompt	"Well, it was kind of weird that when you added up the mass of the two reactants it was LESS than the actual mass of the product. Shouldn't it have been the same? Maybe the reaction used something in the air to combine with the other two chemicals which made it result in a product with a bigger mass?"	10 of 12 83%
Other post or comment that moves the discussion forward	"Good point…I forgot about Gladys being retired. That would probably complicate things. The husband and plumber do sound suspicious. Oh yeah, rising temperature is supposed to make the pressure greater. I wonder why the lake is the opposite. I guess all of that water pressing down just makes the bottom have higher pressure."	2 of 12 16%
Help seeking		
Help providing		

Chemistry, after intervention

Type of post	Example	Frequency
Non-contributing	"I can't make it to the online discussion because my friend has a eagle scout honor ceremony tonight"	4/41 10%
One word or sentence fragment response		
Agreement without elaboration to another student's post		
Direct answer to prompt	"I think what happened is the fresh water one melted faster because it was pretty much living with the water if you know what i mean, so it collapsed on all sides to make it melt faster. Whereas the salt water is more dense so the ice gets to sit on it and melt as a layer over the water. The ice cube doesn't dissolve with the salt water, it melts on it. IDK, but that's my opinion/hypothesis."	13/41 32%

Other post or comment moving the discussion forward	"Well, pressure was an important topic we focused on and Im going to do that one, so maybe you could include that one?"	4/41 10%
Help seeking	"I don't really understand Endothermic reactions. How could the heat from the surroundings transfer to the products of the reaction?"	13/41 32%
Help providing	"Absolute zero is when all the motion in matter stops, kinda like that kinetic energy and temperature thing we did, where if you lower the temperature the particles inside will slow down. Absolute zero is when it stops. I hope I am right on this one, but i kinda had trouble with this one too."	7/41 17%

Physical Science, before intervention

Type of post	Example	Frequency
Non-contributing	"verry interesting"	11/36 31%
One word or sentence fragment response	"A tire swing"	13/36 36%
Agreement without elaboration to another student's post		
Direct answer to prompt	"I thought that it was interesting how Galileo and his friends had to get creative with figuring out a way of measuring time for the pendulum on the video. That was really cool how they used the star and the building to measure time."	12/36 33%
Other post or comment that moves the discussion forward		
Help seeking		
Help providing		

Physical Science, after intervention

Type of post	Example	Frequency
Non-contributing	"Ya I think that is all"	8/97 8%
One word or sentence fragment response	"and anilizing and interpreting dat"	2/97 2%
Agreement without elaboration to another student's post	"Yes I agree that the videos were a little confusing and the third measurement was much harder."	8/97 8%
Direct answer to prompt	"I learned that gears are kind of like an inclined plane. Both simple machines trade force for something else. With gears you can trade rotational speed for force and	56/97 58%

	with inclined planes you can trade distance for force."	
Other post or comment that moves the discussion forward	"I'm wondering if this investigation is going to be similar to the pendulum one. Where on the pendulum investigation of you changed the length of the pendulum by a third you would get half the frequency. I wonder what you would have to change to get twice as much mechanical advantage for the lever."	17/97 18%
Help seeking	"I watched the video. gears are hard to understand and I m totally lost on the worksheet. I have no idea how you do it."	5/97 5%
Help providing	"On page 188 in our textbooks shows pictures of the three classes of levers. It helps visualize where the effort force and resistance force are positioned as well as the folcrum."	2/97 2%

APPENDIX K

VOH ARTIFACTS SUMMARY

Chemistry

Topic	Participants and Duration	Questions addressed that originated from the discussion thread	Additional questions addressed	Total number of direct questions addressed
21: Acids and Bases	2 students 40 min	• If acids can be powders • The definition of a strong acid or strong base • Other ways of measuring strength of acid besides litmus paper	• What happens when acids and bases combine • What a pH scale measures • What exactly a titration is	6
22: Specific heat and endothermic/exothermic reactions	2 students 40 min	• The difference between kinetic energy, heat and temperature • How can heat from surrounding transfer to products in endothermic reactions • Examples of endothermic reactions.	• How to do calorimetry calculations • How does energy transfer between objects	5
23: Heat and temperature	1 student 10 min	• How normal objects release radiation along with other types of energy		1
24: End of year concept map	2 students 25 min	• How to print content maps	• What I thought of content maps	1
25: Case study	n/a			

Physical Science

Topic	Participants and Duration	Questions addressed that originated from the discussion thread	Additional questions addressed	Total number of direct questions addressed
21: Levers	9 students 45 min	• How to do the third class lever experiment	• Calculating MA from the data for the three levers	2
22: Pulleys	9 students 30 min	• How to complete the assignment using the online pulley simulation	• Why different terms are used to measure MA, and what they mean	2
23: Pulleys and simple machine wrap up	9 students 20 min		• What the pdf homework instructions were – unclear • If students were supposed to answer each other's questions on the discussion board or wait until class	2
24: Gears	9 students 30 min	• How to complete the last page of the worksheet		1
25: End of year concept map	9 students 30 min		• If student content maps had enough detail	1

APPENDIX L

NOTES FROM VOH JOURNAL

Week 21

Physical Science: It took a bit of time to iron out kinks in communication. I wish I had spent more time reviewing levers myself before the session. I tried to use the whiteboard feature to explain where to identify the fulcrum but it felt awkward. I felt answering individual questions went well. I opened audio and spoke back and forth with a few students who had detailed questions, this was helpful. I wish I had thought to upload some pictures of levers to assist. Lots of questions about how to complete the homework lab which I should have prepared better for, but I think we worked through it all.

Chemistry: Relative to physical science, in some ways it was easier to manage student questions with fewer students. I realized later I gave them some misinformation about pH, had to send a follow up email to Dr. G about that. We went over all the different questions that had been raised in the discussion forums. I felt much more comfortable with the chemistry content!

Week 22

Physical Science: There were no big misconceptions, I think most of the class is comfortable with this material. Still some concerns with the terminology/vocabulary, which I was also a bit confused about. The virtual lab used different terms than the ones they used in class. They all left thinking they understood it, but I let John know there is likely going to be more questions with that tomorrow. I spoke privately with one student for some time after the rest of the class logged off, she was confused with the various changing terms for input force/effort force, etc. I had unlabeled images of different pulleys that we labeled together, felt like productive review. I also had a screen shot of the lab that students used to explain to each other what to do, that was great. Students mostly answered each other's questions as they came up.

Chemistry: It felt more productive this week. I knew what students were struggling with before the office hours started, so was able to prepare my thoughts on addressing those issues. I uploaded some images and typed in some definitions into a presentation to help guide us, based on what was coming up in the discussion thread. I ended up using an actual whiteboard rather than the virtual one to review calorimetry calculations. I felt it was helpful for students. They had a lot of content questions.

Week 23

Physical Science: Not a lot of questions or confusion this week. Felt like a review week. There was some debate over the homework assignment, as to if they were supposed to be posting their responses to questions or just writing them in their science notebooks and bringing them to class. We discussed it and did not agree with what Dr Graves meant by his wording of the assignment, but at least they all were reminded that they needed to bring the answers to class, so hopefully they will all do that.

Chemistry: Only one student present – she asked a question about radiation, that she had also brought up in the forums. We chatted a bit about the class in general after that, she shared that she likes that the class is self-paced but still holds her accountable, and that the best part is the lab component.

Week 24

Chemistry: Students felt pretty comfortable with this assignment, didn't have a lot of questions. They did share with each other and me what they had done, both emailed me their concept maps during the session so I could look at them and get them comments. They both decided to add more. They felt this week was more work for them than usual, but that it was time well spent. They couldn't print their maps but we figured out a solution.

Physical Science: The physical science students all seemed comfortable with the worksheet and how gears work on bikes by the end. We went over some of the numbers to make sure we were all doing it the same way, and everyone was able to follow as far as I could tell. They asked some specific questions about gears that I HOPE I was helpful with, I was teaching this to myself before our meeting so I wasn't sure.

Week 25

Chemistry: No one came! There weren't any questions raised on the forums this week, so this wasn't that surprising to me.

Physical Science: Very few questions. I was surprised that we went 30 minutes when I looked at the time, it didn't seem like we did much. We talked a bit about the concepts maps and how to print, etc, and I showed them the self-evaluation rubric. One student shared her map with the group (by attaching it in the discussion forums) and we all looked at it and critiqued. No one else wanted to share. I asked some questions about what their favorite and least favorite parts of the year as a whole were, I guess just chatting about the class in general is where the time went!