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Jessica Saini
McMaster University, sainij9@mcmaster.ca
Danielle Brewer-Deluce
McMaster University, brewerdd@mcmaster.ca
Noori Akhtar-Danesh
McMaster University, daneshn@mcmaster.ca
Anthony N. Saraco
University of British Columbia, anthony.saraco@ubc.ca
Ilana Bayer
McMaster University, bayer@mcmaster.ca
Courtney Pitt
McMaster University, pittc@mcmaster.ca
Bruce Wainman
McMaster University, wainmanb@mcmaster.ca

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Using Q-Methodology to Evaluate Student Perceptions of Online Anatomy in the Time of COVID-19

Abstract

Pursuant to pedagogical changes necessitated by the COVID-19 pandemic, this study was designed to determine which aspects of an online anatomy course students most preferred and most disliked using Q-methodology. Data were collected in fall 2020 and winter 2021, and 166 student responses were analyzed via by-person factor analysis. Three distinct subgroups were identified: Group 1 (n=66) reported being comfortable with the technology skills required for studying anatomy online; Group 2 (n=50) reported dissatisfaction with several elements of course delivery, including evaluations, laboratory assignments, and the amount of lecture content, believing that they were essentially "teaching [themselves]"; Group 3 (n=29) was characterized by being happy with tutorial activities and the guidance received from teaching assistants. Common to all groups was the preference for physical rather than virtual specimens and for faculty-made practice questions as opposed to the overwhelming number of online specimens available for review. There was an overall positive attitude shift among students regarding online delivery across semesters. Given ongoing uncertainty surrounding the pandemic, these findings provide important considerations for future potential online/blended classes on anatomy education.

Suite aux changements pédagogiques nécessités par la pandémie de la COVID-19, cette étude, qui a été menée en employant la méthodologie Q, a été conçue afin de déterminer quels aspects d'un cours d'anatomie en ligne les étudiants et les étudiantes préféraient le mieux et aimaient le moins. Les données ont été rassemblées en automne 2020 et en hiver 2021, et les réponses de 166 étudiants et étudiantes ont été analysées au moyen de l'analyse factorielle par personne. Trois sous-groupes distincts ont été identifiés : le groupe 1 (n=66) a déclaré être à l'aise avec les compétences technologiques exigées pour étudier l'anatomie en ligne, le groupe 2 (n=50) a exprimé son mécontentement par rapport à plusieurs éléments concernant la manière dont le cours avait été enseigné, y compris les évaluations, les travaux de laboratoire et la quantité de cours magistaux, et a déclaré qu'en fin de compte, ils « s'étaient enseigné à eux-mêmes », et le groupe 3 (n=29) a été caractérisé par le fait qu'ils avaient aimé les activités de tutorat et l'aide obtenue de la part des assistants d'enseignement. Un élément était commun à tous les groupes, il s'agit de la préférence pour les spécimens physiques plutôt que virtuels et pour la pratique de questions préparées par les professeurs et les professeures plutôt que par le nombre impressionnant de spécimens en ligne disponibles pour examen. Les étudiants et les étudiantes ont adopté une attitude globalement positive concernant l'enseignement du cours en ligne durant les divers semestres. Étant donné l'incertitude continue par rapport à la pandémie, ces résultats fournissent des considérations importantes pour l'enseignement futur des cours d'anatomie en ligne ou hybrides.

Keywords

online learning, course evaluation, anatomy education, COVID-19, Q-methodology; apprentissage en ligne, évaluation des cours, enseignement de l'anatomie, COVID-19, méthodologie Q

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The ongoing COVID-19 pandemic has disrupted life, and education, across the globe (Longhurst et al., 2020; UNESCO). Quarantine restrictions have limited in-person access to institutions, causing many courses to rapidly move online (Darici et al., 2021; Evans et al., 2020; Srinivasan, 2020). While such changes present difficulties, this experience also provides an unprecedented opportunity to investigate the effects of a rapid, universal shift to online learning in anatomy.

Anatomy education has unique barriers that complicate online teaching (Evans et al., 2020; Longhurst et al., 2020). Specifically, physical cadaveric specimens have been used as the primary method of teaching anatomy since the seventeenth century—a trend that continues today (Iwanaga et al., 2020; Keenan et al., 2019; Pan et al., 2020). In fact, all Canadian undergraduate medical programs use cadavers to teach anatomy (Rockarts et al. 2020).

Such persistence may be attributed to the ability of physical specimens to provide an avenue to learn visuospatial concepts, considered one of the most demanding aspects of anatomy education (Chytas et al., 2020; Keenan et al., 2019; Iwanaga et al., 2020), above and beyond alternative methods. Educators also cite tacit benefits to cadaver use; namely, the development of soft skills pertaining to ethics and professionalism (Flynn et al., 2021; Franchi 2020; Iwanaga et al., 2020; Longhurst et al., 2020).

Learning from cadaveric materials, however, necessitates proximity incompatible with COVID-19 social distancing restrictions (Iwanaga et al., 2020). Additionally, students no longer have access to accompanying aids, such as models, pathology specimens, and skeletons (Franchi, 2020).

A limited number of studies have analyzed student perceptions of online anatomy education in the context of the pandemic. Darici et al. (2021) evaluated student perceptions of an online histology course which involved virtual microscopy, as well as active learning elements through breakout rooms and synchronous sessions (Darici et al., 2021). The researchers discovered, via Likert scales and open responses, that most students did not experience technical problems, but for those who did, the experience was frustrating (Darici et al., 2021). Despite these concerns, stable attendance in synchronous sessions, as well as positive course evaluations, suggested that students were satisfied with the online learning environment overall (Darici et al., 2021). As another example, Flynn et al. (2021) used Blackboard Collaborate and Visible Body software to teach medical and physician associate students. Synchronous small group learning activities were also incorporated. Through informal feedback, the researchers ascertained that students appreciated the group work and interactivity, and found the modelling software helpful (Flynn et al., 2021). The topic of online anatomy was also discussed in a special issue of Anatomical Sciences Education in 2021 (Pawlina, 2021).

Still, studies to date have primarily employed Likert scales and open responses to collect information about subjective views (Rieber, 2020). While these methods may be easy to conduct, economical, and familiar, they also lend to an oversimplification of the data and difficulty in interpretation (Brewer-Deluce et al., 2019; Ho, 2016; Jackson and Trochim, 2002; Rieber, 2020; Smithson et al., 2015; Steyn et al., 2019). In contrast, the emerging area of Q-methodology can prove useful as a tool for capturing subjective perceptions in a systematic manner (Brown, 1993; Brown, 2019; Rieber, 2020; Yang, 2016). It is a mixed methods approach, using both quantitative and qualitative data to reveal groups of people with shared perceptions within a larger cohort (Akhtar-Danesh et al., 2008; Rieber, 2020).

Q-methodology has been used to evaluate courses in various disciplines, including nursing, bioinformatics, physics, medicine, and palliative care (Akhtar-Danesh et al., 2008; Berkhout,

2017; Chen et al., 2015; Gaebler-Uhing, 2003; Grijpma et al., 2020; Ha, 2014; Ha, 2016; Ha, 2018; Landeen et al., 2015; Li et al., 2018; Paige et al., 2015; Ramlo et al., 2008; Ramlo, 2015; Yeun et al., 2014; Yeun et al., 2020). The methodology is well suited to evaluating different forms of learning, such as online instruction, blended learning, or flipped classrooms (Al Murshidi, 2020; Baxter et al., 2009; Chen et al., 2015; Kurt & Yildirim, 2018; Ramlo, 2015; Ramlo, 2021; Valaitis et al., 2007). Q-methodology has also been used specifically in the anatomy setting (Brewer-Deluce et al., 2019; Byram et al., 2019; Mackinnon et al., 2021).

While online anatomy education has been discussed within the literature, very few studies have done so in the context of the pandemic or while using Q-methodology as a rigorous tool to understand perceptions. Thus, the current study seeks to understand the perceptions of students with respect to an introductory anatomy course that moved online due to the pandemic. Q-methodology was used as a systematic, mixed-methods tool for course evaluation. The study was approved by the Hamilton Integrated Research Ethics Board.

Method

The current study used a course evaluation grounded in Q-methodology to determine student perceptions of an online, introductory human anatomy and physiology course at McMaster University in the 2020-2021 academic year.

Course Information

The course was divided into two semesters, each with its own final exam and grade. Details regarding student enrollment are available in Table 1. There were three mandatory activities in the course: lecture, laboratory, and tutorial (Table 2). Virtual specimens were used as a tool for learning in laboratory and tutorial spaces. More specifically, students used the Bassett Collection—an online resource containing stereoscopic photos of specimens (MGH, 2017).

Table 1
Student Enrollment in Fall and Winter Semester Based on Program

Program	Number of students enrolled in fall 2020 semester	Number of students enrolled in winter 2021 semester
Health Sciences	239	243
Integrated Biomedical Engineering and Health Sciences	138	134
Engineering	37	33
Midwifery	26	26
Total	440	436

Table 2
Mandatory Course Activities

	Lecture	Laboratory	Tutorial
Delivery	Asynchronous	Asynchronous/Synchronous	Synchronous
Components	Lectures	Laboratory modules (asynchronous) Sessions with TA (synchronous)	Sessions with TA
Assignments	N/A	Long answer concept questions (asynchronous)	Peer-teaches/presentations
Time	2 hours	2 hours	1.5 hours
Platform	Avenue to Learn*	Avenue to Learn* Microsoft Teams**	Avenue to Learn* Microsoft Teams**

Note. TA = Teaching assistant; *Avenue to Learn for asynchronous content and recordings of synchronous sessions; **Microsoft Teams (Microsoft Corp., Redmond WA, USA) for synchronous sessions.

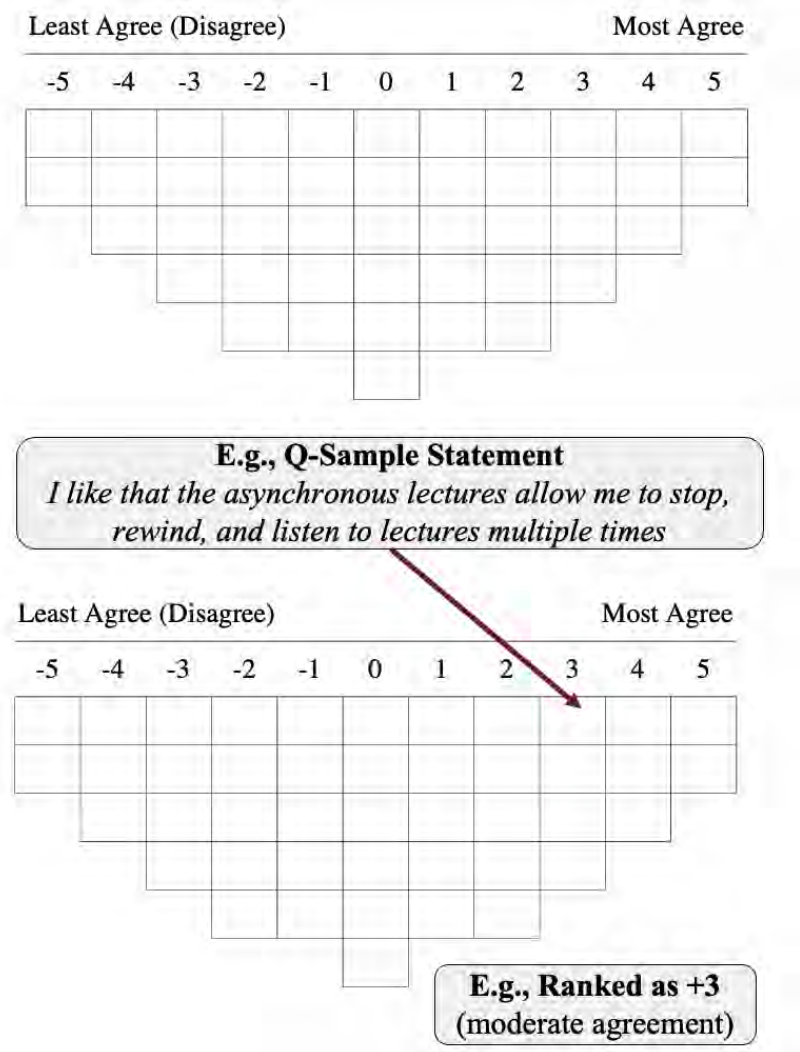
Final grades were determined from the following assessments: term tests, a bellringer exam, laboratory modules, long answer concept questions, and peer teaches/presentations. Term tests assessed course content at regular intervals throughout the semester. The bellringer exam assessed students' ability to identify virtual specimens and answer follow-up questions.

Q-Methodology

The study involved four phases, typical of Q-methodology: instrument development, data collection, factor analysis, and factor interpretation (see Akhtar-Danesh et al. 2008; Brewer-Deluce et al., 2019; Brown, 1993; Valenta & Wigger, 1997). First a comprehensive list of statements regarding anatomy education was gathered (n=109 statements), called a *concourse*. Statements within the concourse were sourced from prior concourses, qualitative student feedback, teaching assistant (TA) surveys, as well as relevant literature. The number of statements in the concourse was reduced by domain experts (e.g., course instructors, Q-methodology experts), aiming to maintain the comprehensiveness of the concourse in a condensed format called the *Q-sample* (n=44 statements).

Next, an online Q-sorting activity was created in which participants utilized a *Q-sort table* to sort the statements (Figure 1). The table was formed with an equal number of cells as there were statements within the Q-sample (i.e., 44), and the columns were assigned a continuum of values from least to most agree (-5 to +5). Participants sorted statements into each ranking until the Q-sort table was full, now simply called a *Q-sort*. Upon completion of the activity, participants were given the opportunity to provide qualitative feedback on the four statements that were most strongly ranked (-5 or +5; also called *critical statements*), and to complete a short demographics survey.

Figure 1
The Q-Sort Table Used for The Current Investigation



After a successful pilot test, students were introduced to the Q-sorting activity as a means of course evaluation. The activity opened twice in the academic year: prior to the fall and winter exam periods respectively. Students generated a unique identifier both for entry into a remuneration contest, and to allow researchers to identify persons completing both the fall and winter assessments.

The completed Q-sorts were analyzed via a by-person factor analysis (principal axis factoring method with varimax rotation) using the "qfactor" program in Stata (Akhtar-Danesh, 2018). Analysis usually reveals several *factors*, or groups of students, with each group having similar perceptions. Then, a *weighted synthetic Q-sort* is determined for each factor. The weighted synthetic Q-sort reflects the Q-sort which would typify a particular factor - or in other words, the weighted average of all the Q-sorts that fall under said factor.

For each factor, there are some statements that have scores significantly different from the scores of the other factors, called *distinguishing statements*. There are also statements with scores that have no significant difference between factors, called *consensus statements*. Special attention is given to distinguishing and consensus statements that are strongly ranked (i.e., -5 or +5).

Results

In total, 269 Q-sorts were collected: 106 from the first semester and 163 from the second semester. The following Q-sorts were excluded from analysis to avoid pseudoreplication: the second Q-sort submission by a single student in one semester (n=2), Q-sorts that were completed by the same student across semesters, as evidenced by a unique identifier (n=62), and Q-sorts that did not have an associated identifier (n=39). The fall and winter Q-sorts were then combined (42+124=166) and used in the final analysis.

Using a by-person factor analysis, a three-factor solution emerged with 66, 50, and 29 Q-sorts loaded on each factor, respectively. 21 Q-sorts did not load significantly on any of the factors. The factors were assigned a descriptive moniker based on what made each unique, defined using the distinguishing statements. Gender, age, previous degree, previous degree in anatomy, year of study, program, and expected grade were not associated with factor groupings (chi-squared test, $p > 0.05$). A selection of distinguishing and consensus statements for each factor are depicted in Table 3, alongside corresponding statement numbers.

Factor 1: Connected and Contented (n=66)

A total of 66 students loaded on the first factor (60 in 2nd year and 2 each in 1st, 3rd, and 4th year). “Connected and Contented” (CC) students were comfortable with the course overall and did not express any criticism. The students that comprised this group strongly agreed (+4) that they were comfortable with the technology skills required for studying anatomy online, finding the online platforms simple and straightforward to use (Statement #5). They also expressed moderate agreement (+3) regarding the ability of lectures to foster connections between anatomy and physiology (Statement #27), attributing this to the tendency to discuss structure and function together during lecture. Finally, students expressed moderate disagreement (-3) that more time was required to complete multiple-choice question exams (Statement #18).

Overall, Factor 1 is typified by students who felt content or possibly ambivalent with course structure and online schooling. The moniker “Connected and Contented” reflects the fact that students were connected in a technological sense, found connections between anatomy and physiology, and were content with what the course was trying to impart in both lectures and evaluations.

Table 3

Selection of Distinguishing and Consensus Statements

Statement Number	Statement	Statement Score		
		Factor 1	Factor 2	Factor 3
	Factor 1 Distinguishing Statements			
5	I'm comfortable with the technology skills required for studying anatomy online.	4	0	1
27	I think that the lectures fostered connections between anatomy and physiology.	3	0	0
18	I need more time to complete my MCQ exam.	-3	2	2
	Factor 2 Distinguishing Statements			
28	I think the way in which we are evaluated does not fairly represent what the material covered.	-4	4	-3
11	The long answer worksheets are beneficial to my learning.	0	-4	-2
4	I think lectures covered an appropriate amount of content.	2	-4	0
25	I feel like I am teaching myself. It is like paying tuition to watch YouTube videos.	-2	4	-1
	Factor 3 Distinguishing Statements			
30	I think TA office hours are very helpful.	1	-2	4
1	I feel that the expectations for the peer teaches/presentations are unclear.	-1	0	-4
8	Tutorials are useless to me.	-1	1	-5
	Consensus Statements			
10	I think that virtual specimens do not replace the physical presence of specimens.	3	5	5
26	I would benefit from more faculty-made bellringer and short answer practice.	5	5	5
38	I found the textbook was useful and supported what I learned in lecture.	-4	-5	-3

Note. Factor 1 = Connected and Contented (CC); Factor 2 = Disconnected and Disgruntled (DD); Factor 3 = Interconnected and Collaborative (IC); TA = Teaching assistant; MCQ = Multiple choice question

Factor 2: Disconnected and Disgruntled (*n*=50)

Fifty respondents loaded on the second factor (42 in 2nd year, 4 in 1st year, 2 in 3rd year, and 2 unknown). "Disconnected and Disgruntled" (DD) students were deeply unhappy with several elements of the course. The group strongly agreed (+4) that evaluations were unfair representations of the material (Statement #28). Students expressed, via qualitative feedback, that tests were far too short in terms of both the number of questions and the amount of time provided. They felt that the questions were not comprehensive, focusing on small details and low-yield content, and that the grading scheme could be unfair. Furthermore, students strongly disagreed (-4) that long answer concept questions (laboratory assignments) were beneficial to their learning (Statement #11), stating that the assignments were unhelpful and unclear, inconsistently graded, and included content not in keeping with what they were currently learning. Students also strongly disagreed (-4) that lectures covered an appropriate amount of content (Statement #4), expressing concerns regarding the extensive time required to write notes, as well as the workload in comparison with other classes.

Perhaps most striking, students strongly agreed (+4) with the following statement: "I feel like I am teaching myself. It is like paying tuition to watch YouTube videos" (Statement #25). Qualitative feedback revealed a few different reasons, including: incomprehensive lectures that necessitated consultation with external resources, unhelpful tutorial and laboratory sessions which increased reliance on independent lecture learning, and insufficient interaction with professors. While this statement was intended to elucidate student feelings towards online schooling, a mixture of responses and explanations were revealed. It is likely that the opinions offered are related to Factor 2's dislike of online learning, however this is unclear without a direct comparator of how this statement performed in an in-person version of the course.

Overall, Factor 2 is typified by students who were disgruntled with many central elements of the course, and felt as if they were "teaching themselves". The moniker "Disconnected and Disgruntled" reflects the fact that students did not positively engage with the course, and they felt as if they were on their own in learning course content, which left them disgruntled.

Factor 3: Interconnected and Collaborative (*n*=29)

A total of 29 students loaded on the third factor (28 in 2nd year and 1 in 1st year). "Interconnected and Collaborative" (IC) students were happy with the course, and tutorial activities in particular. Students strongly agreed (+4) that TA office hours were helpful (Statement #30**)**, strongly disagreed (-4) that the expectations for peer teaches/presentations (tutorial assignments) were unclear (Statement #1), and very strongly disagreed (-5) that tutorials were useless (Statement #8). Qualitative feedback revealed similar explanations for the ranking of all three statements. Students appreciated the fact that office hours and the tutorial space allowed them to interact with their TA who would go over key concepts, provide practice questions, and answer questions. They also attributed the clarity of tutorial assignments to TAs.

Overall, Factor 3 is typified by students who enjoyed synchronous tutorial activities and guidance received from TAs. The moniker "Interconnected and Collaborative" reflects that students actively sought out connection and enjoyed the ability to collaborate with their peers.

Consensus Statements Among All Factors

Certain perceptions were also shared among all three groups. The strongest selection of consensus statements are discussed, defined as statements with at least two factors with a weighted synthetic score of ±4 or stronger.

The primary concern among students was regarding virtual specimens and bellringers exams carried out online. Students agreed (CC:+3, DD:+5, IC:+5) that virtual specimens did not replace the physical presence of specimens (Statement #10). Qualitative feedback revealed that students wished they could have visited the laboratory in-person, and felt as if they had lost an opportunity. Their preference was also rooted in their frustrations using virtual resources. Many cited difficulty orienting themselves when viewing a two dimensional image, and there were also concerns regarding the vast number of virtual specimens available in the Bassett Collection. Connected with these concerns, students also strongly agreed (CC:+5, DD:+5, IC:+5) that they would benefit from faculty-made bellringer and short answer practice (Statement #26). Students expressed that practice questions made by faculty could accurately guide expectations for bellringer exams and help them understand the relevant specimens within the Bassett Collection.

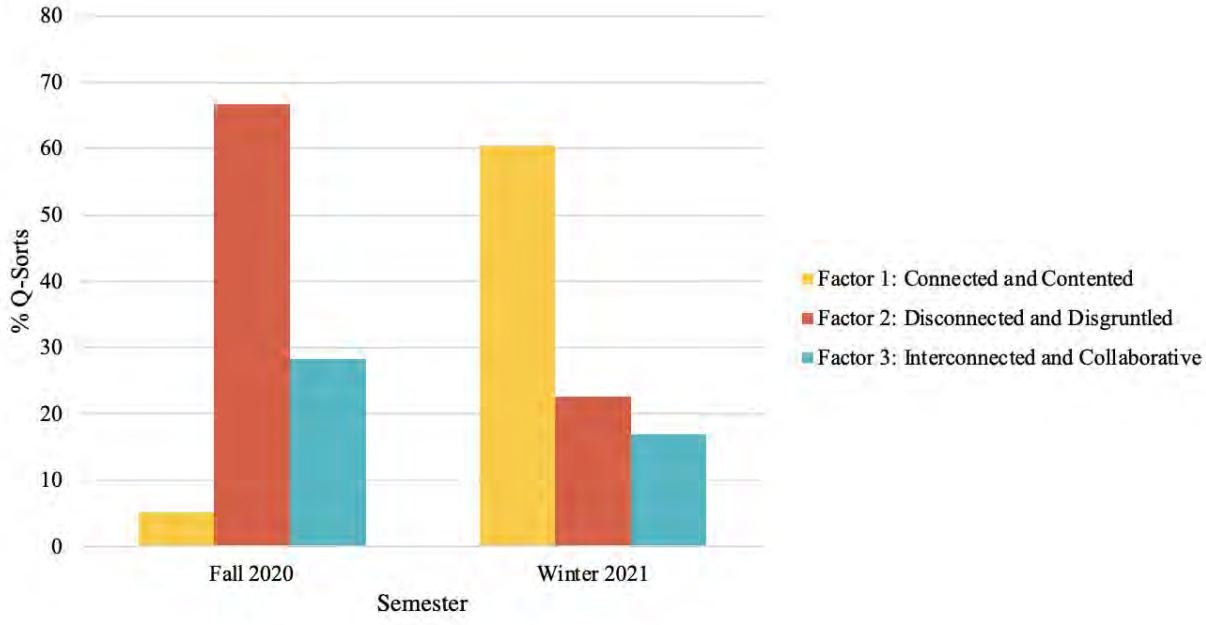
In addition, students disagreed (CC:-4, DD:-5, IC:-3) that the textbook was a useful resource (Statement #38), with many confessing that they did not use the textbook at all due to a lack of time. Interestingly, students also disagreed (CC:-5, DD:-3, IC:-4) that the synchronous laboratory sessions created a toxic environment where students showed off (Statement #16). This contrasts with previous cohorts pre-pandemic who indicated a feeling of discomfort in such settings, potentially revealing a benefit of online learning.

Fall and Winter Semester Comparisons

The data were analyzed to determine the proportion of Q-sorts loading on each factor in the fall and winter semester, respectively (Figure 2). Evidently, a greater number of students loaded on Factor 2 (Disconnected and Disgruntled) in the fall semester. This changed in the winter, with a greater number of students loading on Factor 1 (Connected and Contented). Knowing the characteristics of each group, it appears that students were more unhappy in the fall and content in the winter.

Figure 2

Percent of Q-sorts Loading on Each Factor in the Fall and Winter Semester



Discussion

The Q-sample statements comprehensively covered all aspects of the course. The following discussion outlines key takeaways based on statement rankings and qualitative feedback for each aspect. Relevant statements are depicted in Table 4.

Table 4

Selection of Statements Arranged by Course Component

Statement Number	Statement	Statement Score		
		Factor 1	Factor 2	Factor 3
	Lecture			
23	I like that the asynchronous lectures allow me to stop, rewind, and listen to lectures multiple times.	5	2	4
12	I think there should be transcripts for asynchronous lectures.	3	3	2
	Synchronous and Asynchronous Lab			
32	Synchronous lab sessions were critical to my understanding of anatomy.	-2	-4	2
3	Asynchronous lab modules were critical to my understanding of anatomy.	0	-2	-2
	Synchronous Tutorial			
8	Tutorials are useless to me.	-1	1	-5
	Virtual Specimens and the Hidden Curriculum			
10	I think that virtual specimens do not replace the physical presence of specimens.	3	5	5
14	I think there should be a standard set of slides/specimens that all groups will cover in synchronous labs and tutorials.	3	3	3
26	I would benefit from more faculty-made bellringer and short answer practice.	5	5	5
36	I feel that learning from virtual human prosections is a privilege.	1	-1	-1
	Online Learning in General			
31	I prefer online learning compared to the in-person format.	0	-5	-4
16	I find the synchronous sessions to be a toxic environment because some students will try to show off.	-5	-3	-4

Note. Factor 1 = Connected and Contented (CC); Factor 2 = Disconnected and Disgruntled (DD); Factor 3 = Interconnected and Collaborative (IC)

Asynchronous Lectures

It is important to explore the impact of asynchronous lectures given that many anatomy institutions adapted to online learning by introducing asynchronous resources rather than synchronous webinars (Flynn et al., 2021). All three groups valued asynchronous lectures, though suggested some areas for improvement. Specifically, they agreed (CC:+5, DD:+2, IC:+4) that they were appreciative of the ability to stop, rewind, and listen to lectures multiple times; but also agreed (CC:+3, DD:+3, IC:+2) that transcripts should be available (Statement #23 & 12). Students felt it was difficult to take notes because they were dense with information and occasionally difficult to hear. Students also stated that creating transcripts would allow them to focus more on lecture content rather than writing notes. For example, one student stated:

> "I feel like a lot of the time I spend for this class is just watching the lectures and stopping every 5 seconds to take notes. By having a transcript it would allow one to actually watch and understand the lecture rather than just write everything the lecturers say and not necessarily pay attention to the actual content being taught. Having transcripts would help with this issue and allow students to better understand the concepts being taught. It is in the best interest for those who are hearing impaired too [...]."

Beyond closed captioning or transcript PDFs, another approach to address student concerns could include providing skeleton notes, which would reduce the amount of writing required by students, thus allowing them to listen and participate to a greater extent (Neef et al., 2006).

Synchronous and Asynchronous Lab

Given the nature of the content, and typical use of physical specimens, anatomy laboratories are one of the most difficult course components to transition online. Unsurprisingly, the three groups had varying preferences in terms of laboratory sessions. In general, the Connected & Contented and Disconnected & Disgruntled groups disagreed that synchronous laboratory sessions (CC:-2, DD:-4) and asynchronous laboratory modules (CC:0, DD:-2) were critical to their learning, with students finding them repetitive of lectures (Statement #32 & 3). Specific to the synchronous laboratory sessions, students felt that TAs were inadequately prepared, perhaps suggesting a gap in TA training specific to laboratory as opposed to tutorial. This could be due to the nature of each setting, as tutorial spaces focus more so on concepts, while laboratory focuses on exploring specimens. TAs may require greater training on laboratory skills, such as how to view virtual specimens and translate this information to students.

In contrast, the Interconnected & Collaborative group provided a moderately positive ranking (+2) for synchronous laboratory sessions, and a moderately negative ranking (-2) for asynchronous laboratory modules (Statement #32 & 3). While the moderate ratings indicate more neutral feelings, the results do suggest that the group found value in course components which involved interaction. Such results align with prior research suggesting that students appreciate the collaborative aspects of synchronous webinars in anatomy education (Flynn et al., 2021), and provide grounds for continuing to offer synchronous activities when possible.

Synchronous Tutorial

In comparison to laboratory sessions, tutorials were intended to offer students greater opportunity for unstructured discussion, and the ability to ask clarifying questions to near-peer teaching assistants. Again, owing to the benefits of interaction, the Interconnected & Collaborative group was unique in their enjoyment of tutorial sessions, disagreeing strongly (-5) that tutorials were "useless", while the other two groups felt differently (CC:-1, DD:+1) (Statement #8). One student stated:

> "The tutorials give me time to ask questions to both my peers and the TA. Tutorials have provided me with good practice and have helped me understand the content on a more profound level. Since the tutorials are smaller than the [faculty Q&A] sessions for example I feel more comfortable asking questions during tutorial. Thus I would say that the tutorials are far from useless to me."

The purported benefits of near-peer TAs have been previously acknowledged in the literature and include the following: students who have recently taken the course may be more knowledgeable in guiding other students, there exists a "cognitive and social congruence" between student and TA, and students tend to feel relaxed with near-peer TAs (Johansson et al., 2018).

Interestingly, both the Disconnected & Disgruntled and Interconnected & Collaborative groups provided lower scores for laboratory rather than tutorial spaces, which could originate from the aforementioned discrepancy in TA training, and the fact that the laboratory was more significantly impacted by the transition to online learning. Pather et al. (2020) evaluated what educators perceived to be the disruptions and changes to anatomy education due to the pandemic. Analysis revealed that "hands-on" experiences were among the major disruptions to anatomy education according to educators (Pather et al., 2020). As such, it follows that laboratory events, which were more "hands-on" compared to tutorial pre-pandemic, were more significantly disrupted.

Virtual Specimens and the Hidden Curriculum

The unprecedented, universal shift to virtual specimens provided an opportunity to assess whether new resources can successfully replace teaching methods as foundational as physical specimens. Results, however, were unfavourable, as all three groups strongly agreed (CC:+3, DD:+5, IC:+5) with the statement "I think that virtual specimens do not replace the physical presence of specimens in the lab" (Statement #10). These feelings are supported by Pather et al. (2020), who found that students were wary of not using cadaveric specimens to learn anatomy, stating that they lost an opportunity to use "real" experience for concept integration. While difficult to address via distanced education, one option may be to incorporate increased practical experiences post-pandemic, to ensure that cohorts who did not encounter those "real" experiences may have an opportunity to do so (Pather et al., 2020).

In general, students agreed (CC:+3, DD:+3, IC:+3) with standardizing specimens and materials used in synchronous sessions across sections (Statement #14), and strongly agreed (CC:+5, DD:+5, IC:+5) that offering more faculty-made bellringer practice would benefit their learning (Statement #26). Students cited issues with inconsistent synchronous session delivery, which depended upon TA experience, and issues with the Bassett Collection, which was

considered overwhelming and difficult to navigate. Guidance from trained TAs on how to approach a consolidated number of faculty-vetted virtual specimens could help ease student difficulties.

Finally, anatomy courses are often viewed as a cornerstone to health care courses, not only for the fundamental concepts they cover, but also for the "hidden curriculum" surrounding humility, patient interaction, and empathy that interacting with a donor concomitantly provides. Critically, and in contrast to previous Q-based course evaluations, all three groups exhibited near-ambivalence (CC:+1, DD:-1, IC:-1) regarding whether learning from virtual human prosections was a privilege (Statement #36). Similar findings have been presented by Talmon et al. (2014), who examined the use of eAutopsy as a virtual tool for medical students to learn about postmortem examination. Researchers found that the online modality resulted in less of an emotional impact on students (Talmon et al., 2014). Together, these results emphasize the importance of considering all aspects of the educational experience, especially those beyond course content, when shifting to a new modality. For example, explicitly noting components of the "hidden curriculum" rather than relying on the role modelling common in in-person classrooms, and creating opportunities for students to engage in self-reflective activities are two methods for imparting such valuable soft skills (Shiozawa et al., 2019).

Online Learning in General

Online learning, especially when delivered as an emergent response to the pandemic, presents several challenges to learners, beyond those typically anticipated in in-person classrooms. Results indicated strongly negative rankings (DD:-5, IC:-4) towards online learning from the Disconnected & Disgruntled and Interconnected & Collaborative groups and a neutral ranking of zero from the Connected & Contented group (Statement #31). Students cited issues with engagement, interactivity, and motivation in the online forum. For example, students expressed: "I like going into class, talking with people face to face [...]" and "Online learning is very dependent on your own motivation and work ethic. It is easy to feel isolated and to fall behind in work [...]". Finding ways to mitigate identified barriers to online learning present an ongoing area for course development, particularly as some institutions consider more online/blended offerings based upon courses developed during the pandemic. Lack of motivation, for example, is of particular concern as research suggests that motivation is integral for productivity and learning, and is especially important for success in self-directed settings (Abdel Meguid et al., 2019), common in online learning.

In contrast, certain students may feel more confident interacting online rather than in-person, increasing their engagement (Flynn et al., 2021). The notion is supported by the shift away from students historically finding laboratory sessions to be a toxic environment in which some students show off and dominate the learning space (Statement #16). One caution, however, is that the change may be the result of an overall decrease in engagement, with many students citing that sessions could be quiet with little participation. Ensuring interactive elements, such as breakout sessions, remain in synchronous spaces can help encourage active participation (Darici et al., 2021).

Trajectory Between Semesters

As evidenced in Figure 2, students transitioned from being more unhappy (larger proportion weighed on Factor 2) towards being more content (larger proportion weighed on Factor 1) between the fall and winter semesters. This is consistent with research by Pather et al. (2020) who found that students provided more positive comments regarding online anatomy as the pandemic progressed, even if opinions were initially negative.

While difficult to say for certain, there are a few theories that could explain this trend. First, anatomy is typically considered a demanding subject both due to the volume and difficulty of the information presented (Cheung et al., 2021). Students may have adapted to the novelty of the content as time progressed. Further, emergent changes to accommodate pandemic restrictions meant that many students were learning online for the first time, and in courses that were not originally designed to be offered via that medium. Thus, it is possible that as the school year progressed, students developed the skills necessary to learn remotely and online. Further, instructors also adapted as online course delivery persisted and initial rounds of course feedback were made available. This may have allowed for minor, yet valuable, course modifications directly supporting student needs. Or standardized resources may have emerged across multiple courses, reducing the resource demands for students. Lastly, and perhaps the least optimistic theory, is that students simply resigned to their fate, thus feeling more apathetic as time progressed.

Limitations

Course delivery was nearly identical across both semesters, with the exception of term tests. The first term test in the fall included a feature which did not allow students to go back and forth between questions. However, this was changed for subsequent tests as proctoring software was introduced to prevent academic misconduct. Fall term tests were also shorter (30 minutes) compared to winter term tests (40 minutes). Such changes could have influenced student perceptions across semesters. For example, the average score for the statement, “I need more time to complete my MCQ exam” (Statement #18) fell from 1.47 in the fall (agreement) to -0.91 in the winter (disagreement). Results could depict an improvement in students’ disposition towards evaluations due to course changes.

Conclusion

The current study used Q-methodology to evaluate an introductory anatomy and physiology course that moved online in response to the COVID-19 pandemic. Study findings can be useful to instructors, particularly of laboratory-based courses, looking to transition to the online/blended space, as well as educators simply interested in the wealth of information that can be discovered through course evaluations conducted using Q-methodology. Results identified three predominant groups of students within a larger cohort, as well as key areas of strength and limitation specific to the COVID-induced online environment. There was evidence of an attitude shift from the fall to winter semester, which could suggest that certain challenges posed by the course, and perhaps online learning, may be addressed with time and course reform. Even so, there were persistent concerns, common amongst all students, that highlight major challenges associated with online learning. For example, student perceptions of online laboratory content, and in particular the use of virtual specimens, underscores the value of in-person hands-on experiences

which may never be fully supplanted by online approaches. Furthermore, students had mixed opinions regarding synchronous and asynchronous activities. Understanding which opportunities offer students the best learning, and for whom they present the greatest challenges will be important for future online offerings of anatomy. Future studies should also examine extracurricular factors influencing students' online learning experiences, including access to resources and students' learning competencies.

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