Use of Nursing Entrance Exams to Validate Success of Educational Platform in Undergraduate Anatomy and Physiology Courses

Dissertation

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Abstract

Anatomy and Physiology (ANP) courses are a standard requirement for effectively all undergraduate healthcare programs in the country. A large majority of students enrolled in these courses are attending 2-year colleges and pursuing nursing certifications and recertifications. Traditionally, the instructional method and content of Anatomy and Physiology courses is based on traditional instructor focused lecture platforms, with laboratory content centered on physical modeling and manipulation. As technology advances and the continued impacts of the COVID-19 pandemic shift our educational platform methods, larger scale considerations for what merits student success are considered. Comparison of course success in ANP and summative assessment success on nursing entrance exams, illustrates that the platform of content instruction is potentially less meaningful and that larger scale considerations may be necessary for assessment skills and the transition of ANP content knowledge, particularly with long term COVID-19 impacts on education.

Keywords: online, Anatomy and Physiology, summative assessment, COVID-19.

Dedication

Dr. Don Merkle, professor of science at Longwood University in Farmville Virginia. Dr. Merkle implemented a no excuses, rigorous yet engaging instructional method for his Anatomy and Physiology students. He pushed each of us to be better as individuals, more accountable as students and deeper thinkers as scientists. He never let me settle, never gave me an easier route and during my time at school and to the year he passed, never let a birthday go by where he didn't text "Tri Beta pizza girl" and send well wishes. The reason I pursed science and eventually teaching, is thanks to the mentor he was to me and the example he set for me.

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My mother, father and husband all battled various cancer diagnoses while I was pursuing my degree. Through treatments, surgeries and recoveries, they never asked to me to step away from something that I was passionate about. Their support of education and patience with me while I continue my education, despite the challenges of life, has been instrumental in my professional and personal endeavors. I am eternally grateful for their love.

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Chapter 1. Introduction

There have been a number of restructuring movements in science education over the decades, based on changing political tides or various other individual reformer motivations, such as course content or teaching methodologies. Reform in education has also pushed for teachers and teacher educators to develop more ambitious and innovative teaching practices, particularly in science (Guy-Gaytán et al., 2019). One facet of science educational reform specifically, is calling for teaching methodology that engages more active learning processes and provides alternatives to dissections, while maintaining the tactile nature of biological sciences (DeHoff et al., 2011).

Even prior to COVID, Anatomy and Physiology education specifically, has traditionally been viewed as "building block" subject matter driven by traditional instructional methods and heavy in hands on laboratory practices. Success in these courses is regarded as exceedingly important for community college health care certifications and other higher learning, health science degree programs. While most students enrolled in ANP (Anatomy and Physiology) do not enter with a clear understanding of the expected rigor (Eagleton, 2015), there is a high level of "anatomical knowledge and structural detail" for each organ system that is required for the course, from both program administrators and course facilitators (O'Byrne et al., 2008). ANP

courses are typically designed around lecture-based instruction, heavy in new terminology and it is classically combined with the use of cadavers, models and microscopy for the reinforcement of gross anatomy concepts in a laboratory setting. However, this traditional approach of face to face instruction (blend of lab and lecture) has been challenged in recent years as part of these education reforms and also as a response to a spike in Anatomy enrollment for both majors, non-majors and preprofessional students (O'Byrne et al., 2008). As of late, the biggest challenge to our standard instruction approach has been the prevailing COVID-19 pandemic (Rosario, 2021).

While most research agrees that class size is a primary concern for both laboratory and lecture settings, it also argues that the cost and limited access to cadavers both institutionally and per course, is a constraining factor that pushes the re-evaluation of its instruction (Perry et al., 2007). In addition to cadaver costs, the investment of laboratory preparation time and constraints of laboratory space impacts many institutions ability to maintain prosections and other gross anatomy resources (Gopal et al., 2010). Additional points of consideration for adjusting collegiate ANP course instruction are the growing number of high school curriculum now offering Anatomy courses with utilization of dissection specimens, such as cats and fetal pigs and higher failure rates. Use of curriculum and lab resources in particular, that are excessively consistent between high school and junior college courses, makes ANP study redundant for students entering into 2-year colleges or 4-year universities. Particularly for those institutions that do not

have the access to cadavers, as laboratory experiences will mirror those offered in the high school setting.

A final argument against the traditional model of ANP instruction is the high failure rates seen in many first year science based courses (Johnston & McAllister, 2008). While course failure is a realistic facet in undertaking higher level education, the current data suggests that the economic implications for the institution are only heightened by the effects failure can have on the learner and possibly the country when considering potential unemployment rates (Eagleton, 2015).

Existing research emphasizes the afore mentioned growing need for change in the current instructional practices of not just science courses, but for Anatomy and Physiology courses specifically. Demands for these alterations are based largely on the shifting classroom student demographic and their increasingly diverse and specific learning needs. In addition, the use of technology and transition of learning to online platforms is gaining momentum. Particularly with the innovation of new virtual resources and as the continued COVID 19 pandemic instructional changes are established as the new normal. The available research on the teaching transitions that were both pandemic forced and student driven, cohesively stress the need for implementation of more instructional guidelines and continued examination of their success. Many go as far as to say that they are finding great success in formative assessment and student perception of the online platform (Harrell et al., 2021), but that this is still no replacement for the cadaver based gross anatomy and collaborative traditional classroom (Rosario, 2021).

Regardless of the contradictions we are seeing from research or instructors, the old anatomy is dead'' and the concept of ''come to the lecture'' or ''read the book'' is rapidly becoming antiquated (Reidenberg & Laitman 2002). By means of this paper and its associated literature review, the aim will be to evaluate how Anatomy and Physiology education is answering the reform calls by evaluating how it is blending the necessity of science modeling into its virtual curriculum. Furthermore, learning technologies that are currently being implemented in ANP classrooms and laboratories will be discussed, in addition to their standards of success.

Finally, as an expansion of the idea of success, the goal of the research study will be to evaluate the effectiveness of utilizing course success outcomes for Anatomy and Physiology against nursing entrance exam outcomes. This comparison will be utilized as a means of validating the success of varying instructional platforms of Anatomy and Physiology, particularly for online instruction. The assumption of the researcher and goal of the associated study will be to state with more confidence that while technology and modeling practices vary greatly, our online platforms are creating equal success to our traditional face to face classrooms.

Chapter 2: Literature Review

2.1 Modeling Importance

In the last decade the topic of modeling has been discussed comprehensively in science education (Sarah Schönbrodt et al., 2022). As science is a universal subject matter and branch of what is considered standard knowledge, modeling has decidedly taken the place of the "mundane" scientific method in order to promote more critical thinking within its contents (Bati & Kaptan, 2015).

While John Dewy may arguably have been the more noteworthy education reform activist of the early 20th century, with his push for community and experience in the learning process, the first prominent figure in evolving science education specifically, was likely Galileo (Halloun, 2007). For Galileo, science needed a "cycle of model construction, analysis and corroboration" to help in assessing the physical realities of the world (Halloun, 2007). Since that time, modeling has become an integral aspect of scientific inquiry and as calls for continued reform in science education are brought about, modeling and its educational uses remains a primary instrument of change (Svoboda & Passmore, 2013).

Most available research on scientific modeling agrees that the goal of modeling is to create manipulatable aspects of a physical world that can be revised, assessed and reconstructed as new evidence and patterns are presented (Halloun, 2007). In essence,

models are a “limited version of its target” concept (Jong et al., 2015) and although many disagree on a singular definition or method of implementation (Svoboda & Passmore, 2013), all seem to consistently agree that modeling is a necessary component of science comprehension. All this considered, the more our standard “teacher-student” interactions that drive scientific modeling are shifted, understanding new techniques and their implementation will be imperative (Sulistyani Sulistyani & Rika Riwayatiningsih, 2020). Conventionally, learning through models (or model-based inquiry) has utilized representations that were physical, mental, or diagrams in format (Jing Lei et al., 2016). Typically, instructors work to develop the mental models that students will construct and the external models utilized are an equally important focus for the biological sciences. With such diversity in science disciplines, the external models are particularly important when considering Anatomy and Physiology (ANP) education and the exact aims of the course (Svoboda & Passmore, 2013), which are structure and function of the human body. However, use of both mental and physical models can be critical when understanding complex phenomenon and considering the multiple ways that models can be created and utilized, blending both forms is becoming more commonplace in classrooms. Traditionally for ANP utilization of models are seen embedded in lecture-based instruction, which is heavy in new terminology (mental model) and classically combined with the use of cadavers, organ replicas and microscopy for the reinforcement of gross anatomy concepts in a laboratory setting (physical models) (Roy et al., 2020). While typically, in higher level education, instructors and their associated lectures and labs can be seen as the modeling tools that provide students with step by step

demonstrations of how to perform tasks or to construct new and complex knowledge processes through verbal explanation (van Wermeskerken et al., 2018). Over time, this version of modeling has become to many, more of a "pedagogical model" that makes the purpose of the tool and it's uses irrelevant, moving the model from a functional instrument to a resource for rote memorization (Guy-Gaytán et al., 2019).

Although these are becoming more pedagogical in definition, exploratory models in which students use simulation or interact with models that have been previous created, could be a solution. While exploratory models have the potential to create successful learning progressions in science, having the models be expressive as well, by creation and implementation of spreadsheets and other modeling systems, is necessary for consideration (Stylianidou et al., 2005).

A more modern way that Anatomy and Physiology courses in particular have blended these various types of modeling (physical, mental, exploratory) is by utilizing existing exploratory models and recreating them expressively through student molding or manipulation of a clay medium (DeHoff et al., 2011).

Another seemingly simple way that modeling in science education has transitioned from the more classical practices to more current trends, is through the use of a modeling-based text. Modeling in this sense, exploits the most utilized and classical classroom resource, the scientific textbook, and builds into each chapter sequential learning stages that cover modeling processes and terms, limitations of concepts and examines behaviors of the topic. By building sequential support structures such as models into the text

content, students are better able to identify and engage with scientific content (Jong et al., 2015).

To truly implement science modeling activities online, digital tools are imperative (Sarah Schönbrodt et al., 2022). Technology learning tools are one of the principal ways that modeling can be seen evolving in the ANP classroom. There is abundant research suggesting that technology is bringing incredible opportunities to student learning processes and that these technologies are developing and changing rapidly. At its most basic form, video technology is permitting instructor modeling that blends the traditional pedagogical model with more current trends. Through instructor videos, students are able to attend, organize and then integrate the knowledge of the tasks being demonstrated or explained (van Wermeskerken et al., 2018).

Another more current use of scientific modeling comes from a desire of education reformists to blend what some students perceive as overwhelmingly abundant and diverse representations of content (simulations, videos, models, graphs, charts) for easier focus. Using a bifocal modeling framework, physical and virtual models are used cooperatively. Bifocal modeling not only utilizes content models, but it also models the behaviors of what current scientists are actually utilizing in professional settings and practices (Blikstein et al., 2016).

While many of these modeling-based technologies, such as simulations, videos and programmable media are currently in use, their implementation is still considered underdeveloped (Jing Lei et al., 2016). As with any technology, how it is designed and implemented, particularly as a model, will be important. Many argue that if modeling is

implemented haphazardly without understanding of its intent and nature, it could “go the way of inquiry” in science education, which was lost in terms of meaning and has become misused in curriculum (Svoboda & Passmore, 2013). As models take the shape of the aim of the modeler (educator), this idea of appropriate implementation will also be paramount for consideration in our novel COVID educational environment.

Research on modeling instruction in the classroom agrees that it is a student-centered practice with a goal of each student being active in the process, but not left to navigate the process on their own. Thus, placing importance on the “teacher mediation” role of modeling instruction where the educator becomes a moderator, arbitrator, negotiator and initiator (Halloun, 2007). With this said, the goal of the model is to “permeate” each stage of student inquiry from conception to testing and finally argumentation (Svoboda & Passmore, 2013). As such and being a teacher driven process, modeling based instruction (MBI) requires that teachers know well how to engage students at all stages of the modeling process, instead of modeling to illustrate a particular concept. Most research reinforces this notion by arguing that for true learning using MBI to take place, teachers have the responsibility of organizing “coherent, systematic and flexible” lessons that follow a modeling schema (Carpenter et al., 2019).

Another major tenant of MBI for science classrooms is the use of scaffolding in model use. Scaffolding can be seen as a routine intervention of the learning process that assists in providing scientific direction to the learning process (Halloun, 2007). Giving students the “cognitive and procedural support” necessary to connect inquiry, concepts and models is one of the primary tenants of MBI. Additional tenants of MBI that are the

responsibility of the educator/facilitator are levels of interaction (for various technology model tools) and collaboration. As one of the goals of modeling is to challenge the initial assumptions of the student, or to create discrepant events (Blikstein et al., 2016), the role of collaboration amongst students and instructors is imperative to move from the subsequent cognitive dissonance to theory-based understanding (Halloun, 2007).

Collaboration has typically been seen in teacher implementation of small groups and peer to peer dialogue, a consideration that is critical in considering modeling as practical in the new COVID enforced virtual science classrooms (Jing Lei et al., 2016). With the interrupted instruction seen in COVID impacted education in 2019, the majority of school districts were forced to implement some form of remote instruction. While COVID is the culprit for many of the new K-12 transitions to virtual, blended and hybrid instruction methods, the university setting has been a more familiar feature of remote and virtual learning in recent years (Greener, 2009). The traditional approach of face to face instruction (blend of lab and lecture) had been challenged prior to the pandemic, as programs saw a spike in Anatomy enrollment for both majors, non-majors and preprofessional students (Eagleton, 2015) leading more higher-level institutions to offer more virtual learning opportunities (O'Byrne et al., 2008). While teachers have been more open to new instructional methods and thought processes for their course, their roles are changing. One of the primary ways that modeling can be utilized in this new remote classroom is through e-modeling of appropriate learning behaviors from the instructor such as; social presence online, knowledge of search tools, self-directed learning and adaptation (Greener, 2009, p.). Using an online platform to deliver higher

positive effects on student learning, the instructor will have to be embedded in the course, providing feedback, insights, assistance and well guided prompts. As cognitive and procedural scaffolding are such an integral aspect of technology-based modeling instruction, successful design and implementation of the course falls on the knowledge of the educator (Jing Lei et al., 2016). Additionally, predesigned models have proven to implement scaffolding well in science classrooms, but there is little knowledge or room for understanding if these predesigned models limit students from engaging in the re-evaluation of the initial conceptions or the assumptions of the original model (Blikstein et al., 2016). This concept falls back on the idea that science education, particularly Anatomy and Physiology, will need a consideration of model construction to maintain integrity (Halloun, 2007) as they move into more virtual platforms.

2.2 Technology Considerations

For those instructors of Anatomy and Physiology working to accommodate these changing course demands by developing or incorporating more cost effective, student learning friendly and program specific resources (O'Byrne et al., 2008) many have made considerations to rely more heavily on technology resources. Technology is fast becoming a more prominent part of educational requirements and many technological resources are becoming a more integral part of our students daily lives (Gopal et al., 2010). Many studies suggest that transitioning the more formal classroom setting to either blended, virtual or computer supported platforms, will allow teachers to manage larger

groups of students, reduce equipment and laboratory costs, as well as give students the control to drive their own learning development (Johnston & McAllister, 2008).

The technology that is being utilized for many ANP courses varies from supplemental laboratory tools (ex: virtual reality and stereoscopic glasses) to computer assisted learning programs with web-based applications such as YouTube and simulations comparable to Physics Education Technology (PhET). In an effort to better accommodate a heterogenous student demographic and to open larger class sizes, many instructors are utilizing computer assisted learning technologies. These technologies blend resource links into the currently existing institutional Learning Management Systems (LMS) such as; Blackboard, Canvas and Brightspace. One example of this "blended" style of learning utilized Adobe Flash MX to create anatomical images with color coded roll over features, drag and drop options, rotation capability and built in formative assessment (O'Byrne et al., 2008). The images created by Adobe Flash allowed for 2D textbook images to have 3D characteristics and interactive capabilities. Another form of web-based technology tool called Natural Language Processing is built into ANP learning management systems similar to the Adobe Flash visuals. Although, considerations will need to be made for Adobe Flash as it has more recently been removed as an outdated format with new browser settings.

Defining a technology tool as "a website" this particular type of digital learning includes "dynamic tools" which in this case resemble a Pronunciation Corner, Spelling Bee and Interactive practice test tool (Gopal et al., 2010). Theoretical support for language-based learning in virtual or digital environments are positioned strongly in

Natural Language Processing (NLP) as one of the most effective and "popular" methods for comprehension of electronic information (pg. 501). While NLP is not as developed as a theoretical framework, there are advocates of NLPIR (Natural Language Processing Information Retrieval) who claim it has vast importance in text processing and knowledge acquisition (Lina Zhou & Dongsong Zhang, 2003). Use of NLP technology is heavily dependent on reading, spelling and writing as interrelated in learning processes. In order to accommodate these language-based learning trajectories, development of the website should allow a spelling bee feature, interactive identification tool and web resource links like lecture videos (Gopal et al., 2010).

Similar web-based technology tools can be as simple as Virtual Learning Environments (VLE) such as Blackboard or Canvas, that incorporate resources such as recorded lectures, online discussions and revision tutorials. Built on the principles of Vygotsky's constructivist approach as well as Kolb's theory, the intent of the resources is to present organ system content in a series of phases. Students would be provided an overview of the system, watch a corresponding streamed dissection video (experience), use interactive links for practice labeling (experimentation) and complete online written summaries (reflection) (Green et al., 2006).

Many instructors have also begun utilizing case studies and case histories as a means of promoting critical thinking (Nasr, 2012). Additionally, they promote these case studies as a way to foster modeling of clinical behaviors (Prince et al., 2005).
Another more recent approach to unifying anatomical concepts with digital means, has been in combining laboratory and lecture. A progression that is often called a "studio

model" this is the process of blending lab and lecture create presents students with the opportunity to immediately reinforce lecture content and also allows instructors to better target the learning activities (Lunsford & Diviney, 2020). Similarly, it has been suggested that use of a Universal Design for Learning framework and use of student stations (instructor area, cadaver area, computer assisted and dry tables) allow students multiple means of engagement with multiple means of representation (Balta et al., 2021).

For colleges battling the availability, space and cost of cadaver specimens for labs, technology has offered alternatives to viewing human organs. Through use of Anatomage tables as one example, students have the ability to manipulate, "peel" and digitally dissect various real-life imaging of human cadavers. The technology offered in these tables provides students a view of full body anatomy, regional anatomy and various segmentations with the ability to annotate, pin and quiz. While the table is considered a valuable tool in visual comprehension of anatomy that promotes observation and discussion, there is still insufficient research to support comprehensive learning outcomes (Brucoli et al., 2020).

Additional educational technology tools that are being researched in use of ANP laboratories are the stereoscope and associated stereoscopic images. This technology utilizes $2.00 student provided stereoscopes and stereoscopic images taken during a cadaver dissection. The benefit to this technology is that one cadaver dissection and its associated imagery can be used across multiple sections, courses and programs. The technology also allows for organs to be seen in comparison to one another, before being removed from the body. A final technology tool that has implications for ANP

laboratories is the HoloLens. A version of augmented reality (AR), the HoloLens is a wearable device that visually reviews regional anatomy of preselected body systems. Research on the HoloLens was implemented was directed by the guidance of the "just in time" learning theory, that says students will retain what they need to know at any given time. Using this lens, the body systems were reviewed by single organ system, for short periods of time and quizzes immediately followed exposure. More recently, during the pandemic many educators turned to 3-D anatomy apps, padlet communication platforms and videogames such as Minecraft for classroom collaboration modeled learning, with marked formative success, but acknowledged room for expansion (Timmis et al., 2016).

Additional support for the use of these types of technology in anatomical education come from positive psychology, in which students are seen to engage more fully in experiences that are positive and subsequently calm anxieties associated with learning (Chen Chen et al., 2019). These active learning opportunities also allow students to become more engaged contributors to their learning process. The utilization of technology has been shown to promote more autonomous learning (Johnston & McAllister, 2008). Research indicates that many students entering college level courses are becoming more self-directed and that implementation of interactive online learning tools can promote more, student driven and task-oriented learning (O'Byrne et al., 2008).

While the use of this technology can be cumbersome, expensive and intimidating for many instructors, it has been reported that the biggest challenge to improving ANP education comes from instructor's resistance to change (Lunsford & Diviney, 2020). "Effective teaching is at the heart of science education," (Gopal et al., 2010) and being

student centered creates more successful learning and productive learning environments (McFarland & Pape-Lindstrom, 2016). For instructors, change in delivery methods needs to be seen as a continuous process (Stylianidou et al., 2005) and learning new methods allows instructors to "become the student again" and to better understand the student struggle (Lunsford & Diviney, 2020).

Although technology seemingly offers many instructors the ability to tailor learning methods to the incredibly heterogenous populations of learners now entering Anatomy classrooms (O'Byrne et al., 2008), selection of appropriate educational technology, places instructors as the authority in terms of selection and implementation. Emphasis is on these educators to select not only the resources that are appropriate to the learning objectives (Gopal et al., 2010) but to maintain student engagement and academic success, all while being conscious of preventing the technology from "overriding pedagogical aims" (Green et al., 2006).

Considering the dangers of improper technology implementation, the global COVID-19 pandemic that occurred during 2020-2022 presented both educational and personal challenges for both teachers and students in this regard (Gordy et al., 2021). Many courses and institutions were forced to make hasty and abrupt transitions to virtual platforms, creating further challenges and technology trials for all involved in education during this time.

2.3 Measuring Success

The use of educational technology in ANP courses varies drastically, not only in terms of definition, but affordability, ease and necessary instructor expertise. In addition to these accessibility factors, institutions and instructors will need to validate technology use with student success. “Academic success is a term that is often used to indicate student’s ability to succeed in an academic environment, but sometimes confusion is created by the way this term is used. Although the standard of academic success must be upheld to the same level in any academic institution, the needs of each student population in achieving the same level of success may vary considerably” (Nasr, 2012).

While many studies promote the use of student satisfaction surveys to qualitatively strengthen support of technology implementation, very few illustrate academic success on a content driven level or against national standards. Use of the Virtual Learning Environment (VLE) has produced studies that measure success as an acceptable “pass rate achieved on examination” (Green et al., 2006). The student success results for the use of these technology tools also strongly indicated that students in control groups or those that utilized traditional learning methods, typically scored the same if not better, then the experimental groups on supplemental assessment. For the HoloLens technology mentioned previously, there were no cases where the augmented reality lenses provided better learning outcomes. The authors speculate that the lower anxiety and higher efficacy was more important in terms of cognitive interference (Chen Chen et al., 2019). For those technologies that were computer based, the use of the simulations, quizzes and other virtual tools, was reported as being more significant in relationship to self-directed

study and customization of content (O'Byrne et al., 2008). Statistically, this research conveys a sense of affirmation for many instructors and researchers who regard ANP technology as insufficient in replacing the real feeling and manipulation of animal tissue (Johnston & McAllister, 2008). However, with Vygotsky's cognitive theory as a driving force, the preference is to have enhanced social interactions (discussions and case studies), cultural tools (lectures and lectures with technology assisted features) and a greater zone of proximal development (critical discourse and real-life clinical applications) (Eagleton, 2015). When considering Anatomy and Physiology, should the content be universal, or as O'Byrne (2008) states, is the level of detail discipline depend and the role of the instructor to merely "provide engaging environments that address student learning needs?

Chapter 3: Methodology

3.1 Quantitative

Increasingly, we are seeing in higher education research, a need to focus on measurable indicators of success. This is even more evident in our evaluation of new technology based learning and virtual platforms. By identifying these predictors, interventions can be made by the institution and educators at the beginning stages of new educational processes, such an the impending and continued transition to fully online Anatomical Sciences (Lewis C & Lewis JH, 2000). There is research that illustrates the importance of the entrance exam to predicting student success in nursing programs. In addition, performance on an admission test can also indicate students successful admission into institutes of higher professional learning, one of many goals for community college education (Rahbar MH et al., 2001). Understanding how students learn is particularly challenging in a course such as Anatomy and Physiology (ANP). This is more evident when we consider the many ways the content is approached and utilized instructor to instructor, course to course and even institutionally. While comprehensive understanding on the general form and function of the human body is a shared outcome, every demographic of student from healthcare to general bachelor of science, will need to connect with the "disciplinary content" in a way that is relevant to their own professional needs (Balta et al., n.d.). It can be argued that regardless of the

path that students pursue following college, an agreed upon skill that all must carry is the ability to think critically (Nasr, 2012). Although there is no gold standard of use for anatomical knowledge (Prince et al., 2005), most instructors would argue that comprehension of the topic requires students to retain and competently use anatomical facts in various critical situations (Brown et al., 2016). One facet of ANP courses that is increasingly important, coincides with increasing critical shortages of nurses (Gilmore, 2008) and the demand for more educated and well qualified nursing staff, which is anticipated over the next decade (Gartrell et al., 2020). With this said, understanding how to corroborate learning outcomes in ANP for nursing students specifically, will be imperative. This is made more evident when considering the pipeline of physiology courses in community colleges to 4-year colleges and even medical schools (McFarland & Pape-Lindstrom, 2016).

A commonly practiced method of ANP content comprehension is summative evaluation. Utilizing this method is not just a long-standing method for all of academia, but for the sciences, it allows students to be compared to national standards (Brown et al., 2016).

Considering the availability of research on student perception of various technology learning tools and their implementation, a decision was made to further evaluate the more culminating success of the general use of technology tools in online learning platforms for student content comprehension on a more summative scale. This approach would remove variables created by assessing which tool specifically was being used and its implementation, but approach a more encompassing virtual platform.

Because anatomy is considered the cornerstone of medical education (Singal et al., 2021) and an understanding of human anatomy and physiology is essential to good nursing practice (Clifton & McKillup, 2016)

community college ANP was the target institutional level and nursing students in particular were the target demographic.

A retrospective, non-experimental design was selected as a means of observing any potential relationships or patterns between online, face to face and hybrid course and entrance exam success (Rutberg & Bouikidis, 2018). Two community colleges were considered for participation based on their diverse instruction platform offerings of online ANP courses. Both colleges had been hiring institutions of the researcher in previous years, so there was a standing relationship with the college administration that made for easier communication and retention of data. The first college considered (College1) serves a rural Midwest demographic and has a mission to provide in-demand training to advance the local community. This particular establishment had been pioneering the implementation of fully online anatomical sciences in years prior to the pandemic and has been ranked in the top ten schools in their respective state, for their online program offerings. The second college (College2) is another Midwest school of an alternative state that has a commitment on unlocking student potential, while starting their path to a bachelor's degree. This particular post-secondary college has traditionally only offered face to face anatomy courses and has more recently been offering hybrid courses with lecture online and face to face labs, in addition to their typical science programs. College2 did not implement the fully online lecture and lab components until the

COVID-19 imposed disruptions to this standard practice, when access to learning modalities such as “models, specimens and slides” was lost (Singal et al., 2021).

Prior to beginning the actual research, outreach was established with the deans of both colleges nursing departments and a request was made for the availability of all data pertaining to nursing entrance exams, student ANP platform and course success outcomes. Both colleges were eager to participate and as the research parameters were established an Institutional Review Board (IRB) approval application was submitted to the Ohio State Office of Responsibility Research Practices. This proposal outlined research interests (validating success of online anatomy and physiology content through use of nursing entrance exams) and explained the nature of the information that would be collected with particular focus on institution and student privacy. When the IRB had been approved, it was submitted to the both college points of contact and the data collection began. Due to interruptions in department faculty, COVID teaching changes and the volume of data requested (5 years of scores and student platform information), the data collection process took approximately a year (from 2019-2020 respectively). A OneNote site was set up for both colleges to utilize that would allow them to upload large amounts of data to a password protected site. From this location, the data was evaluated, organized and filtered. While a 5-year data set was requested, both schools were able to provide the data from all years that they had actively been recording the necessary information. Each college provided student ID numbers (assigned to protect and eliminate student identification), year and semester of enrollment for ANP courses, platform of ANP

enrollment, entrance exam results broken down by year and score along with other basic enrollment information.

The institutions selected utilize different standardized tests for their respective nursing programs. While the NCLEX (National Council Licensure Examination for Registered Nurses) is a test all nursing students take to certify their content knowledge and would be a more consistent assessment tool, it does not accurately direct association of content knowledge back to the student's instructional method of ANP while enrolled in school. Students could potentially develop more anatomy content depth while in the nursing program and the time frame of the test being at the end of the nursing program would allow these student opportunities for growth. To eliminate this added variable, the entrance exams were selected as the best indicator of immediate summative assessment of the anatomical knowledge.

As the online platform in particular is the variable under consideration, more state-wide and institutionally selected standardized tests were examined. College 1 utilized the Health Education Systems, Inc. (HESI) test for initial entrance and the Health Education Systems, Inc. LPN to ADN (HESIL) in the first year for program continuation. Students taking this assessment are required to achieve an 850 overall to be considered passing, with a portion of that test being dedicated to Anatomy and Physiology specifically. College 2 administered the Test of Essential Academic Skill (TEAS) test prior to entrance. This test contains at least 32 human body and organ system specific questions. For the TEAS test, a score of 65% is considered passing. Both schools relate their entrance scores to a national standard and utilize them as one of the factors that

predict student program success and foreshadowing of success on the NCLEX (National Council Licensure Examination), which is required for entry into the profession of nursing. The information relating to these tests and how they are utilized was obtained from informal interviews and Email communications with the nursing deans, which was part of the pre-testing considerations and thus did not contain formal interview questions or documentation.

As the data was organized and new trends were made evident, the data parameters were adjusted to further compare college to college and pre and current pandemic information. Each adjustment to the data sets is discussed in the results. Additionally, the volume of statistical information presented a need for additional insight and outside assistance was recruited. Both colleges utilized an Institutional Effectiveness Coordinator staff position, who was responsible for presenting necessary statistical insight regarding the college to local state and government organizations. Both staff members were willing to navigate the statistics of the data for the purposes of this research. For both colleges, the total data points were assessed. College 1 culminated 4,101 data entries total and College 2 culminated 861 data entries total. For both schools 4 years of data was initially filtered for evaluation in order to show patterns of success for online instructional platforms, in the most current data set.

For the purposes of this study, the number of students is termed unique identifiers to account for the multiple testing attempts each student is able to complete. As College1 had the longest history of online instructional offerings of ANP courses, this college was evaluated in deeper detail and then cross compared to college 2 for validation of results.

In this first evaluation, the pass or fail rate for each course was set at a C- or greater. The pass filter for the TEAS test was set at 67% and the HESI set to 850.

For the purposes of this study, the number of students is termed “unique identifiers” or “unique counts” to account for the multiple testing attempts for each student. Each college allowed a maximum of 2 attempts for each Anatomy and Physiology course (ANP1 or ANP2) and both allowed at least two attempts on the associated entrance exams. These considerations created data where each institution reported many repeat student ID’s, which needed to be accounted for in the results. For the data points, identifying unique counts instead of student ID’s was offered by statisticians as a solution to these confounding variables. This practice limits the identifications (what is measured) to attempts and not the student ID’s, meaning of 23 students, they may have participated in 32 actions or “attempts” at a given course or test. Here we focus strictly on the attempts.

Student surveys have been utilized in previously conducted research to evaluate undergraduate perceptions of ANP education. In chapter 2, discussion of learning technologies and assessment, we see that researchers are able to gain access to students more honest opinions by allowing them anonymous feedback opportunities through surveys and interviews, particularly ones that tap into a more natural student environment (Clark & Vealé, 2018).

While the majority of the previously mentioned qualitative analysis indicated positive support of virtual/online lab and lecture learning tools, the overall feeling for many researchers of fully online course offerings was still apprehensive at a minimum.

Additionally, the majority of these research studies were conducted prior to the COVID-19 pandemic. More current research involving online anatomical science education, takes into consideration student and instructor perceptions during a mandatory public health emergency digital switch (Singal et al., 2021).

As this shift in education platform has been more global, feedback of students on aspects of digital learning, will be essential in ensuring "timely modifications" in online anatomy education (Singal et al., 2021).

3.2 Quantitative

In an effort to further see the realities of these assessment-based phenomenon through the student view, a mixed methods survey was administered to all anatomy courses at both college institutions, including face to face, hybrid and online students. The survey link was sent to the department dean and then distributed to course instructors. The survey was anonymous and security of students protected by requiring a college specific email address to participate. This also allowed the researcher the ability to ensure participation from both colleges.

The hope in the survey administration was to produce a more rounded analysis of online endeavors and success through a familiar online survey platform (Chalmers & Cowdell, 2021). The goal was to see if the majority of our students enrolled in Anatomy and Physiology courses are pursing Nursing certification (to justify use of the nursing entrance exam) and to see of those students, how many are enrolling in online platforms and what their perceptions of these courses on their success were. Additionally, to further

assess the second trend seen in the data of students' success rates on the entrance exams or those students not attempting to take them, questions were posed that touched on examination.

The questionnaire was created utilizing Survey Monkey and contained 10 questions; 2 open ended, 2 Likert scale and 6 multiple choice. Participation is the survey was voluntary and incentive was provided in the form of Amazon gift card drawings. The participant sample size was considered valid, as saturation in results was met after the 15^{th} participant. Past that point, additional participation did not alter the themes noted in the previous assessment (Astroth & Chung, 2018).

Chapter 4: Data Analysis and Findings

4.1 Quantitative

As College1 had the longest history of online instructional offerings of ANP courses, this college was evaluated in deeper detail and then cross compared to college 2 for validation.

An initial drill down of the data for College1 utilized data parameters that were isolated by a 4-year assessment and course outcome, pass or fail. Course, by definition, could apply to Anatomy and Physiology 1 or 2, included an online lab (4 credit course total) and the student count was named unique identifier to account for multiple attempts made by individual students. The results of the analysis indicated that 2,222 attempts were made at Anatomy and Physiology courses between 2019 and 2022, of those attempts the majority of students enrolled in face to face instruction (1,061 unique identifiers) and the lowest enrollment was seen in hybrid instruction (376 outcomes). The population of online students had an overall course pass rate of 68%, the highest of all three platforms across the 4-year time span. The data also allows us to see the impacts of the COVID-19 pandemic on student enrollment, as the attempts made for face to face courses dropped from 244 unique students to 48 students between 2020 and 2021, consistent with the onset of the pandemic (Singal et al., 2021) Table 4-1. According to conversation with the science department leads via Email, the pandemic regulations for their state allowed them to continue face to face instruction in modified small group settings and to transition hose students unable to attend these meetings to an online offering.

Counts of unique students by Course Outcome that feature Labs						
CRS Instructional Method	AY	Successful	%	Unsuccessful	%	Grand Total
100% Online	2022	74	62%	46	38%	120
	2021	192	71%	78	29%	270
	2020	196	75%	64	25%	260
	2019	74	55%	61	45%	135
100% Online Total		536	68%	249	32%	785
Face-to-Face	2022	102	63%	60	37%	162
	2021	48	75%	16	25%	64
	2020	244	65%	129	35%	373
	2019	299	65%	163	35%	462
Face-to-Face Total		693	65%	368	35%	1061
Hybrid	2022	13	35%	24	65%	37
	2021	142	61%	89	39%	231
	2020	34	62%	21	38%	55
	2019	29	55%	24	45%	53
Hybrid Total		218	58%	158	42%	376
Grand Total		1447	65%	775	35%	2222

Table 4-1 Comparison of course outcome by platform at College1.

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To further evaluate the results of the initial analysis, the data for College1 was expanded to cover all years of recorded data for each instructional platform, 16 years of face to face, 12 years of online and 7 years of hybrid instruction (Figure 4-1). The new data sets utilized to create the graph, validate the preference of student enrollment in face to face instruction and illustrate varying patterns of course success. For face to face instruction, the tendency for students to be more successful steadily declines from 2006 to 2010 and then drops sharply with the introduction of the online platform in 2010. This steady fall in face to face student success continues from 2010 to 2021, when there is a slight increase. From 2010 on, the online platform has seemingly steady success with a sudden and sharp decline in 2018 followed by a prominent rise in 2020 that reaches a plateau and then subsequent fall in 2021. The hybrid platform, while significantly less years of data, illustrates a mirror trend of the online classes, outside of an anomaly in 2018, where the success of the hybrid class rises above the online course. The 2018 variance was not able to be accounted for by the institution or instructors when cross-examined via Email.

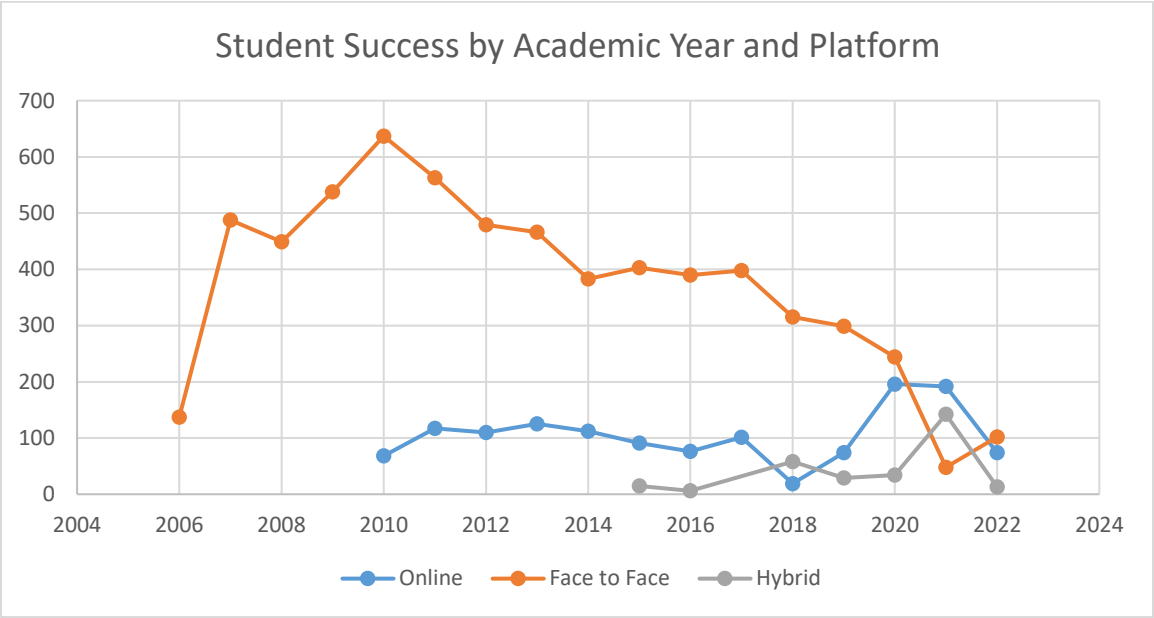


Figure 4-1 Expanded comparison of course outcome by year for College1.

Next, the data was assessed for instructional method and successful completion of the nursing entrance exam for College1. For these values, only those students who successfully complete the ANP courses at a department measured C- or greater, were included in the collected data. These students could include those who had completed Anatomy and Physiology 1, 2 or both. Additionally, the data was maintained as "unique identifiers or attempts" instead of student ID to continue and account for those students who would have attempted either course more than once. As the HESI test has both an entry level assessment and a more specific LPN to ADN secondary level assessment, both were evaluated in the comparison. According to the data, the most successful students on both tests over the course of a 4-year period were enrolled in online ANP platforms, 73% for the HESI and 60% for the LPN to ADN HESI respectively. The HESI LPN to ADN exam, which contains a greater volume of Anatomy and Physiology (ANP) specific content, shows consistent success between the online and face to face platforms, with a success rate of 75% for both in 2021 and 50% for both in 2020 (Table 4-2). With this data set, the hybrid figures consistently showed the lowest enrollment and lowest success scores. Considerations for these numbers are considered further in the discussion section of the paper.

Unique Counts of Students of whom are Course Successful (C- or Higher) that took the Entry Level HESI					Unique Counts of Students of whom are Course Successful (C- or Higher) that took the ADN Level HESI				
CRS Instructional Method	AY	1) Passed	2) Did Not Pass	Pass %	CRS Instructional Method	AY	1) Passed	2) Did Not Pass	Pass %
100% Online	2022	6	2	75%	100% Online	2022	0	0	
	2021	25	8	76%		2021	3	1	75%
	2020	25	7	78%		2020	3	3	50%
	2019	12	8	60%		2019	0	0	
100% Online Total		68	25	73%	100% Online Total		6	4	60%
Face-to-Face	2022	5	1	83%	Face-to-Face	2022	0	1	0%
	2021	1	1	50%		2021	3	1	75%
	2020	44	21	68%		2020	3	3	50%
	2019	47	21	69%		2019	0	0	
Face-to-Face Total		97	44	69%	Face-to-Face Total		6	5	55%
Hybrid	2022	0	0		Hybrid	2022	0	0	
	2021	29	13	69%		2021	3	3	50%
	2020	2	1	67%		2020	0	0	
	2019	2	1	67%		2019	0	0	
Hybrid Total		33	15	69%	Hybrid Total		3	3	50%
Grand Total		198	84	70%	Grand Total		15	12	56%

Table 4-2 Comparison of Course Successful Students on HESI Assessment at College1.

The results for the 4-year analysis provided insights into the pass and fail rates of those students impacted in and around the COVID-19 pandemic time frame for College1 specifically. In order to further evaluate these trends, a more critical look was taken at student HESIL success and course pass rates over the course over an 8-year period. For this data (Table 4-3), the filter for passing score of C- or better was removed and the rates of course success or failure were compared against summative assessment (HESIL= LPN-AND specific) success or failure.

For this data, the term "students" continues to represent the unique attempts made or actions completed. For online in particular, this means that 23 is the number of students, but to account for duplicate efforts they competed 32 actions or attempts. With this said, percentages were not reported and it was decided that strictly looking at those unique counts was the best way to eliminate extraneous information.

The face to face enrollments were able to be course successful and assessment successful in 77% of the attempts. The online attempts were able to be course and assessment successful in 65% of the attempts, with hybrid only showing 25% success in both course and assessment. Of greater significance, these results also show that 48% of online, 42% of face to face and 75% of the hybrid attempts were able to pass the course, but were unsuccessful with the standardized assessment.

In order to validate the method of analysis and results for these findings, College2 was utilized for a comparative analysis. College2 had a longer standing hybrid program with implementation of the online offering, only during the pandemic. The same filters were applied to the data for College2 (Table 4-4) and the results indicated that of these

ANP platforms 13% of online attempts, 33% of face to face attempts and 48% of hybrid attempts, were successful at completing the course and the standardized assessment (TEAS). In contrast, 81% of online, 55% of face to face and 37% of hybrid attempts were successful in the course but unsuccessful in the standardized assessment.

		Instr Method Values		
		100% Online	Face-to-Face	Hybrid
HESIL Outcome	CRS Outcome			
1) HESIL Passed	1) CRS Successful	15	72	1
	2) CRS Unsuccessful	3	22	1
2) HESIL Not Passed	1) CRS Successful	11	39	3
	2) CRS Unsuccessful	3	10	1
Grand Total		23	93	4

Table 4-3 Success of platform specific attempts with assessment success at College1.

Row Labels	Column Labels Online Students	Face to Face Students	Hybrid Students	Total Students	Total %
pass					
1) CRS Successful	3	111	36	150	100%
2) CRS Unsuccessful	2	27	12	41	100%
fail					
1) CRS Successful	18	186	28	232	100%
2) CRS Unsuccessful	7	83	16	106	100%
Grand Total	22	334	74	430	100%

Table 4-4 Success of platform specific attempts with assessment success at College2.

Seeing a pattern emerge for both College1 and College2, in regards to the high rate of students with unsuccessful attempts on standardized testing, regardless of platform, another analysis of College1 data was conducted to see the trend in assessment scores over the course of more inclusive year sets. This filter was set in an attempt to neutralize the confounding variable the COVID-19 pandemic could have placed on all data points between the academic years 2019-2022 and the additional variables of educational platform. This new data set included all students attempts that passed the ANP course (C- or greater) regardless of instructional method and looked strictly at pass fail rates of attempts on the standardized test. The results depicted a steady increase in the number of failing attempts on the HESIL test, from the lowest amount of 17% in 2015 to 71% in 2021. Consistently, we see the highest rate of passing at 83% in 2015 and the lowest rate at 26% in 2021 (Table 4-5).

	HESIL Outcome Values								
	1) HESIL Passed			2) HESIL Not Passed			Grand Total		
Calendar Year	Students	Taken	Outcome %	Students	Taken	Outcome %	Students	Taken	Outcome %
2014	6	6	60.00%	4	4	40.00%	10	10	100.00%
2015	5	5	83.33%	1	1	16.67%	6	6	100.00%
2016	10	10	71.43%	4	4	28.57%	14	14	100.00%
2017	19	19	82.61%	4	4	17.39%	23	23	100.00%
2018	14	14	70.00%	5	6	30.00%	18	20	100.00%
2019	19	19	48.72%	18	20	51.28%	27	39	100.00%
2020	16	16	45.71%	17	19	54.29%	26	35	100.00%
2021	6	6	28.57%	10	15	71.43%	15	21	100.00%
Grand Total	**95**	**95**	**56.55%**	**59**	**73**	**43.45%**	**129**	**168**	**100.00%**

Table 4-5 Success Rates of HESIL Test Over 8 Year Span

To better visualize the impact on assessment specifically (Figure 4-2), a line graph was created to illustrate the year to success trend. The graph depicts a more serious continuous decline in success between 2017 and 2022.

In order to corroborate these findings, the same application was made to College2 data in order to assess the full scope of years of recorded data for TEAS test assessment. The only change in formatting was that 15 years of data were available for comparison. A line graph (Figure 4-3) illustrates a mirroring decline in both variables to the College1 results. This is particularly evident in College2 between the years of 2019 and 2022, regardless of educational platform or course specific success for ANP instruction.

The impact of this correlation will be discussed further in the discussion section, as it is not necessarily indicative of causation and the positive correlation can only be applicable to a particular year span (Hayes C, 2005). Again, the goal of the research was to show online platform success compared against other instructional platforms of Anatomy and Physiology. This deep dive was in response to a pattern that emerged from that initial comparison and will be important when considering the academic years and the potential impacts of the COVID-19 pandemic on student success.

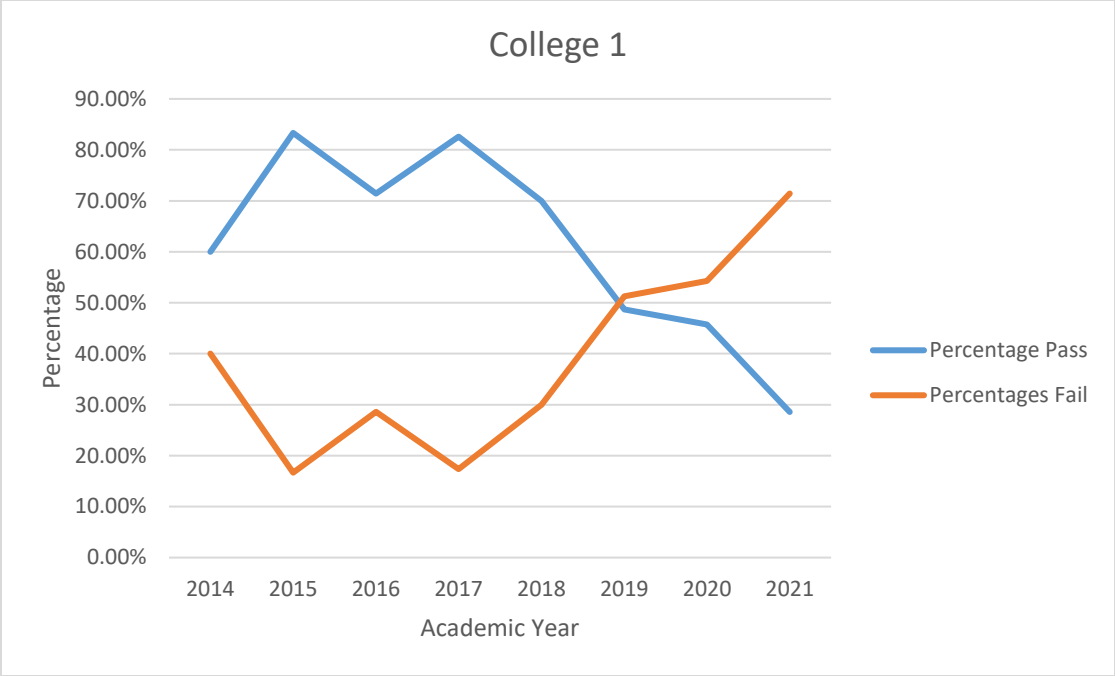


Figure 4-2 Success Rates of HESIL Test Over 8 Year Span.

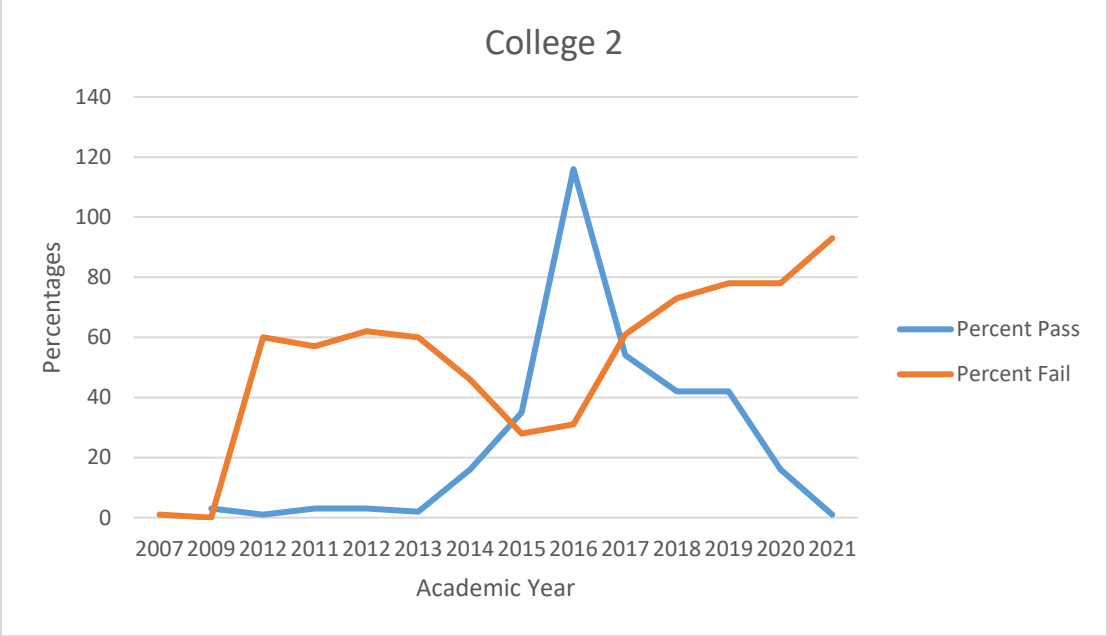


Figure 4-3 Success Rates of TEAS Test Over 15 Year Span.

The data thus far has reported on the success of attempts at Anatomy and Physiology courses between platforms of ANP education, indicating that online instruction can be measurable against face to face and hybrid instruction. This was evident for both College1 and College2. The data also began to illustrate trends across all platforms, of declining success in standardized nursing assessment between the years of 2016-2022. These patterns measured students who failed and passed the test regardless of educational platform. In order to find merit back on to main research question of success in online platforms specifically, the course success outcomes were utilized as a filter and the success of testing for only successful student in the online platform were compared for College1 and College2 across all years of data (Table 4-6 and Table 4-7).

This comparison illustrates that 73% (86 students who passed of those 118 that completed the test for both sections as there is not guideline that you have to have both courses completed to take the assessment) of online student attempts were able to be successful in the course and on the test. This is compared to 74% (233 students who passed of those 312 that completed the test) of face to face ANP students. These findings were compared against College2 and due to the very low sample size of the online college, the data was not considered in this section. Please see Appendix A for the corresponding tables. What is considerably more evident in these data tables, is that there are a very large number of students in both anatomy platforms, who are not participating in completion of the standardized assessment. This will be considered further in the discussion.

RevTitle	HESI Entry	Successful Students	Successful %	Grand Total Students	Grand Total %
Hum Anat/Phys II	1) Passed	59	100.00%	59	100.00%
	2) Did Not Pass	21	100.00%	21	100.00%
	3) Not Taken	235	100.00%	235	100.00%
Hum Anat/Phys II Total		315	100.00%	315	100.00%
Human Anat & Phys I	1) Passed	27	100.00%	27	100.00%
	2) Did Not Pass	9	100.00%	9	100.00%
	3) Not Taken	279	100.00%	279	100.00%
Human Anat & Phys I Total		315	100.00%	315	100.00%
Grand Total		**441**	**100.00%**	**441**	**100.00%**

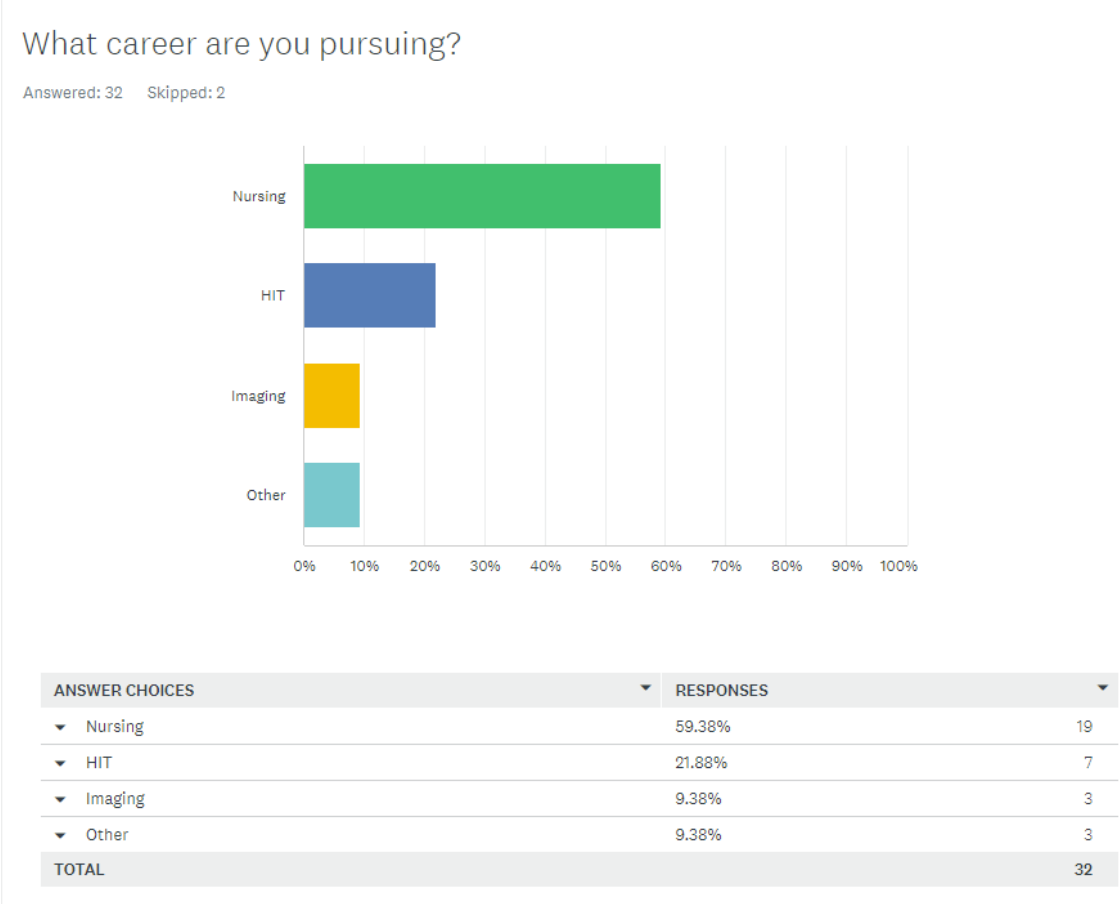
Table 4-6 Success on HESI/HESIL for Couse Successful Online Students

RevTitle	HESI Entry	Successful Students	Successful %	Grand Total Students	Grand Total %
Hum Anat/Phys II	1) Passed	124	100.00%	124	100.00%
	2) Did Not Pass	40	100.00%	40	100.00%
	3) Not Taken	457	100.00%	457	100.00%
Hum Anat/Phys II Total		621	100.00%	621	100.00%
Human Anat & Phys I	1) Passed	109	100.00%	109	100.00%
	2) Did Not Pass	39	100.00%	39	100.00%
	3) Not Taken	608	100.00%	608	100.00%
Human Anat & Phys I Total		756	100.00%	756	100.00%
Grand Total		**828**	**100.00%**	**828**	**100.00%**

Table 4-7 Success on HESI/HESIL for Course Successful Face to Face Students

4.2 Qualitative

The survey indicated that the majority (98%) of participants had taken some form of fully online Anatomy and Physiology 1, Anatomy and Physiology 2 or a second attempt of either course. In support of earlier assertion of the predominantly health care student demographic, 90% of the students were on a health care tract (imaging, health information technology, nursing) and of that data set, the predominant (60%) student group contained nursing students (Figure 4-4).



ANSWER CHOICES	RESPONSES	
Nursing	59.38%	19
HIT	21.88%	7
Imaging	9.38%	3
Other	9.38%	3
TOTAL		32

Figure 4-4 Qualitative Analysis of Online Student Programs

As the goal of the more qualitative nature of research is to "engage in reflective and interpretive thinking (Clark & Vealé, 2018)," with this in mind, students were asked to consider their reasonings for enrolling in the fully online course. This question was created as an open-ended question on the questionnaire. Utilizing a free word cloud website, monkeylearn.com to capture the trends of the written data, 3 students specifically mentioned pace, 6 referenced scheduling (personal or professional), 3 COVID restrictions and 2 campus access limitations as reasons for enrolling online (Figure 4-5). The generated cloud map helps to illustrate not just a numeric value for the number of times the words appeared in the written responses of the survey, but the importance of those terms, making the placement of the word and the frequency enlarge the term in the visual map. Specifically, the word full time was the largest generated word and it was present in the most responded along with indications that the majority of students enrolling in this particular course and platform and balancing career and academia. The remaining students were unclear in their answers as to a reason for enrollment specifically.

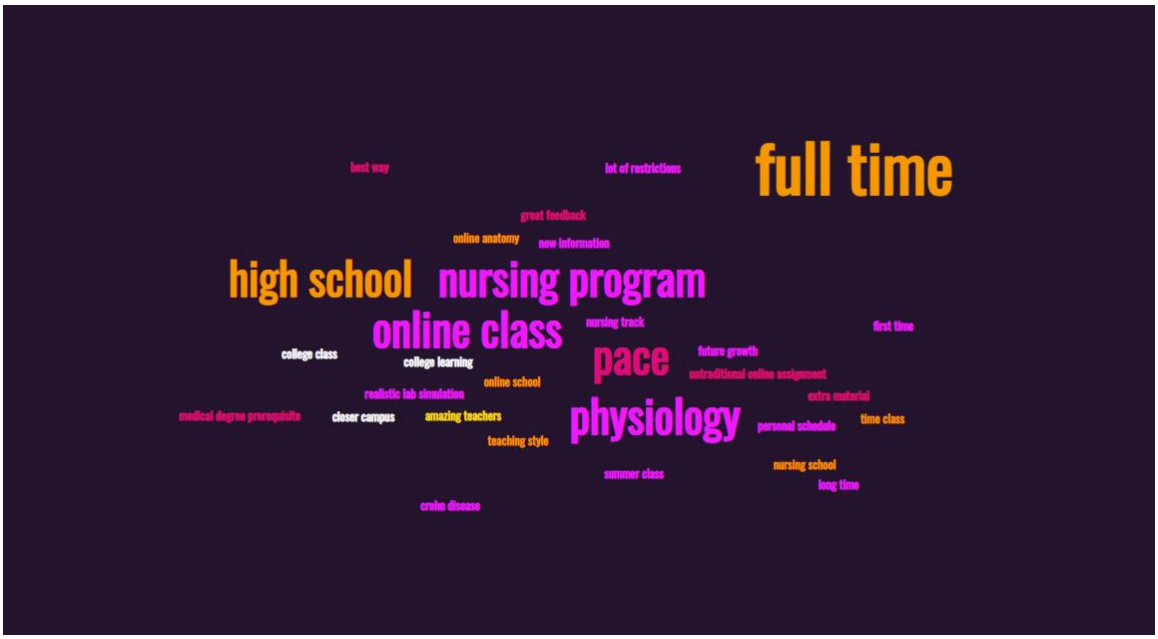
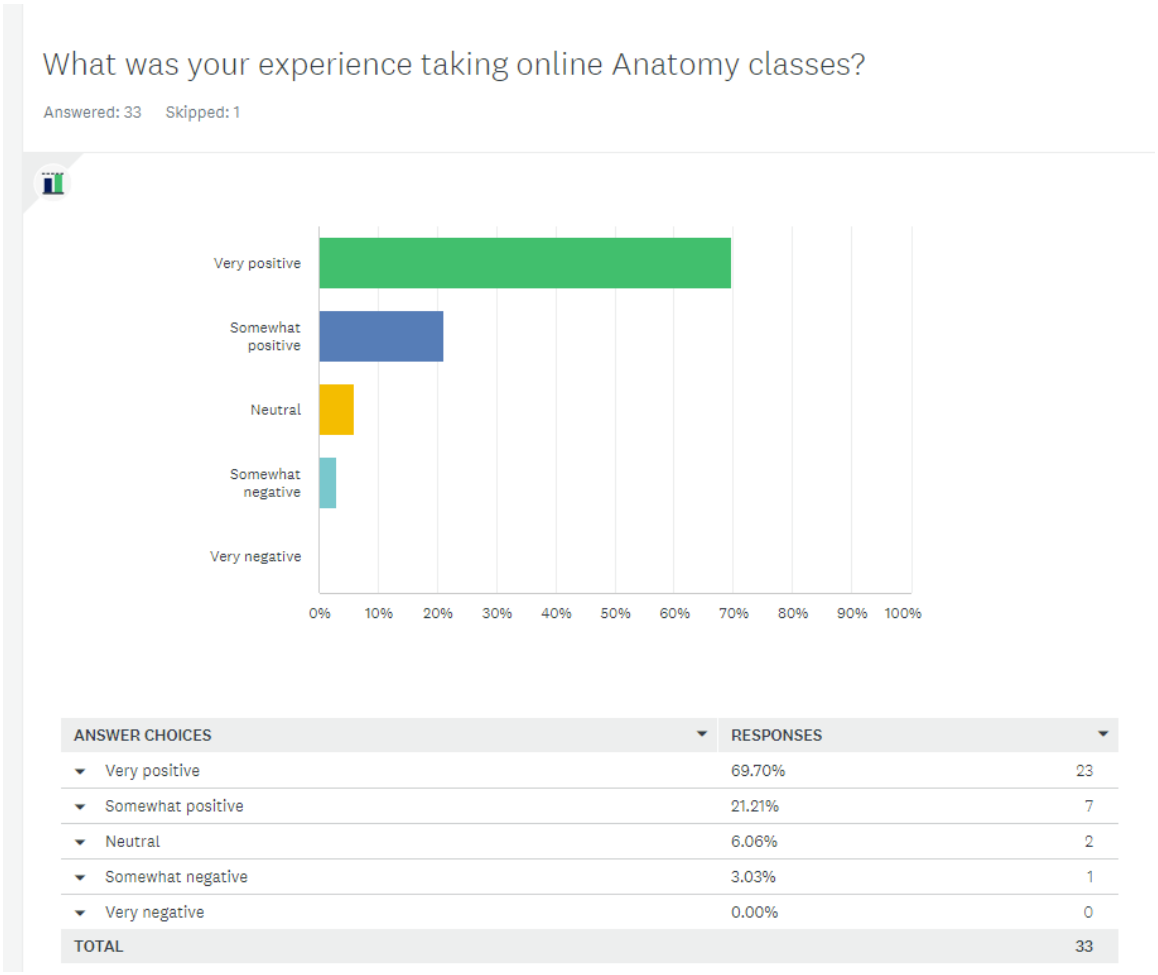


Figure 4-5 Word Cloud for Question #3

A second open ended question looked deeper into what students thought was the aspect of the online Anatomy class that most impacted their success. Corresponding to the previous survey item, a word cloud was generated and the results for this response can be seen in Appendix B. The words that most reflect aspects of online anatomy courses as mentioned in the introduction; were instructor, starter class, better general understanding and lots of information. These terms show a great importance in the student opinion of the instructor and their role in creating content success. The other terms show a preference of students to visualize this online platform as a first introduction or beginner course for their anatomical understanding. This could create challenges with student perceptions and realities of course rigor and perpetuate higher failure rates (Johnston & McAllister, 2008).

It was reported, pre and post pandemic, that most students are not in favor of the online platform (Patra et al., 2021) and that particular content topics within ANP are easier to understand, be successful in and are more interesting when physically present in the classroom (Singal et al., 2021). In contrast, these results indicated that the majority (90%) of students surveyed found online anatomy and physiology courses very positive (70%) or somewhat positive 21%, (Figure 4-6) and 96% stated that they strongly agreed (44%) or agreed, that online anatomy helped them to be successful. Those students that left neutral or somewhat negative feedback, indicated in the associated narrative questionnaire that this was due to unfamiliarity of the non-traditional assignments, absence of one on one time with the instructor or distracting work locations without a

dedicated classroom (Figure 4-7). These results also fall back on the concept that instructors carry the responsibility of ensuring that students do not just receive quality content, but that they create a cohesive, welcoming presence in their virtual platform. Additionally, and they should model an online classroom culture that is clear in instruction and intent of assignments to prevent confusion that detracts from the content.



ANSWER CHOICES	RESPONSES	
Very positive	69.70%	23
Somewhat positive	21.21%	7
Neutral	6.06%	2
Somewhat negative	3.03%	1
Very negative	0.00%	0
TOTAL		33

Figure 4-6 Qualitive Analysis of Online Student Perceptions

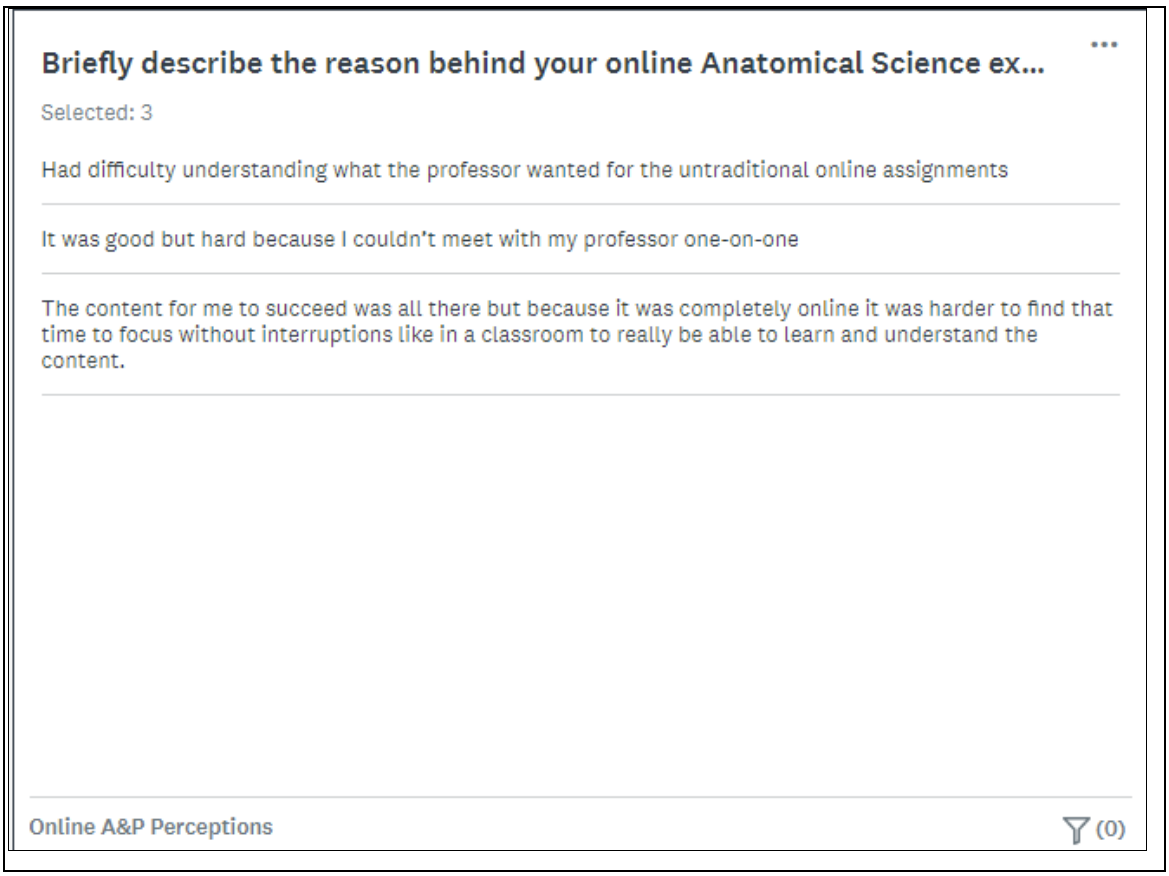
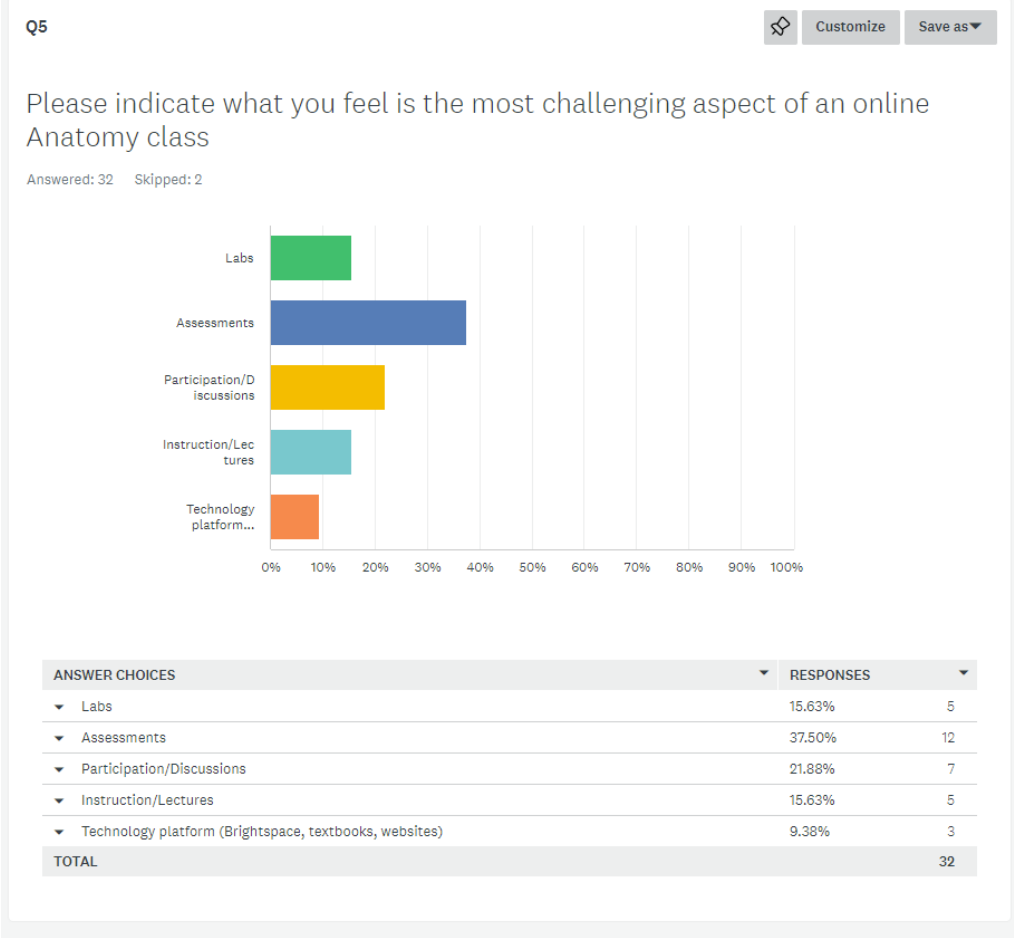


Figure 4-7 Qualitative Analysis-Narrative of Online Student Perceptions

A final important connection to the qualitative aspect of the research was the student perceptions of what were the most important and conversely, difficult aspects of the course in its online nature. Our previous understandings of the transition of Anatomy and Physiology to online formats, was that the laboratory aspects were the most challenging to changeover and their implementation has been the critical focus of most research and investigation. Students seemingly share the sentiment that they feel the labs are the most important (30%), but the majority 38%, (Figure 4-8) indicate that assessment is what they feel is the most difficult aspect. As we have seen in the qualitative data, the assessments are an area of concern for summative evaluation of anatomical content knowledge. Seeing that students are also feeling this burden, instructors will want to evaluate how they measure success, either formative or summative, in their courses and how their assessments aid in that process.



ANSWER CHOICES	RESPONSES	
Labs	15.63%	5
Assessments	37.50%	12
Participation/Discussions	21.88%	7
Instruction/Lectures	15.63%	5
Technology platform (Brightspace, textbooks, websites)	9.38%	3
TOTAL		32

Figure 4-8 Qualitive Analysis of Online Student Perceptions of Challenges

4.3 Analysis and Limitations

The information provided in this paper illustrates a lengthy reform effort of Anatomy and Physiology Education to break free from the traditional instructional approaches of face to face lecture halls with heavily cadaver and physical model-based labs, to more innovative and virtual platforms. These transformations have been pushed by new technology availability (Kruse & Wilcox, 2013), account for geographical disadvantages for a more equal educational field (Lauret & Bayram-Jacobs, 2021). In addition, these changes have been implemented to account for emergent pandemic regulations (Yavuz et al., 2021). This section will discuss the implications of these online transitions in addition to the possible correlations the data have to a larger topic of assessment. Particular consideration will be made for summative evaluation as a method of Anatomy and Physiology (ANP) content understanding and retention for students, as well as its potential role in instructor self-reflection and evaluation.

In assessing the statistical data and the quantitative portion of the study, it appears that the ability for students to be successful in online platforms of education were measurable, particularly for College1. The percentage of students who were able to be course successful with a grade of C- or better (Table 3-1) online (68%) and face to face (65%) for College1 were not only close in percentage, but consistent when compared to the course specific success of those students at College2 (Table 3-4). For College2 roughly 95% of online students were able to be successful in the course, versus 88% of the face to face students. While these percentages are considerable and can be seen comparatively in other research measurements of online versus face to face platform

success (Eansor et al., 2021), considerations of the confounding variables must be made for all data provided by the participating colleges.

The low sample size obtained from the overall data, compared to the data points collected and reported, is related to student ability to repeat ANP courses and entrance exam testing. For both variables (student course attempt and student test attempt) the students are permitted two attempts before program acceptance is considered. This permission applies particularly to College1 whereas College2 allows unlimited attempts at the TEAS test, noting that the most recent score is typically considered over the "best" score. Due to this and the small sample size, no definitive assumptions or statistically significant conclusions can be drawn.

However, the goal of most research is to investigate potential cause and effect (Pearl, 2009). Although correlation is not causation, the aim of the paper was to find a meaningful way to articulate course success in online platforms, while eliminating any causal effects that would prevent the variables (online or face to face and their respective success) as unrelated. Considering these parameters, we can consider online students successful in course completion/passing, when compared to face to face and hybrid students.

Other confounding variables noted in the study were related to the student demographic information such as; admission status (full time vs part time,), student background/demographic (prior college or high school or dual enrolled status) as well as enrollment status (active, drop, fail) from programs they were striving for acceptance into (Gartrell et al., 2020). In addition to these considerations, defining "success" can be

challenging for research. Particularly for content comprehension achieved on the assessment. As presented in this study there is no way to assess if there was influence by instructional methods of the course, particular technology utilized or student testing skills (Prince et al., 2005). To account for these variables, the instructor specific information was excluded, student information was reduced to only individual assigned ID numbers and in many extrapolations, the students who were successful in the course (by college standard), were the only students considered.

A limiting factor in the qualitative tests would be its retrospective design and it would be challenging to predict future implications with any degree of success (Gilmore, 2008). Even with these considerations, we were able to see a basic trend that the platforms of implementation offered and supported by the institution (online for College1, Hybrid & F2F for College2), had comparable success. While College2 may not have had strong online results, they are a predominantly hybrid and face to face backed institution. College1 by comparison promoted a strong online platform presence and their students were comparably successful in the course and on the summative assessments. Results for the quantitative analysis also included data sets that were in and around the COVID-19 pandemic. While this was not an initial focus and the pandemic was simply an extraneous event that occurred during the research, it presented a visible trend for all data sets. Many of the sharp decline patterns we see in the graph representations of student summative assessment success are particular to 2019-2022. Many of the transitions to online were hasty and abrupt for all involved in education during this time, particularly the students (Gordy et al., 2021). While this creates a confounding variable to

our analysis of student success in the educational platforms and summative assessment, it also allows us to see a positive correlation in the data that students, regardless of platform, have seemingly been negatively impacted by the pandemic in terms of assessment success (Figures 3-1 & 3-2).

4.4 Defining Success and COVID-19

Defining success presents many challenges and in the case of this study, this was decidedly defined by a passing grade (against school standard or national standard), but considering the overall assessment trend, it is not evaluated if those students who were successful in the online anatomical platforms during the COVID 19 pandemic were already considered strong academically due to their face to face experiences prior to the pandemic, or if they already possessed the skills necessary to be successful online from technology comfort. In comparison to similar research by (Hussain et al., 2021) student preference for face to face classes had been trending down and student comfort with online platforms increasing, in addition to comfort with technology tools such as phones and laptops (Vagg et al., 2020). These considerations will be discussed further in the considerations for future research, as it would be necessary to look at the student's enrollment status individually (online or F2F for each ANP course) pre and during pandemic to eliminate this variable, something outside the immediate scope of this study. Although countless measures were taken to account for a standard definition of success for the students evaluated, there still remained the consideration of our primary nursing student demographic, during a global pandemic. Those students attending online were

also likely active front line workers in the medical field during the pandemic. A high number of these students had increased fail rates, withdraw rates and declining presence in course due to the mental and physical toll this working environment presented (Hrelic & Anderson, 2022). The implications that this has on our understanding of the results are two-fold; the high rate of failures and the number of students not even attempting the assessments (Table 3-6 & 3-7) could be related to pandemic stresses on nursing students and second that the pandemic may be affecting our enrollment of nursing students particularly in ANP courses.

Considering this, the research available previous to the pandemic indicated that students in Anatomy and Physiology courses were predominantly nursing focused (Geis MJ, 1990). This can also be seen is the qualitative examination (Figure 2-4) where 59% of the ANP students surveyed were pursuing nursing specifically. Of these students, 70% reported that they had not attempted the entrance exam, although they had successfully completed both ANP courses. This is supported with the data from Table 3-8 and 3-9 respectively, where we see that over the course of the 8-year period, the largest total unique counts, did not attempt the HESI or HESIL after enrollment and successful completion of any platform of Anatomy and Physiology. While College2 does not record this particular data for comparison, thus rendering this insight statistically invaluable, it does provide a meaningful piece of data for the institution (College1) when evaluating enrollment and completion of Anatomy and Physiology students.

Other considerations for the data reported are unaccounted for anomalies in 2018 for College1 and College2, where we see a significant dip in passing assessment scores,

regardless of platform and without explanation from either school. As the pandemic had not yet impacted student enrollment or participation in classes, this would need further investigation and insight from institution staff. Initial conversations via zoom and through Email with ANP instructors at both colleges did not provide any insight into institutional or course changes that would account for this data finding.

Additionally, 2022 data was removed from most of the qualitative data to aid in eliminating these incomplete data points, as this semester is still in progress. However, Table 3-2 compares it as a measure of what is still considered the continuing COVID-19 impacted semester (Gordy et al., 2021). As such, this information is not entirely reliable and can only be considered as emerging insight for this table alone and future research considerations.

Academic achievement has more recently been recognized as only one measure of success, but the definition of student success is still dependent on standardized assessment. By blending both the quantitative and qualitative research, it aided in a better method for conceptualizing a more comprehensive view of learning success.

One of the predominant patterns of this research, outside of ANP platform success, relates to student assessment. The qualitative study indicated that assessment holds importance to students and is an area of challenge for them. These insights are backed by the qualitative data, which suggest that students are struggling to be successful in these summative assessment tasks, regardless of platform of instruction. For Anatomy and Physiology students in particular, the programs they are seeking entrance into are highly competitive and their acceptance is dependent on these scores. The summative outcomes

in these cases can determine not only program acceptance, but recognition from instructors, honors societies and the educational community (Darabi Bazvand & Rasooli, 2022). The construction of these assessments would need to be further evaluated for validity in measuring science specific Anatomy and Physiology content knowledge (Earle, 2020) and even further considerations for the question reliability. With more and more online course offering and non-traditional assessments involved within them, the material utilized on these standardized tests will need to be subjected to more scrutiny as question sharing and repetitive use become apparent (Huang et al., 2021).

Insights created by both the qualitative and quantitate data, illustrate a pattern of concern for assessment in all anatomy and physiology courses and on a larger scale that just platform consideration. The qualitative data presented student insights that the instructor is seen as the cohesive unit in regulating success in these courses and their positive presence or absence created an overall positive or negative perception of the course. With the responsibility falling on instructors to ensure this definition of success, do we fall back on the argument of "teaching to the test?" The idea that teachers should help students create success on summative assessment is a fine line in course design.

However, some research argue that good tests can provide valuable information (such as the readiness of our nursing students) and they believe that these tests should "guide our courses and curriculum" (Al Ghafri et al., 2019). Those who argue against standardized testing, neglect that these tests may be the most objective way that the general public can assess how our classrooms operate. Additionally, for those stating that these tests don't truly measure learning, the opposition would argue the idea that we

likely don't even know what we are measuring then (Phelps, 2016). Whether instructors align their course to these tests or not, all standardized tests have consequences, both intentional an unintentional, from personal, social to academic problems (Merchant et al., 2020). The success of students on their assessments will require teachers to stay abreast of changes in assessment and continue enrolling in professional development of their own assessment. This has been noted as a particular challenge of those instructors in higher education particularly, who have been reported to seldom enrolling in these trainings. For teachers to create successful students, continued conversations need to be had by instructors from all departments and institutions to measure and validate the nature of the content and its assessment. The key word for this consideration is continued, as the nature of the testing and the content instruction itself will continue changing, particularly as new technology emerges (Al Ghafri et al., 2019).

4.5 Considerations for Future Research

While most of this data seems promising for online students or those alternate educational platforms (such as Hybrid for College2), the reality is that many undergraduate, professional and graduate programs in the United States, continue to ignore transfer credits of those courses that contained online lab components (Brown & Peterson, 2021).

To deepen the online success specific results of this study, there are many contemplations for future research that should be measured in order to continue pushing for not only the equal consideration of these students attempted credit hours, but the

understanding of the content. Only two community colleges were compared and use of more colleges on a wider scale would deepen the validity of these findings. A comparison of schools that have all offered consistent online offerings would provide better backing, as this study indicated that online success could potentially be determined by the school's history of implementation of the course and not just the online nature of the course specifically. To further this study and to look more particularly at which technology tools were aiding in the success of student content knowledge, a single school deep dive could look at the same passing rates, but incorporate more course specific information such as; technology tools utilized, modeling methods administered, years of online instruction for the instructor, and assessment types.

Another consideration should be given to study only those student results that were fully online for all attempts of AP1 and AP2. While this study did indicate measurable online course success and assessment success, the COVID-19 pandemic may have pushed strong face to face students into online platforms. Eliminating any students with a history of face to face or hybrid attempts would negate this variable. Concerning the COVID-19 pandemic impact of this study, further research could use the patterns presented here of lower assessment pass rates and less nursing students completing the summative exams, to see the continued implications. Expanding this study out another 4 years past the return of face to face instruction or lifted state restrictions, the number of attempts made and successful attempts completed could be evaluated again. This data is important not just for Anatomy and Physiology educators, but for the institutions they teach. Our student demographic in these classes could be

shifting and as we know that the instruction of ANP content can be specific to its use-and every demographic of student will connect in a way that is relevant to their own professional needs (pg. 15) and adjusting how it is taught will be imperative. Additionally, schools will want to reflect on how they retain this student demographic or ensure their completion of the programs enrolled in.

Another consideration could be made for eliminating all repeat attempts so that the data is more cohesive and understandable for general audiences. However, this would take consistent and lengthy participation from the participating colleges and would likely need to look at only those students who are course and assessment successful first time versus those students who required a second attempt.

While every attempt was made to eliminate researcher bias, there is likely unintended bias in the colleges participating and considering that the researcher is primarily teaching online platforms of ANP. Utilizing a larger college demographic and having the primary researcher be a standing staff member such as the Institutional Effectiveness Coordinator staff position at College1 could eliminate these predispositions.

Limiting factors for this study were presented in the form of available data, definitions of success and the COVID-19 pandemic, that occurred in the timeframe of the data collection of the study. Back to our research questions and with the study limitations in mind, our data seemingly indicated that course success does not necessarily equate to content success on summative assessment. However, there were promising results for the use of these data points as a means of comparing success across ANP instructional platforms.

The challenge for Anatomy instructors will be to use this knowledge and the available statistics of their own institution to decide how to best implement Anatomy into these newly evolving curricula. Focusing on how they model, supplement and assess knowledge (Akeel, 2021). These statistics also offer instructors an opportunity for self-reflection by seeing the success rates of their students in particular against other instructors' courses and using a measure of a nationally recognized summative assessment. Keeping instructor name private, similar to the student ID's in this study, it eliminates defensiveness on the part of the educators under evaluation and can lead to more self-scrutiny (*Why Do Teachers Get so Defensive?*, n.d.).

Technology tool implementation inconsistencies, assessment variations between classes and institutions, or in many cases no use of standardized assessment for anatomical knowledge at all, can create anatomical course mistrust or give it an outdated feel (Trautman et al., 2019). The results of this study and its future research implications have importance for not just the instructors of Anatomy and Physiology students, but their institutions. The pandemic has profoundly impacted our assessment practices (Andreou et al., 2021) and our students will require appropriate course rigor along with faculty vigilance and flexibility to ensure success (Hrelic & Anderson, 2022). As we continue to change what it means to attain higher level education, looking at course pass rates alone may not illustrate a true success measurement for anatomical content. However, in conjunction with highly utilized standardized program assessments, they can provide a more comprehensive awareness of the content in question and its ability to be

successfully translated academically, while eliminating instructor differences and seeing larger academic trends.

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Appendix A. Quantitative Data

This information was not included in the qualitative section, as the sample size was significantly lower and seemingly nullified the findings of College1. These data trends still indicate a tendency of lower assessment overall that is considered valuable, but for the purposes of this paper and the focus of the online impact, they are not considered more in depth.

"A last subsequent drill down to compare this to College2 was established utilizing the same parameters (Tables 2-8 and 2-9 respectively). While there were fewer offerings of online platforms for College2, the data indicated that 15% of successful online attempts were able to be assessment successful, compared to 40% of the face to face attempts The values for these data points are further discussed in the next chapter, with emphasis on school history and a particular note on the number of students who did not attempt to complete the standardized assessments at all, a point of consideration for our focus on nursing students as a priority in ANP education."

COUNTA of Science Pass	TEAS Science Pass		
Enrollment Term Yr	fail	pass	Grand Total
10	2		2
12		1	1
20	17	3	20
21	10	1	11
Grand Total	**29**	**5**	**34**

Table A.1 Success on TEAS test for Course Successful Online Students

COUNTA of Science Pass	TEAS Science Pass		
Enrollment Term Yr	fail	pass	Grand Total
9		2	2
11	3	2	5
12	4		4
14	7	1	8
15	5	14	19
16	22	69	91
17	53	33	86
18	79	36	115
19	109	38	147
20	32	12	44
Grand Total	**314**	**207**	**521**

Table A.2 Success on TEAS test for Course Successful Face to Face Students

Appendix B. Qualitative Data

Q3

Briefly describe the reason behind your online Anatomical Science experience.

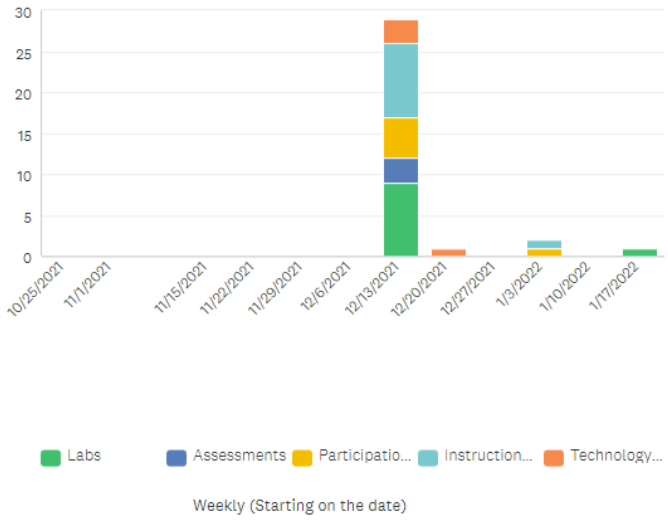
Data Trends do not apply to this question

Q4 (by week)

Chart Type Display Options Trend by... Zoom

Please indicate what you feel is the most important aspect of an online Anatomy class

Answered: 33 Skipped: 1 First: 12/13/2021 Zoom: 10/25/2021 to 1/17/2022

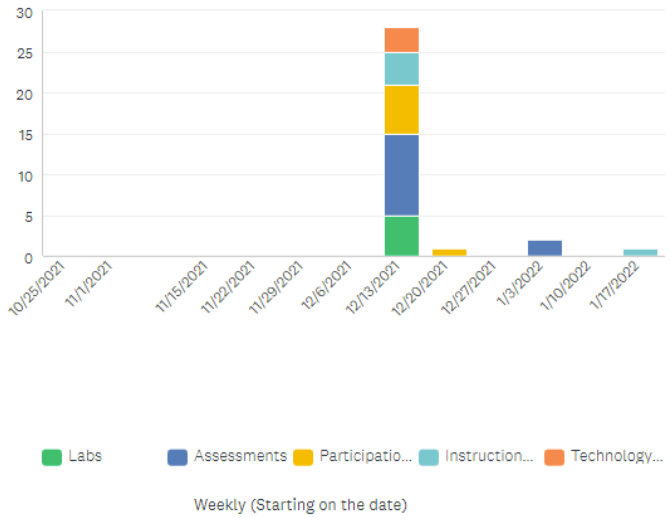


Q5 (by week)

Chart Type | Display Options | Trend by... | Zoom

Please indicate what you feel is the most challenging aspect of an online Anatomy class

Answered: 32 Skipped: 2 First: 12/13/2021 Zoom: 10/25/2021 to 1/17/2022

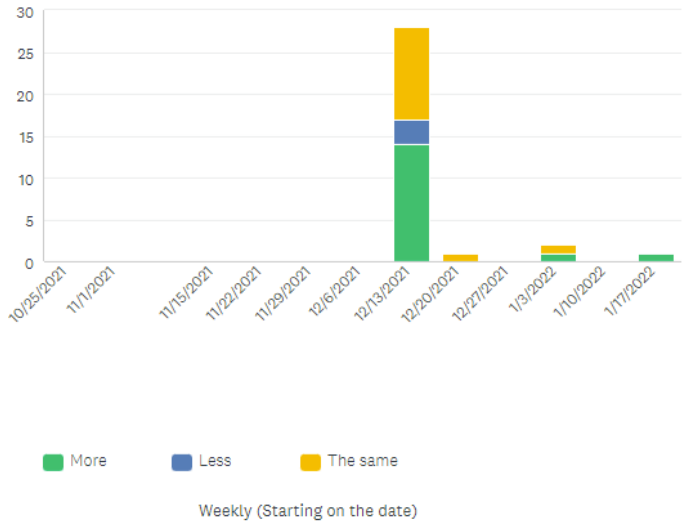


Q6 (by week)

Chart Type | Display Options | Trend by... | Zoom

How much time did it take you to prepare content for online Anatomy, compared to a face to face course?

Answered: 32 Skipped: 2 First: 12/13/2021 Zoom: 10/25/2021 to 1/17/2022

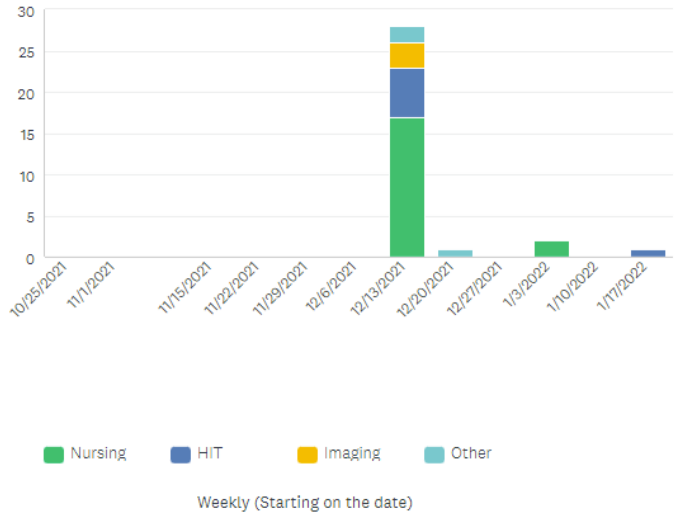


Q7 (by week)

Chart Type | Display Options | Trend by... | Zoom

What career are you pursuing?

Answered: 32 Skipped: 2 First: 12/13/2021 Zoom: 10/25/2021 to 1/17/2022

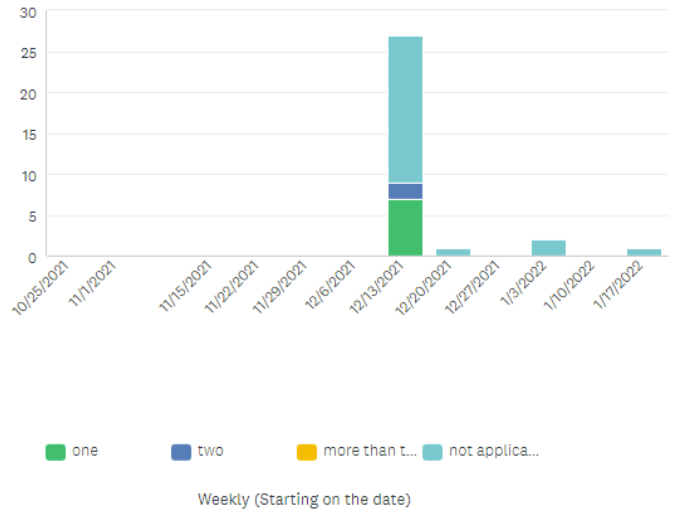


Q8 (by week)

Chart Type | Display Options | Trend by... | Zoom

If you have already taken your nursing program entrance exam or certification, how many attempts did it take to achieve your desired score?

Answered: 31 Skipped: 3 First: 12/13/2021 Zoom: 10/25/2021 to 1/17/2022

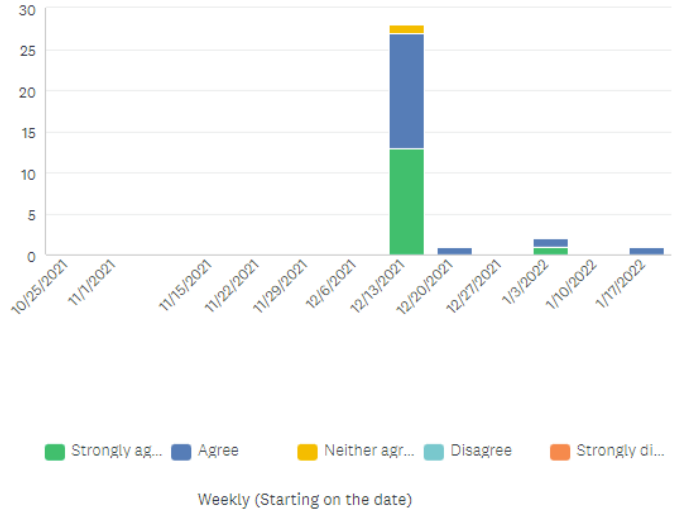


Q9 (by week)

Chart Type | Display Options | Trend by... | Zoom

Do you feel that taking Anatomy online helped you to be successful in your next steps

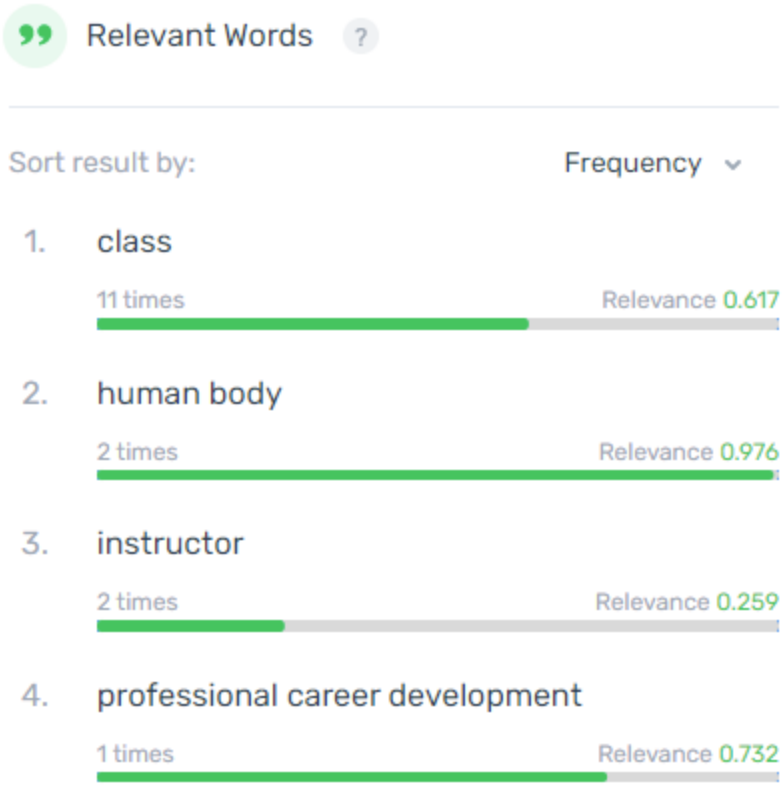
Answered: 32 Skipped: 2 First: 12/13/2021 Zoom: 10/25/2021 to 1/17/2022



Q10

How did taking Anatomy online impact your success? (Optional) Please leave your Email address in addition to your response if you wish to be entered into a drawing for a $25 Starbucks gift card

Data Trends do not apply to this question


Relevant Words
Sort result by:
Frequency
1. class
11 times
Relevance 0.617
2. human body
2 times
Relevance 0.976
3. instructor
2 times
Relevance 0.259
4. professional career development
1 times
Relevance 0.732

5. real life example

1 times Relevance 0.732

6. lot of information

1 times Relevance 0.732

7. better general understanding

1 times Relevance 0.732

8. great starter class

1 times Relevance 0.732

9. therapy assistant journey

1 times Relevance 0.732

10. prehospital care provider

1 times Relevance 0.732

Appendix C. Acronyms

ANP – Anatomy and Physiology

MBI- Modeling Based Instruction

HESI- Health Education Systems Inc.

HESIL- Health Education Systems Inc LPN to ADN

TEAS- Test of Essential Academic Skills

NCLEX- National Council Licensure Examination

ANP1- Anatomy and Physiology 1

ANP2- Anatomy and Physiology 2

COVID-19- Corona Virus Disease 2019