A 3D ANATOMY APP AS A LEARNING TOOL

by

Michael John MacKenzie

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DEDICATION

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ABSTRACT

Complete Anatomy is a digital 3D anatomy platform that allows users to manipulate virtual human models. The purpose of this study was to determine whether the students perceived the app as useful, and how they made use of the app to help them understand anatomy and anatomical relationships. At the beginning of the semester surveys and questionnaires were conducted to determine students' initial perceptions of the app. Over the course of the semester, students were given a brief lesson on how to use the app, provided with resources within the app, and given quiz questions based on images created in the app. At the end of the semester surveys, questionnaires and interviews were again conducted to determine of students' perceptions of the app had changed, and to learn how students made use of the app. From the data gathered, students' perception of the app was positive to begin, and became slightly more positive over the course of the semester. Having a brief lesson on how to use the app, and exploring the tools available in the app made a significant difference in the students' comfort with the app. The flexibility of the app to be used when and where they wanted, and the ability to adapt the app to their current study practices were some of the app's greatest strengths according to the students. Complete Anatomy is a powerful, flexible 3D app that students perceive as useful, and in some cases even necessary. Having the ability to work at times and in ways they prefer makes it an app that benefits student learning.

CHAPTER ONE

INTRODUCTION AND BACKGROUND

Context of the Study

I am an instructor at Medicine Hat College, a small community college in Medicine Hat, Alberta Canada. In 2018/19, Medicine Hat College had 2999 students total between both of its campuses in Medicine Hat and Brooks, with 58% of the students identifying as female, and 11% being international students on student visas (Medicine Hat College Quick Facts, 2020). At this college, I teach several different labs and classes including first year Anatomy and Physiology, Introduction to Biology, and Introduction to Human Physiology I and II. For the purposes of this study, I focused my attention and treatment on the Anatomy and Physiology lab classes.

Anatomy and Physiology is a first year A&P class that is comprised primarily of first year nursing and paramedics students. The lecture portion of the class has approximately 120 students, while the labs have approximately 18 students per section. The labs are taught by 3 instructors that collaborate so the students do the same work and assessments, and their work is assessed in a similar manner. Typically, the class has a variety of students. Some of the students are right out of high school, while others are returning 'mature' students, older students that had been away from school for a while, and some are students that are practicing in their fields already but want to supplement or add additional endorsements. The labs are very content heavy, and require the students to make use of microscopes and models, as well as conduct dissections. In this class we do not make use of cadaveric dissections.

A significant challenge students face is accessing the 3D models and histology slides outside of scheduled lab times in order to help them study and prepare for assessments. Labs are three hours a week, with a couple of extra study labs available for students to work with the models and microscopes. Recently, we have seen a significant increase in students using their smart phones to take images and videos of the microscopic images, and models in lab. Students have made effective use of the images and videos, but the lab instructors thought that access to a 3D interactive app would be even more beneficial to their study time.

As a teaching team, we have accessed a 3D Anatomy app, Complete Anatomy from Elsevier (CA) to try and give the students another study tool they can make use of outside of scheduled lab times. Medicine Hat College has licensed this app so it is accessible to all students in the class free of charge, as long as they have some digital device. It can be loaded on phones, tablets, laptops, and towers, and is available for MacOs, Windows, and Android systems.

During the 2020/2021 academic year we relied heavily on CA as the only 3D tool available to the students while they were learning online due to COVID-19. Until that time, it had been a tool that was available to the students; however, it was not something that was actively used by all the instructors or all the students. Based on the experiences prior to, and during the COVID crisis, the app has become a more significant tool in the lab environment. While we as a teaching group believe that CA is a very powerful tool to help students learn and understand anatomical relationships, I wanted to assess whether the students perceived the app as having a positive impact on their learning.

Focus Question

My focus question was, What are the students' perceptions of Complete Anatomy (CA), the 3D anatomical app, as a learning tool?

My sub-questions include the following:

1. Do students feel the app is a useful tool for learning A&P?
2. Do the students feel the 3D app gives them a better understanding of anatomical relationships compared to what they learn from the models?
3. How do the students use the app?

CHAPTER TWO

CONCEPTUAL FRAMEWORK

Background

A typical approach to teaching Anatomy and Physiology in a lab environment involves the use of dissections, prosections, and 3D models that can be handled and manipulated by the students (Havens, 2020). According to Turney (2007), Winkelmann (2007), and Yammine (2015), due to multiple reasons, not all these tools are available to all students. For example, cadaveric dissection and prosection is the gold standard in anatomy laboratories, but due to costs and ethical considerations it is not available in all labs (ben Awadh, 2019; Raney, 2016; Zibis, 2021). For many laboratory classes, students depend on plastic 3D models to examine and learn anatomy and anatomical relationships (Havens, 2020). While these models alleviate issues such as cost, space, regulatory requirements, and social mores associated with cadaveric labs, they can still be prohibitively expensive to purchase, store, and maintain themselves (Fredieu, 2015). As Zibis (2021) stated, another challenge the typical learning modalities present is they cannot be used by students at home during self-study. Considering all the challenges inherent in traditional anatomy laboratory tools, having a new tool that alleviates some of these issues may be very useful for students learning anatomy and physiology.

Mobile technologies such as tablets and smart phones have become ubiquitous in daily life, but like most technology, they can also be very powerful tools in the classroom (Keenan, 2019). According to Magana (2017), technology should be used to unleash student learning potential in ways that are not possible without technology. In order to

help instructors implement technology in the classroom, Magana developed the T3 framework. In this framework, there are three levels of technology implementation: (a) translational, (b) transformational, and (c) transcendent. Translational is the first level where digital technology is simply used to replace analog technology. The second level is transformational where technology is used instructionally in new ways of teaching that could not be done without the technology. The third level is transcendent, which takes teaching and learning beyond what is currently being done in such a way that includes inquiry design and social entrepreneurship (Magana, 2017). Mobile technology can be a tool to help students and instructors attain some, if not all the levels Magana developed.

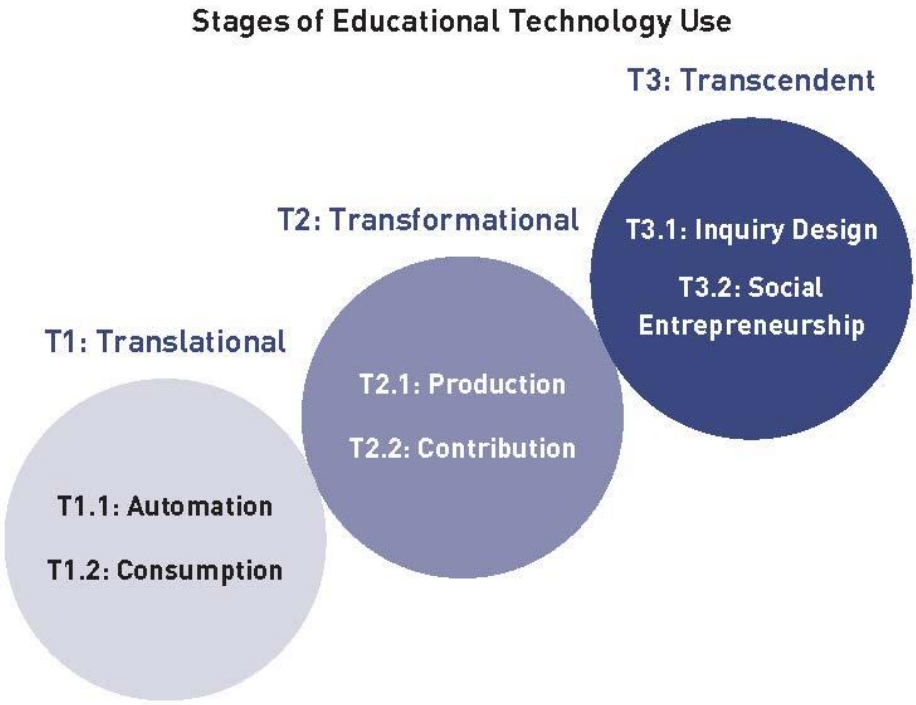

Figure 1. Magana's stages of educational technology use.

Instructors have been making use of technology in classrooms in innovative ways that have improved learning beyond the traditional 2D paper images. Abdinejad et al. (2021) used students' mobile technology in conjunction with a custom designed

Augmented Reality (AR) app to help students learn about 3D chemical structures. The students stated the AR tool improved their ability to visualize and draw 3D molecular structures and that the tools were valuable for their understanding of the content being studied. Reeves et al. (2021) also evaluated using AR to study complex 3D biological relationships. Their students claimed AR to be more interactive and engaging, helped them understand the material better, and would be something they would continue to use in the future. In both studies, students displayed Magana's (2017) transformational level of implementation by experiencing new learning content in ways that would not be possible without AR technology. While the use of AR in the laboratory environment has been shown to be useful, it is not the only way that mobile technology can help students learn.

Mobile Technology in the Anatomy and Physiology Laboratory

Mobile technologies have been used in anatomy labs for a number of years, and over that time how they have been used has evolved. As early as 2012, Mayfield et al. recommended the use of mobile technology in anatomy labs. The study evaluated whether or not iPads would improve dissection learning. They found that students were less reliant on paper and instructor resources, felt they had a greater ability to achieve the laboratory objectives, and had better clarity on the role of dissection in learning anatomy when they had access to iPads while they were performing their dissections (Mayfield et al., 2012). Students were more engaged and more actively involved in the laboratory when compared to groups of students that only had paper resources (Mayfield et al., 2012). Lewis et al. (2014) showed that 3D virtual models improved understanding of

anatomical relationships, and they supplemented existing anatomical teaching. Lewis et al. also predicted that as mobile devices and apps continue to develop and evolve, their use would likely play a larger role in anatomy education.

As mobile technologies have become more powerful it has allowed for the development of multiple types of 3D tools that have increased the flexibility of 3D teaching and learning. Yammine and Violato (2015) did a meta-analysis on 3D Visualization Tools (3DVT) that included 3D static images, 3D animation, 3D movies, 3D interactive programs, and 3D learning environments such as virtual reality. The study showed the use of 3DVT resulted in higher factual knowledge, significantly increased user satisfaction and perceived effectiveness compared to traditional 2D tools.

Research done specifically in anatomy and physiology labs has also showed similar positive results. Several other studies showed increased student engagement, enjoyment, and positive perception of their learning when mobile technology is utilized in the anatomy laboratory as a teaching tool (Chakraborty & Cooperstein, 2018; Morris et al., 2016; Raney, 2016; Scibora et al., 2018; Stewart & Choudhury, 2015). Along with the increased engagement, several studies also showed that students' content knowledge was as good or better than students who did not use mobile technology as a learning tool (Chakraborty & Cooperstein, 2018; Morris et al., 2016; Reeves et al., 2021; Scibora et al., 2018). When you combine the positive perceptions students have, with the flexibility and efficacy of mobile technology it is inevitable that instructors will have to add it as a teaching tool.

Magana (2017) claimed that technology needs to help students learn in ways that would not be available to them without it, and the COVID-19 situation epitomized that

claim. As Canipe (2020) stated, in the COVID-19 environment the shift to online teaching was both rapid and unprecedented. Mobile technology has been a significant tool in that transition. Combining the current situation in teaching with the fact that learners perceive mobile technology as helping improve their learning, it is inevitable that more learning will involve mobile technology in the future.

CHAPTER THREE

METHODOLOGY

Demographics

The goal of my action research was to use a mixed methods research design to determine the effectiveness of Complete Anatomy (CA), a 3D anatomical app, as a tool in teaching the laboratory sections of an Introductory Anatomy and Physiology course. While students still made use of more traditional lab tools, I wanted to learn if the app was something they would use to supplement, improve, or even replace some of those tools. By understanding what the students' perceptions of the app were, I am able to adapt my teaching to utilize it more effectively. A secondary benefit of this research is that I am able to provide feedback to the college about the app, as they currently license it for the students at a significant cost. The research methodology for this project received an exemption by Montana State University's Institutional Review Board and compliance for working with human subjects was maintained (Appendix A).

Medicine Hat College transitioned back to a predominantly face to face learning environment in the Fall of 2021; however, after the previous eighteen months of online learning there were significant changes in teaching practices. In many of the classes on campus, blended or flipped classrooms became much more common, and even in our face-to-face labs the use of technology and tools that were first utilized in the online environment became the norm. For the first time in my instruction, students completed assignments that are only available online, and students used eTexts versus paper textbooks. This was beneficial to my action research because it meant that all the

students brought their own devices to the lab, which means everyone had access to CA in lab.

There were 90 students registered in Biology 277, 57 of them were bachelor of nursing students, 25 were applied degree paramedic students, five students were open studies, two were university studies science, and one was a university studies arts student. Seventy-six percent of the students identified as female, while the remaining 24% identified as male. While no official data was provided, there were minority students from several ethnic backgrounds, including Indigenous, Arabic, Philippine, Pakistani, African, and Chinese registered in the course. Several of the learners were second language learners, while nine of the students were students on accommodations. Only four of the ninety students were older students that had been away from school for a while and considered mature students. Anecdotally, the breakdown of the students was typical. Biology 277 is a required course for both the Nursing and Paramedic programs, so generally speaking they make up the vast majority of the students in our labs.

While this group was demographically a typical lab group, a significant difference between this group and other groups I have taught is that almost all the students were online learners last year. Having come from that experience I expected the students to be a little more comfortable with the technology being utilized, but we also found that as a group the students were struggling in the face-to-face environment. This was evident by an increase in the number of students asking, ‘How do I study?’, ‘What do I need to do to prepare for my quizzes?’, and just a general lack of understanding about the time commitment necessary to be successful in the course.

Research Design

Qualitative Research Design

According to Flick (2011) and Mertle (2020) qualitative research design is less common than quantitative. Flick states that theoretical knowledge, a researcher's perspective, methods, and available resources are all influences that impact research design. While Mertle points out that qualitative research is no less important than quantitative, it tends to be less structured. In the work I did, my approach was what Mertle referred to as the Triangulation Mixed-Methods Design as both the qualitative and quantitative data had equal value with regards to interpretation.

The objectives of the study are to compare students' perceptions of technology pre and post treatment to see if their perception of technology changes, and to gather information on their perception of the CA app itself. Using qualitative measurements such as interviews I was able to gather some information about how students used technology and students' perceptions about the CA app specifically. As Roulston (2018) pointed out, interviews are ubiquitous throughout society and are used in anything from research to the media.

Students were asked to voluntarily participate in interviews post treatment. The interviews were designed to gather information on their perceptions of technology, to see if their perceptions change over the course of the treatment, and to gather feedback directly related to the CA app. The post treatment interview was a tool I used to see what changes students made over the course of the semester with regards to their use of technology as a general tool. I use and encourage the use of several different apps as learning tools, so by performing these interviews I was able to see if their general use of technology changed, not just their use of the CA app. While there were too many factors

to be able to determine causality, by looking at both students' tech use in general and the specific use of CA I could see if there a was relationship between the two.

Quantitative Research Design

According to Mertler (2020) an example of Quantitative Research design is a Descriptive Design. Of the two types of descriptive designs Mertler discussed, my research fit the survey research design. I did this by making use of pre and post treatment Likert Type scales. Likert Type scales are a format for measuring self-reported attitudes or beliefs about something (Horst et al., 2018). By using these scales, I was able to gather data that informed me of the perceptions my students had, and how those perceptions may have changed over the course of the treatment.

To answer whether Complete Anatomy is an app that is beneficial to students in my Anatomy and Physiology lab I wanted to gather information about students' response to CA initially and then again at the end of the treatment period. This was done using a Likert Type Scale at the beginning of the semester, and then the same scale was used post treatment at the end of the semester. This included their comfort (is the app intuitive and user friendly) with the app, the perceived usefulness of the app, the students' expected use of the app (pretreatment) vs their actual usage of the app (post treatment). By using a Likert Type scale, I had quantitative data that was used to support the qualitative questions asked as well.

Treatment

Within the first week of the semester, the students were given both the Biology 277 Tech Survey and the Beginning of Semester Questionnaire. The students were given

two weeks to complete the survey and questionnaire. After the two weeks I then gave the students a lecture to help them understand Complete Anatomy, this included what tools were available to them, and possible ways they could be used to help the students study and prepare for their labs. Along with the lesson on the app itself, over the course of the semester I brought the app in as a teaching tool, sharing images and Screens with the students throughout their lab lectures and while helping them work through their lab assignments. Students joined a 'Group' called Biology 277 W22 within the app. This group allowed the instructors to share 'Screens', fully interactive models the user builds, and resources we had built out to the students (Figure 1). Students were also able to build their own Screens based on the material being covered and share them amongst themselves in their study groups.

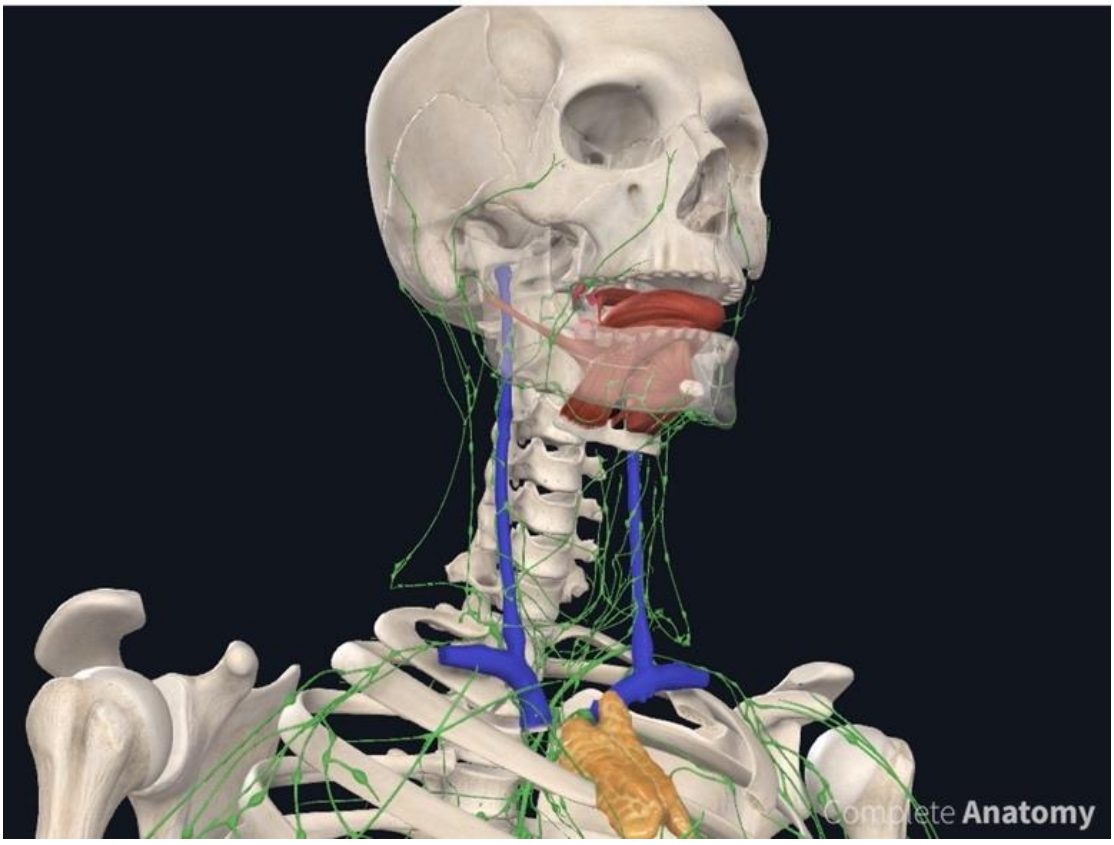

Figure 2. An image of a Screen used in the Biology 277 Complete Anatomy Group.

Along with the ability for the students to make their own Screens to study from, the app includes a quiz building tool. The students were able to use this tool to create their own study quizzes that utilized the Screens and Questions created by either the instructors or themselves. Students were also taught how to build study Groups within the app that allowed them to share the Screens, Questions, Quizzes, and resources they developed amongst themselves. In my labs, exemplars of Questions, Quizzes, and Screens that were developed by the students were shared to the entire lab section as a means to promote the use of the app as a study tool. The specific goal of the treatment was to create an environment that encouraged the students to make use of CA in ways they found to be most effective.

Data Collection and Analysis Strategies

While Complete Anatomy is a very powerful app that has many tools that can be very effective the goal of this action research was to determine if the students felt the same. In the treatment, the students were encouraged to make use of the app, and many of the tools available to them were either used or modelled. Over the course of the semester data was gathered to attempt to understand how the students used the app to study, learn, and understand anatomical relationships.

Data Collection Methods

Table 1. Data Triangulation Matrix.

	Focus Questions		
Data Collection Instruments	Do students feel the app is a useful tool for learning anatomy and physiology?	Do the students feel the 3D app gives them a better understanding of anatomical relationships compared to what they learn from the models?	How do the students use the app?
Biology 277 Tech Survey	X		X
End of Semester Tech Survey	X	X	
Beginning of Semester Questionnaire			X
End of Semester Questionnaire	X	X	X
Complete Anatomy Interview	X	X	X

Biology 277 Tech Survey. The instrument that I used first was the Biology 277 Tech Survey (Appendix B). This scale was made available in the first two weeks for the students to fill out on Google Forms. The goal of this instrument was to establish a baseline of how the students use and perceive technology and Complete Anatomy (CA) both in the lab environment and as tools available to them when preparing. The data collected was ordinal data analyzed quantitatively (Bowen, 2014). According to Horst (2018), Likert Type scales measure self-reported attitudes or beliefs and by using this scale, I was able to gather data that helped me understand my students' perceptions of and comfort with technology including the CA app. While the focus was not just on CA, it gave me an opportunity to collect data that helped me understand where students started from with respect to their comfort with technology. I felt it was important to

understand how students felt about using technology as a tool to see if there was a relationship between a students' comfort or perception of technology and their perception and willingness to utilize an app like CA. This data gave me the opportunity to reflect on whether a student's initial perceptions may have influenced their final perceptions of the app when the semester was over.

End of Semester Tech Survey. The End of Semester Tech Survey (Appendix C) used was a posttreatment Likert Type Scale that was similar to the beginning of the semester Likert Type scale. As with the pretreatment scale, the data collected here was quantitative, ordinal data. Using this posttreatment scale allowed me to observe if there were any significant changes in perceptions towards technology use and CA after a semester where the technology was an integral part of the students' learning environment. While I was not able to show if specific students had changed their perceptions, I was able to show overall if there was a change in the group's perceptions.

Beginning of Semester Questionnaire. The Beginning of Semester Questionnaire (Appendix D) was a survey that combined several different types of items. Some of the items were open ended, while some were multiple choice or Yes/No items. Andres (2020) stated "we read the results of survey research with the purpose of informing our decisions about a range of activities such as buying a car or adopting a new fitness regime" (p. 1). The focus for this study was to help me understand how students use CA and technology, and how they felt about it, so that I could use that knowledge to improve how I use the tools going forward. I also hoped to determine whether there is a justification for Medicine Hat College to continue to license the app for the students' use. These students were in their second semester of the course and had some exposure to CA

and using technology in the lab. This initial survey gave me data about what they perceived would be the benefits and limitations, and whether they planned to make use of it over the course of the semester.

End of Semester Questionnaire. The End of Semester Questionnaire (Appendix E) was the post treatment follow up survey to the Beginning of Semester Questionnaire. Much like the pretreatment survey, this survey provided qualitative data. This survey was focused more on CA itself and was informative about how the students used the app, what the perceived benefits were, and most importantly was it a tool that benefited their studies.

Complete Anatomy Interview. The Complete Anatomy Interview (Appendix F) is a semi-structured series of questions that were used at the end of the semester to gather qualitative data with regards to the students' use of Complete Anatomy in the Biology 277 lab. Interviews allow researchers to "generate detailed descriptions of participants' experience about a phenomenon through asking open questions concerning the participants' feeling, perceptions and understanding" (Roulston & Choi, 2018, p. 4). Through this process I was able to gather thorough, candid information about what the students' experience was while using CA. It was important for me to find out exactly how the students were making use of the app, and while the surveys and scales gave me an idea, by using a semi-structured interview, I was able to gather more specific and detailed information. While the surveys and Likert type scales were informative, the interviews provided the type of information that I could combine with reflection about my instructional practices to come up with more effective instruction in my labs.

Analysis Strategies

According to Flick (2011) and Mertler (2020) qualitative research design is less common than quantitative. While Mertler points out that qualitative research is no less important than quantitative, it tends to be less structured. In the work I did, my approach was what Mertler referred to as the Triangulation Mixed-Methods Design as both the qualitative and quantitative data had equal value with regards to interpretation (p. 108).

Qualitative Data Analysis Technique. The interviews that were used for the qualitative analysis were analyzed through Emergent Thematic Analysis. According to Williams (2012) "emergent themes are a basic building block of inductive approaches to qualitative social science research" (p. 249). As the data is reviewed it is coded into different themes, and then analyzed for connections (Williams, 2012). These themes were based around students' perceptions of technology and CA. The interviews were watched, and student answers were used to determine recurring themes or patterns. Once several themes were identified, students' answers were placed into the appropriate themes. Using this analysis, I was able to see the major themes and, as importantly, I was able to compare those themes to the results of the pre and post treatment surveys. Having this data, I was able to determine if there was a change in students' perceptions over the course of the treatment.

Quantitative Data Analysis Techniques. Using Likert scales is beneficial because it can be analyzed quantitatively. The challenge with the data is whether to analyze the data as ordinal or interval measure (Gracyalny, 2018; Jamieson, 2012). According to Horst et al. (2018), "when using five or less response options, the data can be considered categorical rather than continuous" (p. 3). Ordinal data is categorical with direction, one response being more negative than another, but the difference between the responses is

not necessarily continuous (Jamieson, 2012). By considering the data ordinal, I was able to describe it using frequencies, ranges, and measures of central tendency (Gracyalny, 2018). According to Herbst et al. (2020) "Categorical variables are most often described as counts or percentages" (p. 712). Cox (2020) stated that bar graphs "are very good to compare the frequency of different groups" (p. 51). The Likert data collected pre- and post-treatment was displayed using frequency bar graphs in order to easily visualize student responses. In some cases, the Likert scales from the beginning of the semester, and the end of the semester were analyzed and the bar graphs for each set of data were directly compared to see a visual representation of the students' perceptions both pre and post treatment.

CHAPTER FOUR

DATA ANALYSIS

The purpose of this action research was to determine the students' perceptions of Complete Anatomy (CA), the 3D anatomical app that was used in the Biology 275/277 labs over the course of the year. While the app was introduced as a student tool in the first semester, it was used more as a teaching tool over the course of the second semester. The data collection for this study was done at the beginning and the end of the second semester. The students answered a voluntary, anonymous Likert-style survey (Biology 275 Tech Survey) at the beginning of the semester (*N*=42) and the End of Semester Tech Survey at the end of the semester (*N*=30). The same group of students were also given the Beginning of Semester Questionnaire (*N*=49) and the End of Semester Questionnaire (*N*=31) with qualitative short answer questions. At the end of the semester students were also asked to volunteer for the Complete Anatomy Interview, and there were seven students who were interviewed.

Students seemed very positive about their use of Complete Anatomy. In the Biology 275 Tech Survey when both the 'Agreed' and 'Strongly Agreed' data is combined, 86% (*n=36*) of students intended to use the app over the semester while in the End of Semester Tech Survey 90% (*n*=27) of the students had made use of the app (Figure 3). With that level of positive responses in both surveys it is clear the students felt the app was a useful tool to help them learn anatomy and physiology.

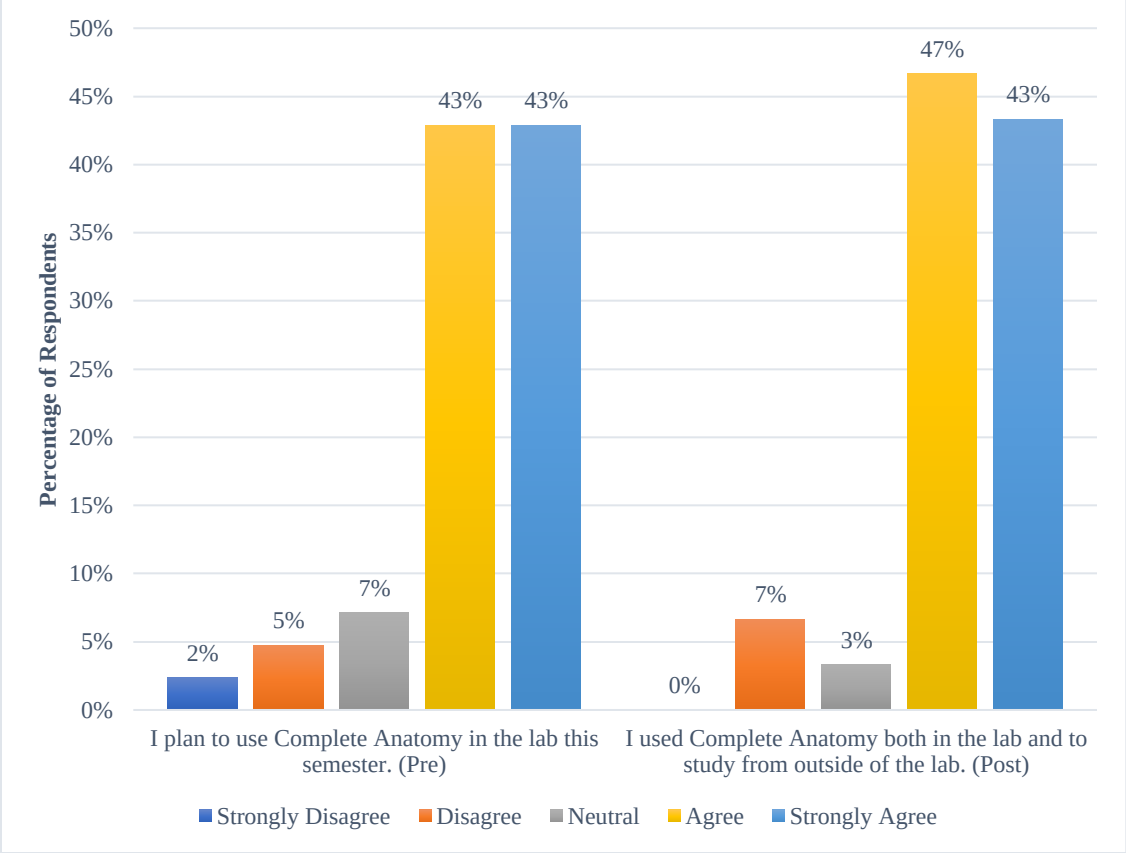

Figure 3. A comparison of the students' pre-treatment (*N*=42) plan to use Complete Anatomy vs their actual use post-treatment (*N*=30).

Student Perceptions

The students in this study were given the app at the beginning of their first semester as a tool to help them understand and find anatomical relationships. By the beginning of the second semester, when the action research was performed, they had had access to the app for four months. While we were concerned whether the complexity and level of information in the app would make it too much of a distraction or too difficult to use this did not seem to be a problem for the students. In the Biology 275 Tech Survey, 27 students either 'Agreed' or 'Strongly Agreed' (*N*=42) that they were comfortable with using the app (Figure 4). In the Beginning of Semester Questionnaire when students

were asked if they were comfortable with the app, 30 students responded positively (*N*=49). Within the positive respondents, a common repeated theme was that while they were comfortable with the app, it was because they had dedicated some time to 'playing around with it' to become comfortable. Another theme that came out in both the positive and negative responses was that the students felt they 'are not using this application to its fullest.'

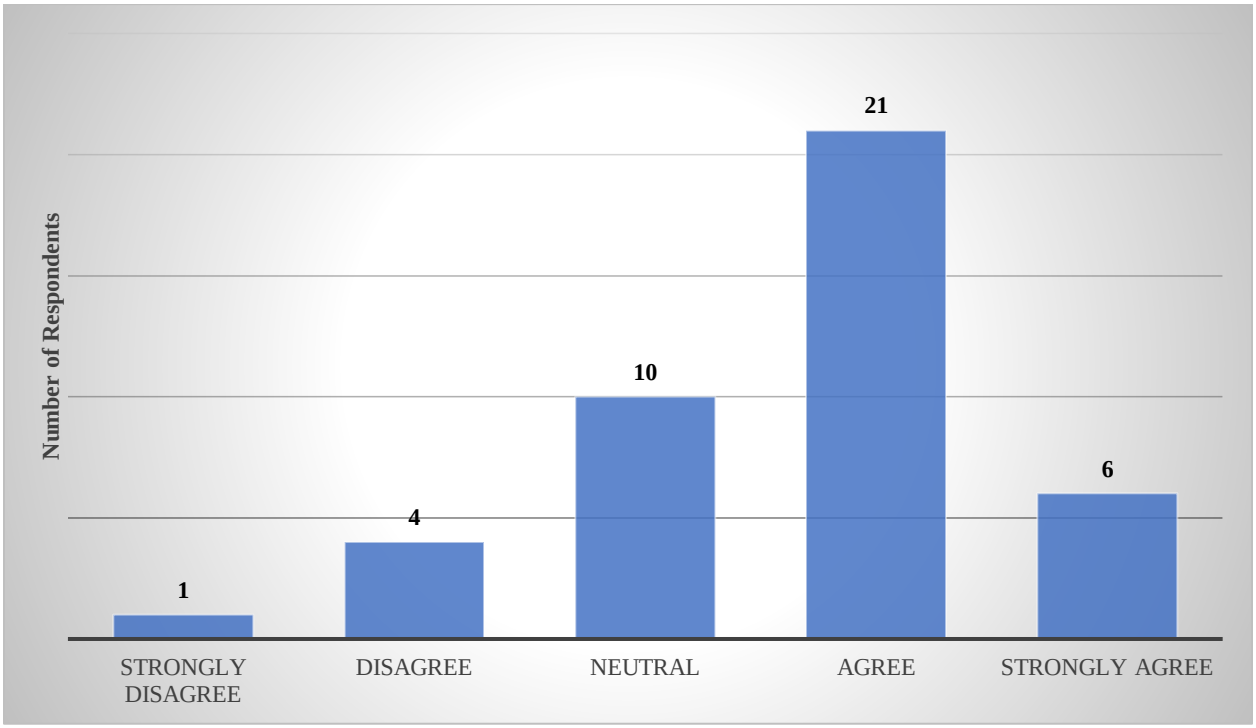

Figure 4. Students' response to the statement "I feel comfortable using Complete Anatomy," (*N*=42).

One of the End of Semester Tech Survey statements was 'Complete Anatomy was too complicated to be useful.' One student agreed with this statement, while 30 either 'Disagreed' or 'Strongly Disagreed' (Figure 5). This statement made it clear that as complicated as CA was, it was not so complicated that it inhibited the students' ability to use it as a learning tool. In the Beginning of Semester Questionnaire respondents were

asked if they had any problems learning how to use the app, and 26 out of the 49 said they had no problems using it. Within that group of 26 respondents, 16 made comments like "It's pretty straightforward." Ten of the 26 respondents felt they had no problem with the app but commented that the quick tutorial made the difference. The respondents made comments like "…learning to use it is easy enough if somebody explains it quickly," and "…this semester it was pretty easy since we were taught how to use it."

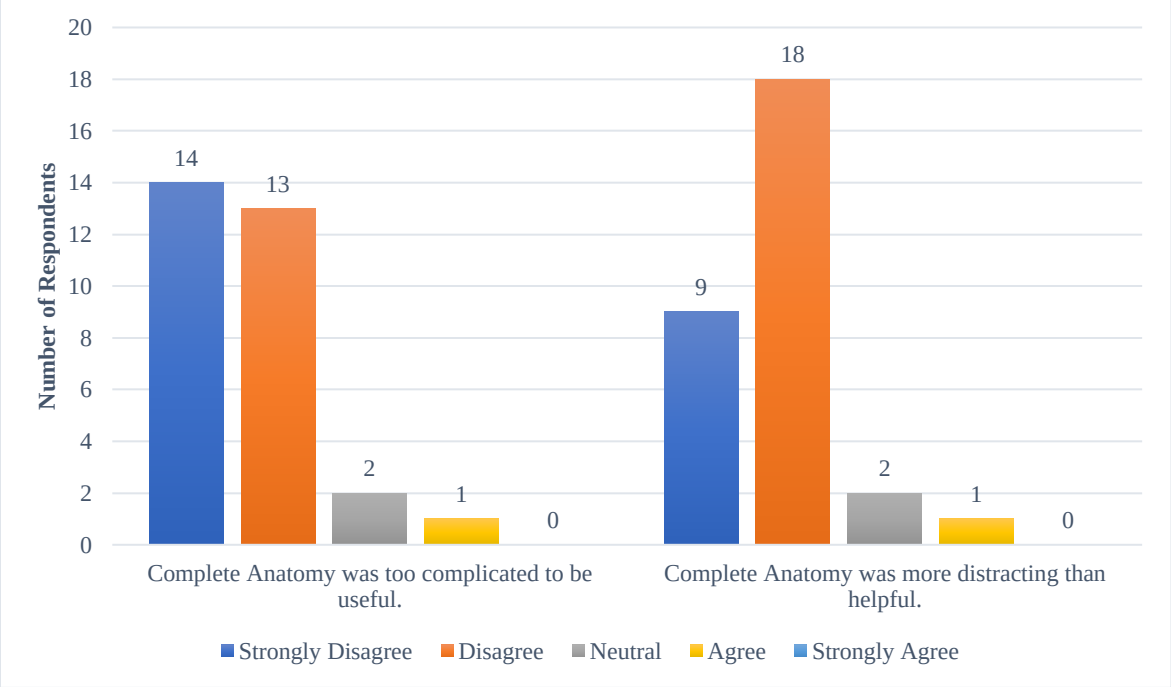

Figure 5. A comparison of Complete Anatomy being either too complicated or too distracting to be an effective learning tool, (*N*=30).

While 27 (*N*=30) students felt CA was not too distracting nor too complicated, there was a difference in the breakdown of the degree of those perceptions. Fourteen students 'Strongly Disagreed' with the statement that CA was not too complicated, while only 9 respondents 'Strongly Disagreed' that the app was distracting. This implies the students did struggle a little bit with maintaining their focus on what they should be

studying while using the app, and likely spent some time looking at features or information that was not necessarily relevant to what they should have been studying.

While the students had access to Complete Anatomy at any time if they downloaded the app provided by Medicine Hat College, they also had access to 3D plastic models during their labs and during study lab times. I wanted to know which type of model, real or virtual, the students preferred to use. Initially, 77% (*n*=32) of students surveyed preferred to use the hands-on model, while 21% (*n*=9) were neutral with regards to their preferences. By the end of the treatment, 44% (*n*=13) preferred the real models versus Complete Anatomy, while 43% (*n*=13) felt neutral about which type of model they preferred. When asked whether they felt they learned more by having access to Complete Anatomy than they would have without it, 80% (*n*=24) agreed in some form while only 7% (*n*=2) disagreed. For the statement "Complete Anatomy didn't help me learn", 93% (*n*=28) disagreed, and 0% agreed with the statement.

Was Complete Anatomy Useful?

When students were asked about whether CA would be useful, they responded that it was. Looking at the Beginning of Semester Questionnaire of qualitative data, thirty-eight of the forty-nine respondents classified it as useful with comments such as, "Yes, there are a lot of situations where a lab model can not do justice to show a particular structure," "…it helps me understand concepts when I am not in lab," and "it gives a very good visual of what we are looking at in lab." The End of Semester Questionnaire data was very similar with an even higher proportion of statements (29 out of 31) claiming it was useful. The students' responses included "Yes, I used it to review

at home after labs when I did not have access to the physical models," "… it was so much easier to see where everything is relative one another…," and "…it was my first choice for help." Given the statement 'Complete Anatomy was a useful app,' 26 of the students (*N*=30) responded that they 'Agreed' or 'Strongly Agreed' (Figure 6).

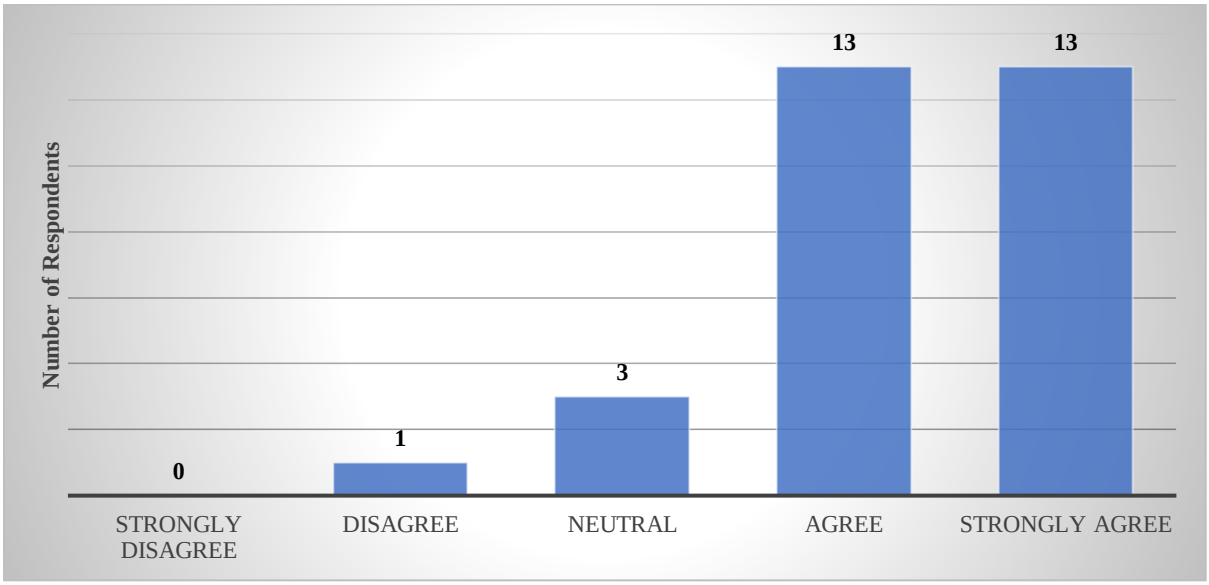

Figure 6. Response to the statement "Complete Anatomy was a useful app," (*N*=30).

In the End of Semester Questionnaire, the students were asked if CA was more or less useful than they anticipated at the beginning of the semester. Six students (*N*=31) stated it was less useful, while 24 of the respondents found the app to be more useful than they initially anticipated. One student responded to the expected usefulness of the app with "Probably less as I only used it to see the posted slides and look at parts that weren't on models." While the student may have had a higher expectation of the app's usefulness, it was clear that they still found the app useful enough to check the posted screens and find parts that were not visible through the plastic models. Another indicator that students did find the app useful was that only one respondent (3%, *n*=1) indicated

they did not use the app at all, while the remaining 30 (97%) all used the app at least once a week to help them learn and study (Figure 7).

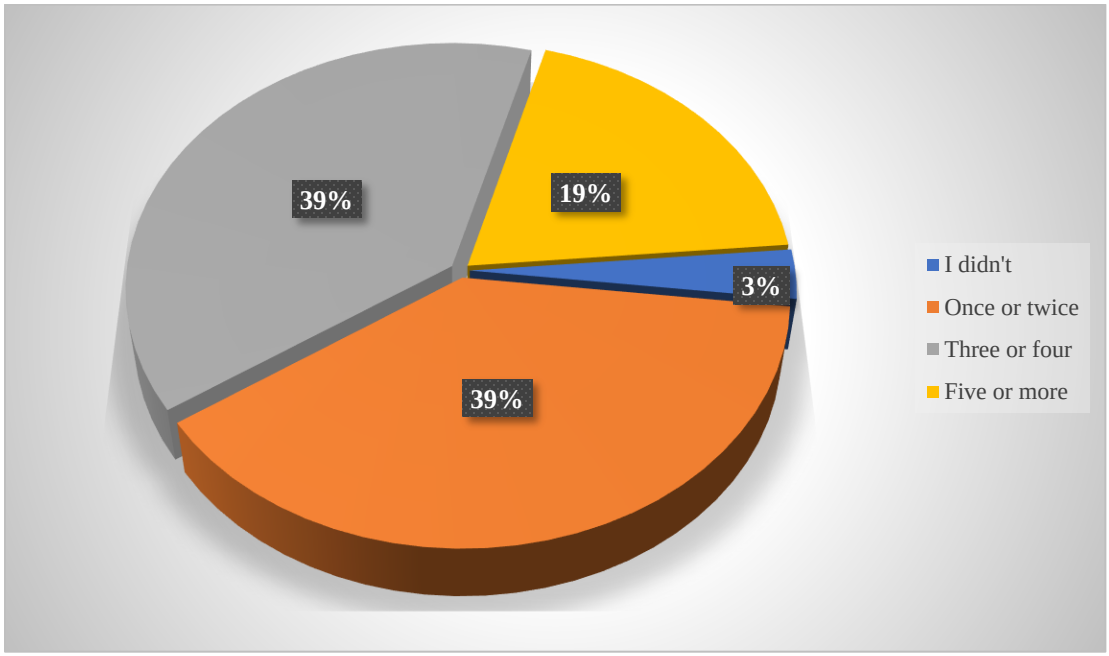

Figure 7. Weekly frequency of use by respondents, (*N*=31).

Does Complete Anatomy Give a Better Understanding of Anatomical Relationships?

Based on the initial four-month exposure to the app students were asked if they thought it would help them learn anatomical relationships over the upcoming semester. Students were then asked again at the end of the second semester if they felt it had helped them learn those relationships. While there was no significant difference shown in a t-Test, ($t(61)=0.702$ at $p=0.05$) in the students' perception of the apps usefulness when comparing the pretreatment and posttreatment responses, it is worth noting that initially 88% (*n*=37) of the students had thought it would be helpful, and by the end of the semester 84% (*n*=25) of the students still felt it helped them learn. Interestingly the

Strongly Agree category shifted from 26% to 37%, while the Agree category shifted from 62% to 47% (Figure 8).

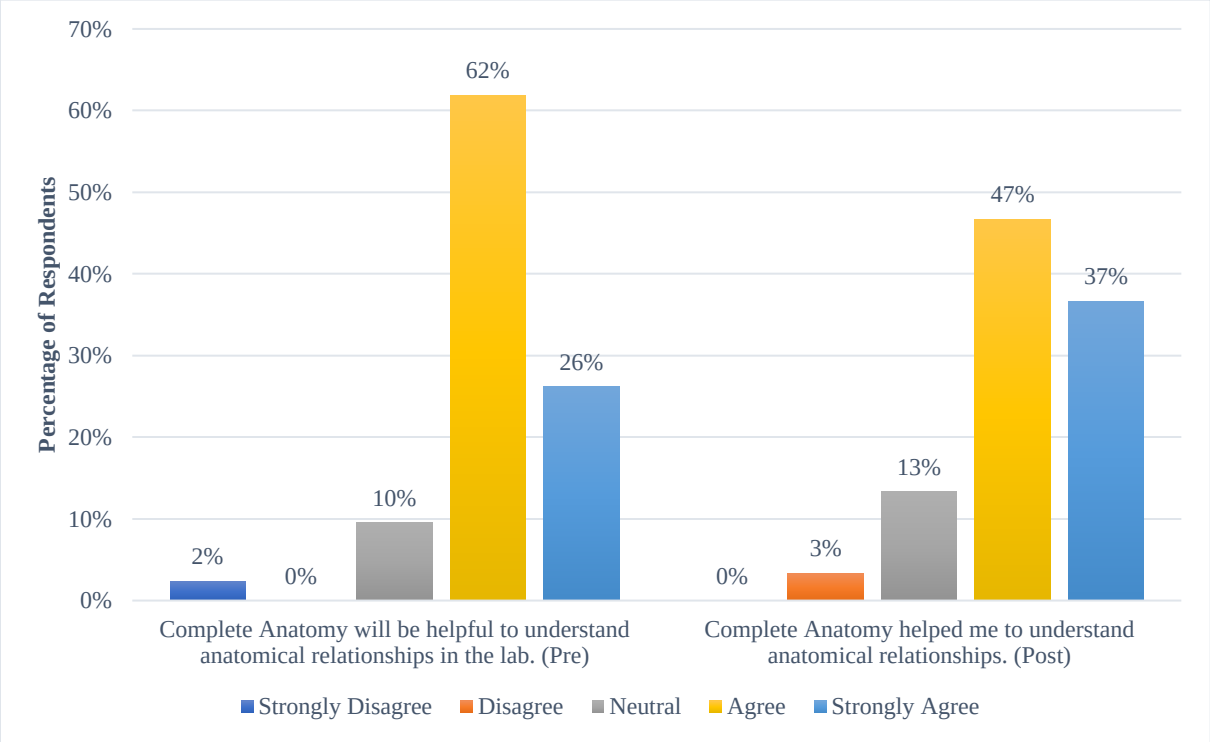

Figure 8. A comparison of pre-treatment (*N*=42) and post-treatment (*N*=30) responses to Complete Anatomy helping to understand anatomical relationships.

While there was not a significant change in overall perception of the app's ability to help learn anatomical relationships, there was a higher percentage of students that strongly agreed with the app's efficacy compared to those who simply agreed.

How do the Students use the app?

For this particular sub-question, I wanted to gather data from two different perspectives. The first piece I wanted to understand was whether or not the students would use the CA to replace the 3D plastic models they used in the labs, while the second perspective was what features of CA did they use, and how did they use them.

When students were asked whether they prefer plastic models over CA in the Biology 275 Tech Survey 77% (*n*=32) agreed with the statement, while only 2% (*n*=1) disagreed. In the End of Semester Tech Survey, the statement was reversed, and they were asked if they preferred CA over the plastic models. After the treatment, 44% (*n*=13) of the students disagreed with CA being their preferred method while 14% (*n*=4) agreed that they would prefer CA.

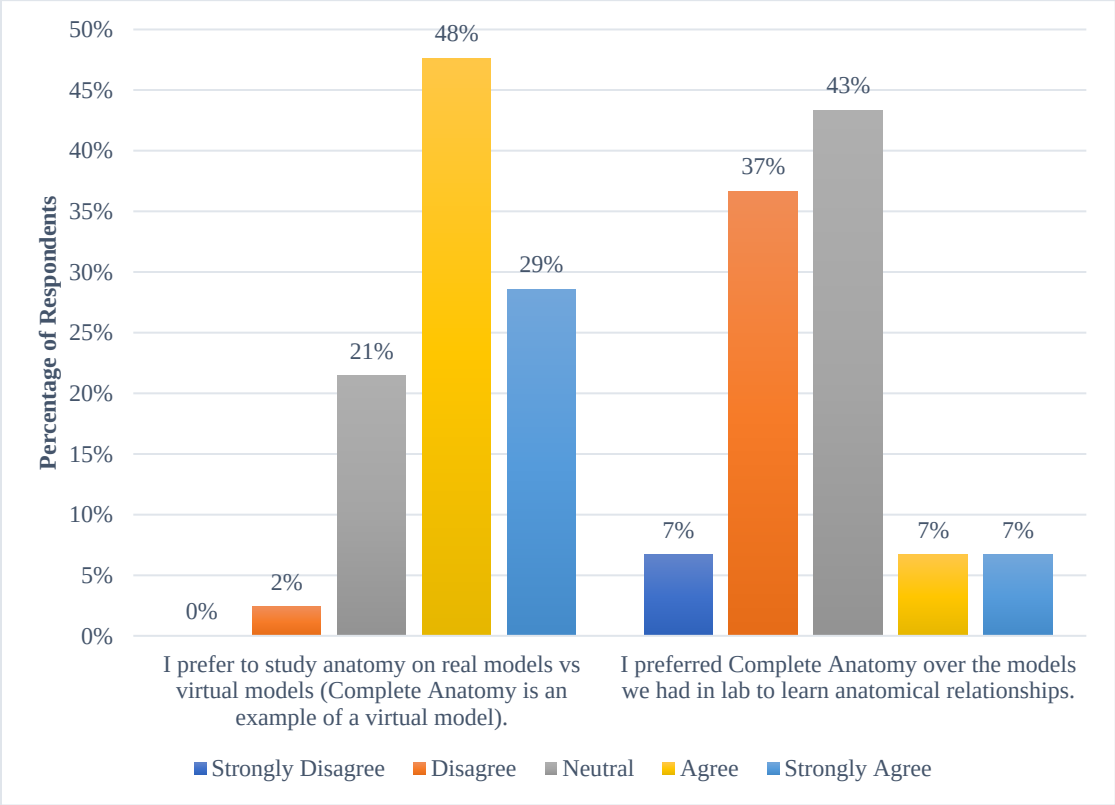

Figure 9. Comparing the results of "I prefer real models vs virtual models" pre-treatment (*N*=42) to "I prefer Complete Anatomy over the lab models" post-treatment (*N*=30).

In Figure 9 the graphs are weighted at the opposite end of the spectrum from one another which matches with the opposite nature of the statements given in the surveys. Both the pre and post-treatment responses from the students were expected as CA was not intended to replace the plastic models students use in class and on quizzes. The fact

that 43% of the students responded 'Neutral' in the End of Semester Tech Survey was unexpected. The End of Semester Questionnaire also asked the students which type of model they preferred and why they chose the model they did. Fifty-six percent (*n*=17) of the students responded that they preferred the plastic models and included explanations such as, "…preferred studying off of 3D models in lab due to the fact that, that was what we were tested on…," " Models were definitely better I found them much easier to study than the online models as well as being a physical thing which made it easier to manuever," and "Sometimes I find it hard to transfer what I see in complete anatomy to the models we use in lab…but then during the lab quizzes lots of the time the questions are involving the models." Of the group of students that said they preferred the plastic models over CA, seven of the seventeen students added a positive comment about CA ranging from "…complete anatomy had a place in my study cycle," to "…but I also like complete anatomy to show things better than some of the models could." The Likert data and qualitative data aligned with regards to how many students preferred CA over the models. In the case of the Likert data, 14% of the students (*n*=4) preferred CA, while 16% of the questionnaire respondents (*n*=5) preferred CA. Based on the End of Semester Questionnaire the most frequent reason students preferred CA was the detail and extra information that it contained to help with their studies.

The second perspective I was interested in learning is what aspect of the app did the students find the most beneficial. This information, combined with anecdotal feedback given in lab, and the Complete Anatomy Interview gave me a good idea of what to highlight as effective tools to future students. In the End of Semester Questionnaire students were asked to check all the uses given they found as beneficial to their learning

(Figure 10). The most popular (84%, *n*=26) benefit of CA was that it could be used anywhere including outside of lab. Only one student indicated the app had no benefit to them at all.

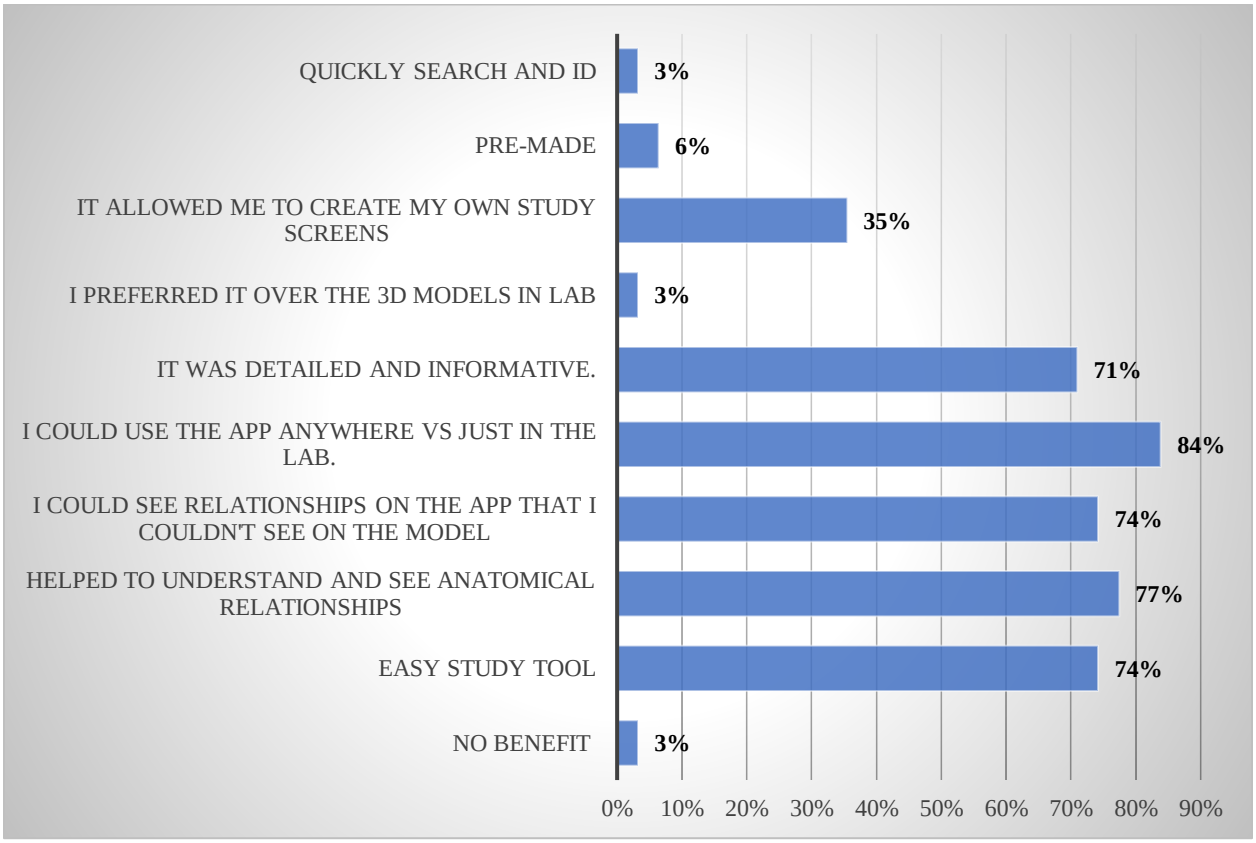

Figure 10. Students' perceived benefits of Complete Anatomy, (*N*=31).

One of the surprising and contradictory data points to come out of Figure 10 was that only 6% of the students (*n*=2) considered the pre-made screens to be a benefit. This contradicts the question of what was the most helpful feature (Figure 11) where 48% (*n*=15) of the students found the premade screens to be the most helpful. Along with this, all the students (*N*=7) in the Complete Anatomy Interview indicated the pre-made screens were a significant 'game changer' and that it made using the app much more worthwhile. In the End of Semester Questionnaire, 26% (*n*=8) of respondents referenced their use of

the pre-made screens in their responses to whether CA was more or less useful than anticipated. Based on that data, I believe the students found the flexibility to learn on their own time a significant benefit, while the most helpful feature they used on their time was the premade screens provided to them. Even a student that claimed the app was less useful than anticipated mentioned that when they did use the app, it was to look at the pre-made screens.

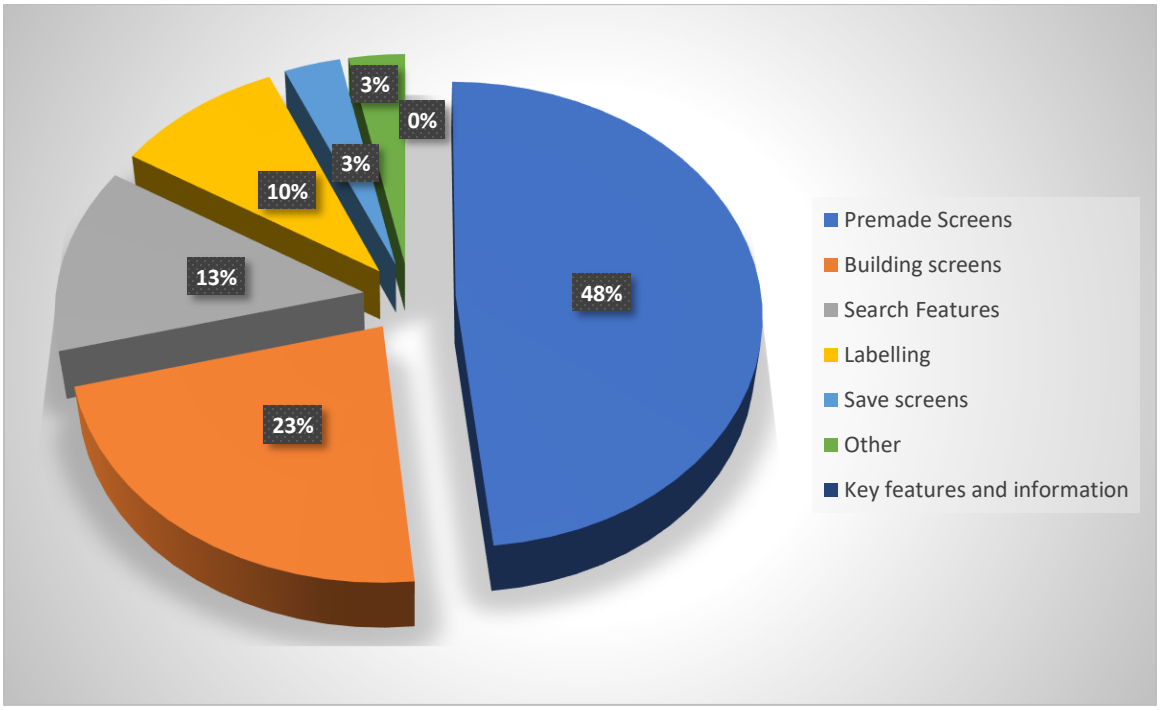

Figure 11. What was the most helpful feature of Complete Anatomy, (*N*=31).

Summary of Data Analysis

Through the use of questionnaires, Likert Scale surveys, and interviews I was able to see that Complete Anatomy was an effective learning tool. Despite the challenges of not being able to directly compare a student's responses pre and post-treatment, and not having the same number or respondents pre and post-treatment it was still possible to analyze the data and have a good overall idea of the students' perceptions of CA. While

the app does have some challenges, overall the data showed that it was useful, effective, and a learning tool that helped students in the Anatomy and Physiology lab environment. CA was never intended to replace the plastic models and time in the study lab, but for many students it gave them the flexibility to study outside of the scheduled study labs, and it was another source of information they could utilize to compliment what they were learning in the lab.

CHAPTER FIVE

CLAIM EVIDENCE REASONING

The goal of this research was to learn students' perceptions and uses of Complete Anatomy in order to determine if the app should continue to be used, and how it could be used more effectively as a teaching tool. Based on the results obtained, the students believed the app helped them understand anatomy, and they made use of the app in both expected and unexpected ways over the course of the semester.

Transformational use of Complete Anatomy

According to Magana's (2017) T3 theory about using technology to teach, the students in this lab never reached the transcendent level but did utilize the app at the transformational level. At this level, the students used Complete Anatomy to learn in a way that they could not have without access to the app.

The simplest difference was their ability to access the resource whenever they wanted instead of being confined to the very limited times of the study lab. While this might not seem like a significant justification for the app, I believe it is far more beneficial than just the timeliness. Students need to have access to tools at times that fit their very hectic schedule and this app allows for that. For the students to have access to reliable, detailed information outside of the lab enables them to become more independent learners, while at the same time using a platform that is consistent with what we were instructing. Instead of the learning simply being memorization of an answer key to model, they had to apply what they found in the 3D virtual model to a slightly different

3D plastic model. This process changes their learning from simple memorization to application of what they are learning.

A second example of Magana's (2017) transformational learning was the Screens built by either the instructors or the students. As an instructor, I was able to create 3D interactive screens that were directly relevant to the material being studied at the time. Complete Anatomy is a very detailed app that contains far more information than what is taught in our introductory Anatomy and Physiology labs. The Screens option in CA allows both students and instructors to scale down the complexity of a region and give the students the chance to see and learn the applicable information, but at the same time they can easily be built up and completed so students can see how everything fits in the bigger picture. The ability for the students to move between the very complex 'complete' picture versus the simplified Screens is Magana's transformational learning in its purest form. This technology was used in a way that could not be done in any other manner to the same degree of flexibility and detail.

Understanding Anatomical Relationships

In this action research, students were asked if they felt if CA was helpful in learning anatomical relationships. By the end of the semester, 84% of the respondents answered that CA did help them to understand those relationships. In the Complete Anatomy Interviews conducted at the end of the semester, all of the students felt that Complete Anatomy was beneficial in learning anatomical relationships. Students in the interview indicated that being able to see connections, move the models to see anatomical features from different angles, and having the models move (pumping heart) gave them a

better understanding of the relationships they were trying to learn. While this is still Magana's transformational learning, it is clear that the students appreciate and benefit using Complete Anatomy.

Students' Use of Complete Anatomy

Over the course of my action research, I was able to learn how students preferred to use the app. Complete Anatomy is a complex app that includes many seemingly useful tools; however, the students did not seem to use as many of the tools as I had expected. Quiz building, drawing on the models, model labelling, and shared study groups are all different tools built within the app. When these tools are combined with the complexity of the app, it can be somewhat overwhelming for the students. In the past this app has been provided without any tutorials or lectures by the instructors. The students were given access to the app and directed to the video tutorials provided by CA. After this action research, that is not something that will be done going forward. In the End of Semester Questionnaire, the Complete Anatomy Interviews and anecdotal comments students indicated that even the brief tutorial made the app significantly easier to use.

Along with the tutorial, a tool that was very well received by the students was the ability for me as an instructor to create models that could then be shared with the entire class group. For each lab we would build multiple Screens that only had the features we were focusing on for that lab, and share that with all the students. By creating the focused Screens some of the complexity of the app was removed, and the students could really focus on the material that was relevant to them. It allowed them to see anatomical relationships that were not obvious or even possible to find on the plastic models. While

I had explained how the students could create their own Screens using the search tool, it was not something that students seemed to do. When I asked students in the interview why they did not make their own Screens they told me it was because they were just not sure if they had all the features, or if they only had the features that were the focus of that particular lab. While I think that students making their own 'screens' would be a powerful learning tool, I believe forcing them to do so will decrease the overall use of the app. Several students expressed that the shared screens were extremely helpful and changed how they perceived the app.

While the shared Screens were appreciated, it was how the students actually used the Screens that was unexpected. The instructor version of the app allows for the Screens to be printed, but unfortunately the student version did not allow for printing or screen saving. The students very quickly worked around this limitation by taking screenshots of the models. They would then import the images into their note taking app and put them next to images they had taken of the plastic model. This allowed the students to write labels on both the plastic and virtual models and make direct comparisons. This was not a technique I mentioned in the CA tutorial, but it is something that will be taught going forward.

I believe the app is a powerful learning tool, but as some of my students indicated it can be an overwhelming app that can 'lead you down the rabbit hole' of distraction. In the End of Semester Questionnaire a student wrote there was no benefit to the app because "…I simply don't have the time to do it. It added more stress." While this may seem counterintuitive, that students' response made me realize I had to justify their investment in using the app by adding it to the quizzes. Giving the students the Screens

we created, and letting them know they would potentially be on the quiz forced the students to access the app. By their own admission, the app became much easier and straightforward as they 'played around with it.' The more they accessed it for the quiz, they more they became comfortable with it, and then they accessed it more to find answers to their questions. All seven interviewees claimed that over the course of the semester their perception of the app became more positive. Some interviewees went from hating the app and thinking it was a waste of time, to using it all the time and attributing her improvement in grades partially to the app, while others starting the semester thinking it would be helpful, to ending the semester thinking it was vital to their learning. One interviewee even claimed the lab could not be done without the app.

The students made it clear that the tutorial helped, but they also made it clear that not all the tools provided by CA were particularly helpful to their learning. They found the self-built quizzes and the drawing tools to be very ineffective. During one of the interviews, the student indicated that the quizzes were cumbersome to build and limited in the types of questions that he preferred to use to study. For him it was much more effective to build a labelled screen, take a screenshot, and then create his own 'flashcards' based on that image. He would repeatedly quiz himself on a blank version of the labelled image and used the labelled version to correct himself. Another student indicated that the drawing tool was not something she found at all useful, but that she did like to modify the instructor provided models and share the modified image within a small study group she had created. Unfortunately, the small, shared groups was not utilized nearly as much as I had hoped, and this was one of the few cases that a student mentioned they used it.

A concern I had with Complete Anatomy was that it may be too complicated for students to use comfortably. After this action research it is clear that, while it is initially daunting, a quick tutorial about some of the apps more relevant features alleviates a lot of the students' anxiety. Once that anxiety is gone, the students have a tool that is very flexible and reliable. The ability to use the app when they want, and combine it with their more traditional learning tools is something the students value.

Impact of Action Research on the Author

The global situation over the last three years has created a significant change in our teaching practices in our Anatomy and Physiology labs. Like most others, we had to find a way to connect and teach to our students in an online environment. I believe this has forced my teaching team to evaluate and adapt new methodologies quicker than we would have had it not been forced upon us. Working on this action research project at the same time has had a profound impact on my teaching.

I started my Master of Science in Science Education at the same time as the pandemic, and so both myself and my students were learning how to learn online. While this was only a coincidence, it was very impactful on my teaching. I was in the same position as many of my students, so this put me on 'both sides of the desk' over the course of the last couple of years.

As an instructor, I am comfortable with Blackboard, the Learning Management System (LMS), that I have been using at the college for many years. As a student I had never seen the LMS, Brightspace, used for my courses. Having used Blackboard for so long, I have forgotten how confusing working around it can be. When students claim

they ‘can’t find’ or they ‘don’t know how to submit’ an assignment there have been times this has been frustrating. As a student trying to learn my way around Brightspace I missed an assignment that I could not find, and I submitted an assignment or two with a not to the instructor saying, “I’m not sure if I’m doing this in the right place… .” Suddenly my students’ struggles became very real and understandable, so I was much more empathetic than I otherwise might have been.

Another benefit of the situation was that I had started my classes as a student prior to the pandemic shut down, so I was able to use my experiences as a new online learner to inform my decisions as an instructor. I knew what I had experienced that had helped, such as concrete deadlines, and what had hindered so I was able to apply that knowledge to make me a more effective instructor.

The MSSE program has also realigned some of what I believe to be the core skills I teach in my labs. Microscopy, dissection, observation, aseptic technique, and culturing are all logical, necessary skills that students in my labs must learn. They are the types of scientific lab skills that everyone can see as helpful in science studies. Word, Excel, and PowerPoint, and being able to use them to communicate effectively has been added to my list of core skills. This action research has shown me how vital it is that my students are able to effectively use these technologies in the both the lab and the classroom. While I was comfortable and capable with the technology, there was still a great deal I had to learn to be successful in my studies and recognized that my students needed to have those same skills to be effective in their futures as well. Not all students are going to be using microscopes in their futures, but they will all have to write, calculate, and communicate regardless of what fields they eventually pursue.

This action research has also provided significant value with regards to the specific impact Complete Anatomy has in my Anatomy and Physiology labs. Having a better understanding of my students' perceptions of the app has already changed some of my teaching practices and will continue to do so in the future. Watching my students use the app in ways that I did not anticipate, or not use it in ways I thought they would, will continue to inform how I use the app, and how I encourage students to use the app.

The first and in some ways the easiest change will be the continuation of the beginning of the semester tutorial. While we have given the students access to the app for several years, and it has been used in several different classes, none of the instructors go through a tutorial. We have relied on the students' curiosity, technology savvy, and the help videos provided by the app itself to teach the students what tools are available and how they can be used. As indicated in the End of Semester Questionnaire many students' felt the forty-five-minute tutorial made learning to use the app very easy.

Along with ensuring the tutorial continues going forward, I have already changed how I use the app. In the Beginning of Semester Questionnaire numerous students indicated they preferred using the plastic models over CA because they were being quizzed on the plastic models and not on the CA images. When I learned this, I decided to encourage use of CA by adding printed Screens to their weekly quizzes. From a teaching perspective this would increase the amount the students would use the app, and it also allowed me increased flexibility because I could print features that could not be seen on the plastic models, or from angles and perspectives the plastic models cannot provide. The insight provided by the questionnaire not only allowed me to adapt my

assessments, but it also made me realize I would need to provide the students a tangible reason to utilize the app.

One of the focus questions of this action research was "How do the students use the app?" From an instructor's point of view, Complete Anatomy has many useful tools like the search feature, the saved Screen feature, the quiz builder, and the drawing tool. I began the semester and this action research hoping the students would value the quiz builder and the search functions. I wanted them to create their own study groups to share models, questions, and quizzes they had built. During the tutorial I spent time showing them how they could use those tools, and encouraging them to do so. I did not plan to build the Screens for them because I wanted them to go through the process themselves to help them learn the lab material. Through this study I learned the students needed more guidance and help than I anticipated. Building the Screens for them was a 'gamechanger.' The Screens that I shared with the class encouraged the students to use the app. They were focused and relevant, so the students were able to apply them directly to their learning. What I did not expect was how some students would use the screens. Instead of using them within the app, they would position the virtual model in the same perspective they would position the plastic models and take pictures of both. They would then put both pictures into a note taking app on their devices and label both images simultaneously. According to the students I spoke to, the ability to see features from the same angle, and go back into CA to find the answers they were not sure of, was a breakthrough in their learning. Based on this information, I will be changing what tools and tips I emphasize in my tutorial.

The experience I shared with my students as I became an online learner, and the feedback to the action research itself have both significantly impacted my teaching. Remembering what it feels like to be a learner and trying to learn in a completely new environment gave me a powerful perspective on what my students were experiencing. Going through the process of data gathering, analysis, and writing has made me reassess some of the skills that are essential for my students to learn. And finally, the direct feedback that was gathered through my action research has helped me understand what students value as learning tools, and how they make use of those tools.

Limitations and Future Study

While this study gave me a great deal of qualitative data, I believe it is very limited in applicability to the wider teaching environment. This action research was very helpful to my teaching practices, and very informative about the efficacy of using Complete Anatomy within my labs at Medicine Hat College; however further study needs to be done and data collected to generalize these results.

Most of my data collection was done anonymously. When I began this action research, I felt using anonymous data would increase the likelihood of students responding and being involved. Unfortunately, this anonymous data made it impossible to see if specific students changed their perspectives and practices or if the use of Complete Anatomy had an impact on the grades.

Another challenge with my study was that it is difficult to collect truly quantitative data showing that Complete Anatomy had a positive impact on my students learning. In order to isolate the use of Complete Anatomy as the reason for a student's

grades would be virtually impossible, and in my opinion unethical. I believe Complete Anatomy helps students learn by giving them the freedom to study when and where they want, by giving them the means to find answers to their questions and information they need to be successful learners. In an educational environment it is unethical to withhold that tool from some, while making it available to others.

For my own pedological best practices I plan to continue this action research. In future iterations I plan to remove both the anonymity and voluntary response to the questionnaires and surveys. By making those changes, it will allow me to ask students more pointed and specific questions based on their answers and results. This information will allow me to further refine my pedagogical practices with regards to the Complete Anatomy app, and how it is used as a teaching and studying tool in my labs.

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APPENDICES

APPENDIX A

MONTANA STATE UNIVERSITY'S INSTITUTION REVIEW BOARD

COMPLIANCE

IRB Exempt Protocol # is MM112421-EX.

The research described in your submission is exempt from the requirement of additional review by the Institutional Review Board in accordance with 45 CFR 690.104(d). The specific paragraph which applies to your research is:

(1) Research, conducted in established or commonly accepted educational settings, that specifically involves normal educational practices that are not likely to adversely impact students' opportunity to learn required educational content or the assessment of educators who provide instruction. This includes most research on regular and special education instructional strategies, and research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

APPENDIX B

BIOLOGY 277 TECH SURVEY

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

1. I am comfortable with using technology.
    a. Very Uncomfortable
    b. Uncomfortable
    c. Neutral
    d. Comfortable
    e. Very Comfortable
2. I plan to use Complete Anatomy to study outside of the lab time.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly Agree
3. I find using technology distracts me from my learning.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly Agree
4. I like to use tech in the classroom.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly Agree
5. In the past I have used an App for my notes.
    a. Never
    b. Rarely
    c. Regularly
    d. Frequently
6. I feel comfortable using Complete Anatomy.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly Agree

7. I plan to use technology in my classes this semester.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly Agree
8. I believe I can use technology to keep me effectively organized.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly Agree
9. Complete Anatomy will be helpful to understand anatomical relationships in the lab.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly Agree
10. Using technology in the lab will benefit my learning.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly Agree
11. Trying to use technology in the lab causes me stress.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly Agree
12. In general, I find it easy to learn how to use a new App.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly Agree
13. I feel comfortable getting help using technology from my instructor.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly Agree

14. I plan to use Complete Anatomy in the lab this semester.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly Agree
15. I prefer to study anatomy on real models vs virtual models (Complete Anatomy is an example of a virtual model).
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly Agree

APPENDIX C

END OF SEMESTER TECH SURVEY

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

1. Complete Anatomy was a useful app.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly Agree
2. I found the use of technology in the lab helped me with my learning.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly Agree
3. I have become more comfortable with using technology over the course of the semester.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly Agree
4. I used Complete Anatomy both in the lab and to study from outside of the lab.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly Agree
5. Complete Anatomy helped me to understand anatomical relationships.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly Agree
6. Complete Anatomy was more distracting than helpful.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly Agree

7. I think I will use Complete Anatomy in future classes.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly Agree
8. I became better at using Complete Anatomy as I used it.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly Agree
9. I feel I understood the material better using Complete Anatomy than I would have without Complete Anatomy.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly Agree
10. The instructor made good use of Complete Anatomy in their teaching.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly Agree
11. Complete Anatomy did not help me learn.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly Agree
12. I used Complete Anatomy to better understand the hands on models we used in lab.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly Agree

13. I preferred Complete Anatomy over the models we had in lab to learn anatomical relationships.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly Agree
14. I needed more help with Complete Anatomy than the instructor provided.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly Agree
15. Complete Anatomy was too complicated to be a useful tool in the lab.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly Agree

APPENDIX D

BEGINNING OF SEMESTER QUESTIONNAIRE

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

1. Have you used Complete Anatomy before?
    a. Yes
    b. No
2. Do you have a device that you bring to classes and labs that you use to help you learn? (Laptops, tables, phones, etc). If so how do you use it?
3. Do you like using Complete Anatomy? Why or why not?
4. Do you anticipate that Complete Anatomy will help you learn and understand A&P concepts this semester?
    a. Yes
    b. No
5. Do you think it is helpful that MHC has provided Complete Anatomy?
    a. Yes
    b. No
6. How do you plan to use Complete Anatomy this semester?
    a. I don't.
    b. To study the material before lab.
    c. To help understand the models while in the lab.
    d. To create study screens to help me prepare for quizzes.
    e. T use instead of the models while studying.
7. Are you comfortable using Complete Anatomy? Why or why not?
8. What do you think is the biggest limitation of Complete Anatomy?
9. What do you think will be the biggest benefit of using Complete Anatomy?
10. Having had access to both Complete Anatomy and the 3D models in the lab in Biology 275, which do you think was the most helpful to you? Why?

APPENDIX E

END OF SEMESTER QUESTIONNAIRE

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

1. Was Complete Anatomy helpful to you this semester? Explain.
2. What was the biggest limitation of Complete Anatomy?
3. On average, how many times did you use Complete Anatomy over the course of a week?
    a. I didn't.
    b. Once or twice
    c. Three or four times.
    d. Five or more times.
4. What was the most helpful feature of Complete Anatomy?
    a. Search feature.
    b. Save screens
    c. Labelling.
    d. Key features and information.
    e. The ability to build screens with only your required content.
    f. Premade models.
    g. Other _____
5. Did you have any problems learning how to use Complete Anatomy? Explain.
6. What was/were the benefits of using Complete Anatomy? Check all that apply.
    a. Easy study tool.
    b. Helped me to understand and see anatomical relationships.
    c. I could see relationships on the app that I couldn't see on the models.
    d. I could use the app anywhere vs just in the lab.
    e. It was very detailed and informative.
    f. I preferred it over the 3D models in the lab.
    g. It allowed me to create my own study screens.
    h. Other. _____
7. Having had access to both Complete Anatomy and the 3D models in the lab, which do you think was most helpful to you in Biology 277? Why?
8. Do you think the use of technology in the lab (downloaded images, note taking apps, Complete Anatomy, APR) was helpful or ineffective? Explain.
9. Compared to the beginning of the semester, do you think Complete Anatomy was more or less useful than you anticipated? Explain.
10. Should MHC continue to provide Complete Anatomy to students in the future? Why or why not?

APPENDIX F

COMPLETE ANATOMY INTERVIEW

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

1. Do you feel that you had a successful semester in Biology 277 labs? What do you think contributed to that success or lack of success?
2. How did you feel about using technology in the lab? (IE: notetaking, labelling the images, studying the histology, Complete Anatomy)
3. Did you like CA? Why or why not?
4. Did you use CA to replace the models or supplement the models? Explain.
5. What did you dislike the most, what did you like the most about CA?
6. Do you believe CA helped/hindered/or had no impact on your learning? Explain.
7. Did your perceptions of CA change from the beginning of the year (when you first downloaded it, possibly even in 275) to the end of the year?
8. Would you recommend future students use the app? If so how would you tell them to use it, and why?
9. Should CA be used more by the instructors in the future? Why? How?
10. Was CA a useful tool in helping you to understand anatomy and anatomical relationships? Why or why not?