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RESEARCH REPORT

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Optimizing group work strategies in virtual dissection

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Abstract

Due to its haptic and interactive nature, virtual anatomy provides an opportunity for small-group learning, enabling students to develop their group work skills before they graduate. However, there is currently little practical guidance supported by pedagogic principles detailing how to incorporate it into curricula. Anatomy educators at the University of Plymouth conducted action research aiming to capture students' overall perceptions of the virtual anatomy platform Anatomage. Questioning the benefits and challenges students face while interacting with Anatomage prompted the creation of evidence-based interventions to be later evaluated. Although a plethora of themes were identified, this report specifically examines those relating to group work. Thematic analysis of initial focus group data found group size and group dynamics impacted students' experience with the platform. Following the implementation of interventions to resolve these issues, a questionnaire and second series of focus groups were conducted to determine whether they were successful. Additional subthemes found from these data included facilitation, social pressure, peer learning and working with friends. This study contributed to the improvement of small group learning and integration of virtual anatomy into curricula based on student and staff feedback. As such, these data support the development of effective group working skills which are fundamental for healthcare professionals and widely recognized by regulators such as the General Medical Council and Health and Care Professions Council. In this report, the authors provide practical advice informed by pedagogy and principles from management and psychology to provide a multidisciplinary perspective.

KEYWORDS
anatomage, anatomy education, digital anatomy, group dynamics, group work, virtual anatomy, virtual dissection

INTRODUCTION

Background

Virtual (or digital) anatomy is a fast-developing field, becoming increasingly accessible for anatomy educators and students. Many platforms provide access to three-dimensional, interactive anatomy through a range of devices and from anywhere with internet access.[1] This versatile tool is not only used in anatomy teaching but also in surgical planning,[2] public outreach,[3] bioengineering[4] and regenerative medicine.[5] However, little guidance is currently available to educators on how to incorporate virtual anatomy into their curricula and teaching practices, using approaches underpinned by pedagogic principles.

Peninsula Medical School was founded in 2002 with a constructively aligned, evidence-based curriculum with an innovative approach to pedagogy. Despite cadaveric dissection being considered the "gold standard" at the time, there was little evidence to support this stance. As recently graduated doctors interact with their patients through surface anatomy and medical imaging, these formed the core of the anatomy curriculum combined with virtual reality imaging and plastic anatomical models.[6] This was the first medical school in the UK to teach anatomy without cadavers and, while radical at the time, is now shown to be as effective as dissection or prosection-based teaching.[7] Many more UK medical schools now teach without cadavers, offering an alternative approach to study that can be more inclusive for many students. However, virtual anatomy technologies can also be a useful adjunct to existing cadaveric curricula, helping illustrate difficult to dissect systems (i.e., lymphatics) and regions (i.e., pterygoid fossa).

While Peninsula Medical School (PMS) produce some of the best-prepared medical students in the country,[8] the school's forward-looking ethos provides opportunity for continual curriculum development. Hence, in 2015 the anatomy department acquired its first Anatomage table. This innovative three-dimensional (3D) virtual anatomy platform currently provides 3D digital representations of four human bodies from the Visible Human Project and Korean Visible Human Project,[9] as well as anonymised patient scans, prosections and histology images. It allows users to engage in a group-based interaction while dissecting or building the digital cadavers with precision, and the ability to orientate the images to different planes.[10] At the time, the anatomy teaching in the curriculum was carried out in very small groups (<14) and the Anatomage table offered further opportunities for hands-on and applied learning, increasing access to healthy and pathological variation as an adjunct to an already successful curriculum. As the only virtual anatomy platform of its kind available at the time, it was decided to invest in this technology to compliment the small group teaching approach in the forward-looking curriculum.

While the system helped students with aspects such as relating 3D anatomy to cross-sectional imaging, there was little student uptake outside of teaching sessions. As such, the anatomy team conducted action research by organizing focus groups to better understand the student perspective and inform improvements. These findings led to a range of interventions that were then analyzed in a second study to determine their impact on student engagement. These data identified group work as both an enabler and challenge when working with virtual anatomy platforms (Figure 1).

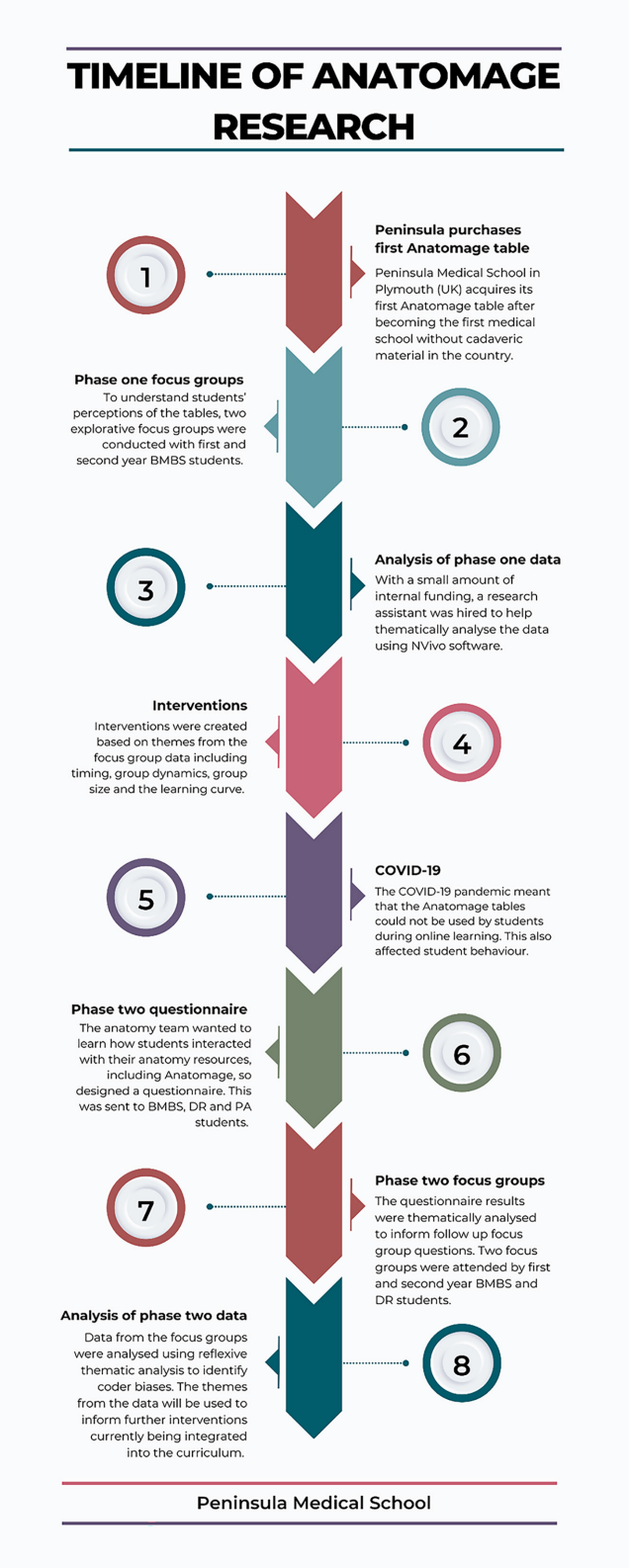

FIGURE 1 Project timeline of events.

Small group work in the curriculum

The anatomy department at PMS utilizes small group activities throughout the curriculum to allow students to apply their understanding and foster peer learning effectively.[11] This includes engaging, hands-on activities like virtual anatomy construction,[1] surface anatomy, clinical scenarios, art and crafts, quizzes, and medical imaging using portable ultrasound probes. The Anatomage tables are integrated into a flipped classroom approach across multiple programs and year groups and are used within a spiral curriculum.

It is possible for multiple students to work together on virtual anatomy platforms at the same time, which presents additional opportunities for collaborative small-group work. In healthcare education, effective teamwork is an essential skill to master as professionals are required to communicate and collaborate within large multidisciplinary teams. If teamwork fails, patient safety could be compromised, and lives put at risk.[12] As such, accrediting bodies require skills acquired in group work to be included in training on all health profession programs.[13,14]

There is a large evidence base encouraging educators to include more interactive small group work in their curriculum to support team-based, student-led learning in both anatomical and medical education.[15-18] One fundamental pedagogic theory supporting small group work is social constructivism[19] which states that social interaction through group discussion, evaluation and clarification is an important part of higher-level learning.[20] Active learning is also a common pedagogy used in higher education practice as it engages students in meaningful learning activities.[21] Groupwork is an excellent vehicle for active learning as the group must collaborate and communicate to achieve their goals. Multiple studies have shown that students learn better when together rather than alone.[22-25] Finally, small group work allows for peer teaching and learning which has been shown to be effective in healthcare education as it helps both the peer tutor and tutee gain knowledge[26] thus leading to the introduction of team-based learning, problem-based learning, enquiry-based learning and interprofessional learning into many healthcare professions curricula.

There are both advantages and disadvantages to incorporating small group work into a curriculum. Small groups can bring together the knowledge and experiences of group members from varying backgrounds. Interaction can stimulate creativity, give the group members a better understanding of themselves and has been shown to increase knowledge retention.[27] However, Beebe and Masterson[28] state that group work can be dominated by one individual, or that some members may step back and rely on others to carry out the task. Neurodiversity may also impact on an individual's integration within a group. These interpersonal processes can impact on factors affecting success including actions taken, decisions made, relationships between members and group productivity.[29] Considerations must be made when incorporating small group work into the curriculum to mitigate these processes and ensure all students benefit from the group activities.

Using virtual anatomy as a platform for group work can also help the students engage with this technology better. The Technology Acceptance Model (TAM) states that enjoyment affects the learner's perception of and engagement with a piece of technology.[30] If students enjoy their learning activities, they will be more likely to adopt the technology, as displayed by the authors' previous research report.[31] As group work has been shown to increase enjoyment,[32] using virtual anatomy to foster group work could also help the students adopt this piece of technology and perceive it to be useful.

While recent research surrounding the Anatomage tables, and virtual anatomy in general, have explored assessment scores and student perception, there is little literature describing how it can be best integrated into the curriculum to support small group work. The current work presents quantitative and qualitative data and personal experience from 8 years of using Anatomage tables, focusing specifically on group work and dynamics, and how this data can inform future practice.

MATERIALS AND METHODS

Anatomage in the curricula

The use of virtual anatomy in the PMS curriculum is underpinned by pedagogy. The activities are based on constructivism[33] so that the learner begins with understanding the most basic structures like bones and organs, they then move on to increasingly more complex structures like vessels, nerves and lymphatics. Active learning[34] is incorporated into activity-led sessions where groups must complete tasks together. These could range from simple identification of structures, the lowest level of Bloom's Taxonomy,[35] to building and color coding entire systems or regions or applying their knowledge to 3D MRIs and cross-sectional imaging and clinical cases. To most effectively complete the activity in the time given, the group must work together and combine their knowledge. Most activities have remained similar between phase one and phase two and have been based on the Anatomical Society core medicine syllabus learning outcomes.[36] Following Kern's 6 steps (Robertson et al., 2019),[37] the Anatomage tables are integrated when they provide added benefit to the learning, so different tools are used for different tasks. Channon et al.[38] determined that the task design is important when creating activities for small groups as it affects the performance and output of the group. There should be clear goals for the activity, using clearly defined learning outcomes for each task and simple instructions. They should also be clinically relevant for healthcare students, so this curriculum developed activities that include clinical case studies, 3D MRIs and cross-sectional imaging.

The anatomy team currently teaches on three programs—Bachelor of Medicine, Bachelor of Surgery (BMBS), diagnostic radiography (DR) and Physician Associate Studies (PAS). Across the programs, almost 50% of the time allocated for anatomy teaching includes Anatomage activities. Students rotate around up to three concomitant anatomy sessions within one visit, which reduces class sizes but limits how many individual sessions can include the tables. The wider anatomy curriculum utilizes surface anatomy, live ultrasound, medical imaging, clinical cases, plastic anatomical models, quizzes and other gamified activities, based on the learning outcomes addressed. Attendance is monitored for BMBS and DR as they are undergraduate courses. Sessions contain between 26 and 40 students depending on the program, stage and session. In each session, these students are divided into subgroups, initially assigned by the facilitator, to undertake the group activities. Group members can change every session. BMBS and PAS programs follow very similar learning outcomes, whereas DR focuses

on medical imaging-relevant anatomy. The structure of the activities is similar across programs, however, DR sessions typically contain more cross-sectional anatomy and second-year students on BMBS and DR are exposed to more pathology. Students can also optionally attend three formative assessments which include questions on the Anatomage table, 10 Anatomage quizzes, self-guided Anatomage construction activities for each system of the body and a cardiothoracic surgical simulation activity facilitated by staff members. The anatomage system be used outside of timetabled sessions, for self-directed learning.

Phase one—Focus groups

Two phase 1 focus group sessions were organized (Tables S1 and S2), one with first year BMBS ($n=4$) and one with second year BMBS ($n=11$) students. At the time, this was the only program taught by the anatomy team. All participants were emailed a participant information sheet before attending and provided informed consent. Focus groups were conducted in person and were led by staff external to the anatomy team, then transcribed and anonymised via a third-party transcriber. Focus group questions were decided by the anatomy lead and research assistant to explore issues surrounding the Anatomage tables commonly addressed in class.

After phase one, data were analyzed (see section "Thematic Analysis" for details), two interventions to improve group work were integrated into the curriculum. Firstly, group sizes around the Anatomage tables were reduced by purchasing more tables and dividing cohorts into subgroups to rotating around activities. Secondly, session instructions were adjusted to assign roles within the group of dissector, reader and active participant, asking students to rotate through the roles throughout the activity.

Phase two—Questionnaire and focus groups

In the phase two data collection, students were recruited from all programs within Peninsula Medical School that use the Anatomage tables in their anatomy curriculum (Table 1).

Students were invited to participate in a questionnaire through QR codes on posters and teaching slides. Data were collected toward the end of the academic year, after completing Anatomage dissections in class. Participation was voluntary and conducted outside of teaching time.

The aim of the questionnaire was to learn more about how the students interact with the anatomy sessions and online content. It covered a wide range of topics including their perceptions of virtual anatomy, how much time students spent of self-directed learning and how students interacted with the digital learning environment content. The questions pertaining to Anatomage were some open-ended questions to elicit rich, nuanced responses from participants, with three closed-text questions (Table S3).

TABLE 1 Percentage return on questionnaire for all programs and stages taught by the PMS anatomy team.

Program	Number of participants	Percentage return (%)
BMBS	52	13
DR	39	59
PAS	16	39

TABLE 2 shows the proportion of the students from each program and stage who attended the phase two focus groups.

Cohort	Number of students
Year 1 BMBS	1
Year 2 BMBS	3
Year 1 DR	2
Year 2 DR	2

All students were later invited to one of two focus group sessions ($n=3$, $n=5$, Table 2) via posters and teaching slides, with the understanding that their participation would be anonymous and voluntary, but that they would receive a certificate of contribution to research as an incentive. The questions are detailed in Table S4. All participants were emailed a participant information sheet before attending and provided informed consent. Focus groups were conducted via Zoom and were led by staff external to the anatomy team. They were transcribed and anonymised via Descript software (Descript, Inc., 2017) which was checked by a staff member who did not know the students. The questions for the focus groups were decided by the research team based on the open-text questionnaire responses to explore the themes from the data in more depth. The students were not divided by year group, due cross-program scheduling issues, so two dates were given to all participants.

In addition, a questionnaire was completed by Year 1 BMBS ($n=65$) students following an extra-curricular session on the Anatomage table. The questionnaire (Table S5) asked the questions detailed in the supplementary table and was completed on Microsoft Forms (full methods detailed in Singer et al.,[31]). A Spearman's rank correlation was carried out on the factors that influence the Technology Acceptance model[30] using IBM SPSS Statistics 25 (IBM Corp., Armonk, NY).

Thematic analysis

The researchers did not have any expected outcomes so phases one and two were analyzed using the inductive approach of thematic analysis, with phase two adding an aspect of reflexivity as the team obtained a copy of Braun and Clarke's Reflexive Thematic Analysis.[39] Each investigator kept a reflexive diary to identify personal and professional biases and how their positionality could influence the data.[40,41] As anatomy educators without clinical backgrounds but

with extensive experience teaching with technology, the researchers were conscious of how their background shaped research questions and interpretations. During data analysis, the researchers continually self-reflected on their theoretical and personal assumptions, preconceptions and biases.

Thematic analysis served as a robust methodological framework, allowing for systematically exploring qualitative data and providing valuable insights into the research objectives.[42] This method gave the investigators the freedom to allow students to share ideas surrounding Anatomage without constraining topics of discussion. Data analysis of phase one was independent of phase two as this was an explorative study, and the researchers did not want the themes from phase one to influence the identification of themes in phase two. The rigor and ethical considerations embedded within the study design contribute to the trustworthiness of the findings, ensuring that the themes identified authentically represent the perspectives and experiences of the study participants.

The data were coded separately by four different investigators—three for phase one in 2018 and two for phase two in 2022 (see section "Limitations" for details). This coding approach allowed data analysis and initial theme formation from the perspectives of people with different backgrounds and experiences. During coding, the researchers continuously went between the codes and data to ensure alignment. The initial codes and themes from each researcher were compared in a meeting, meanwhile returning to the data to see whether each theme fit. The initial codes and themes developed into the finalized themes listed in the results after critically examining and debating between investigators which ones were most representative of the data. After an agreement, the researchers returned to the data once again to find relevant quotes associated with each theme.

Reflexivity statement

The questionnaire and focus group questions were decided collaboratively amongst the anatomy team in the phase one and phase two data collection. The researchers working on the project changed between the two dates due to staff turnover. This meant the questions in the focus groups and the people coding the data changed, which may have led to different interpretations of the data.

All the researchers are specialized anatomy educators without a clinical background but extensive experience in teaching across multiple clinical programs. They have been using Anatomage for many years and so have written the research questions and analyzed data with that positionality. PMS has always championed being at the forefront of using technology for education, so this research project was influenced by the overarching values of the school.

RESULTS

This action research methodology produced overlapping themes from phase one data (groupwork, timing, educational value and learning to use the table) and phase two data (groupwork, 3D visualization, medical imaging, timing, instructions and digital humanity). Groupwork was one theme that appeared in both phases, and as such, the data have been arranged into smaller subthemes. Subsequent research papers will expand on the data and interventions associated with the other themes.

During thematic analysis of the phase one focus group data, aspects of group work relating to group sizes and dominant characters were found to be subthemes (subthemes 1 and 2 respectively). The researchers put initiatives in place based on this feedback to improve those aspects of group work, as detailed in the discussion. Further data was collected in the phase two focus groups to identify how successful these initiatives were. As well as the pre-existing subthemes, new subthemes relating to group work (subthemes 3–6) were found (Figure 2).

Subtheme 1: Group size

In the phase one focus groups, group size was a prevalent topic.

> We're split into the groups and there'll be about six of you crowding round this table trying to all do the same questions, and different people are at different tables.
>
> Ph1 FG2 P2

Data revealed that students felt group size was an important factor in whether they thought the learning opportunity had been useful. It was found that six students per group was too large for every person to access the Anatomage table.

> The only time I've found the Anatomage table really useful is when I went and just did it by myself cos it's too much for the six.
>
> Ph1 FG2 P1

In addition, quantitative data collected supported smaller groups sizes when working around the Anatomage table. Out of 65 students surveyed, 39 of them identified they preferred working in a group of four, while 19 students preferred working in groups of three (Figure 3).

After feedback from phase one focus groups, additional Anatomage tables were purchased so group sizes could be decreased. Subsequently, students confirmed that they liked the small group sizes in the phase two qualitative questionnaire.

Subtheme 2: Group dynamics

In the phase one focus groups, participants claimed that one dominant member of the group allowed the rest of the students to disengage with the Anatomage activity.

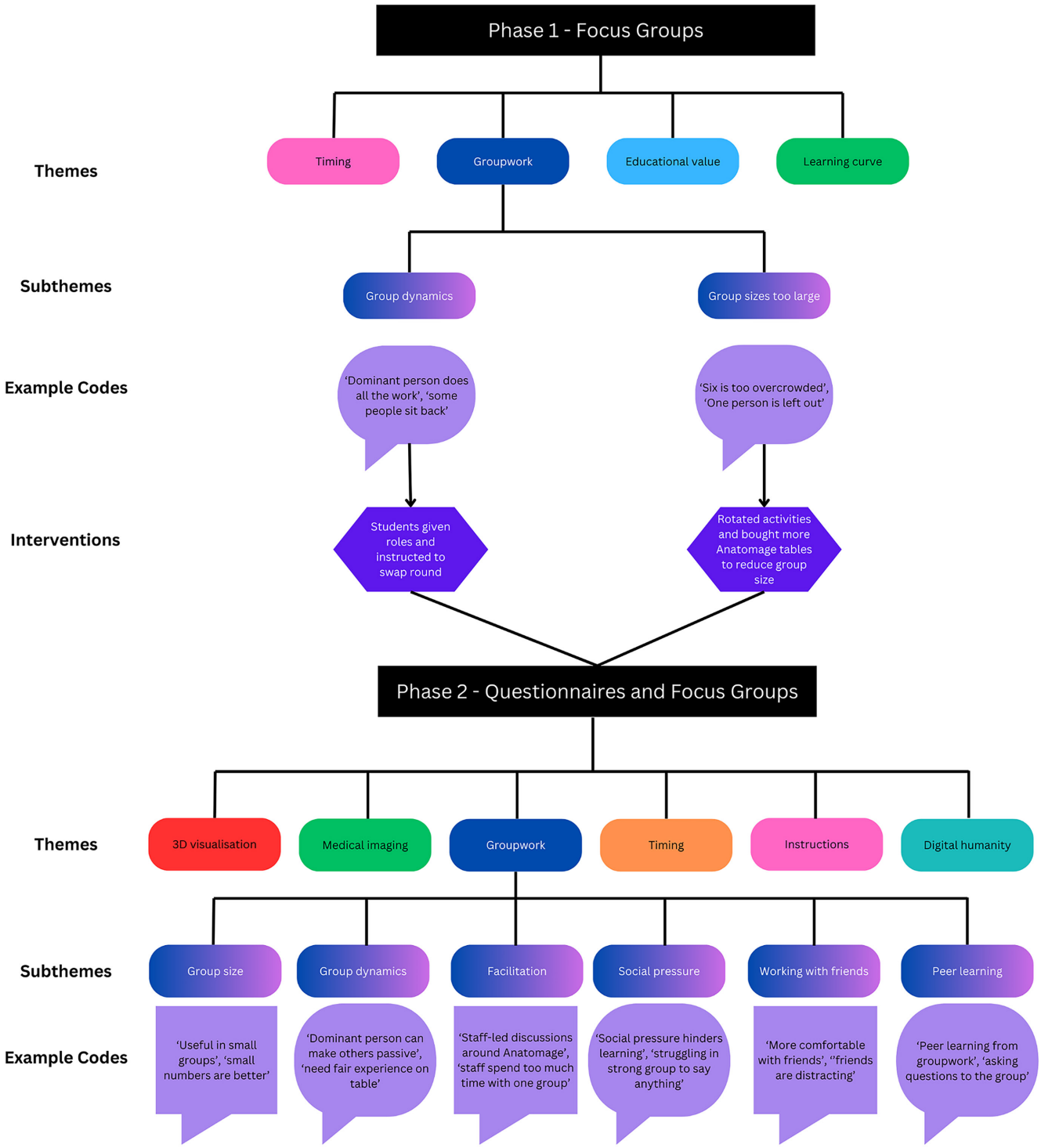

FIGURE 2 Themes, subthemes and example codes and interventions from this study.

> So you have one person ploughing through it and then someone who's sitting behind like I have no idea what's going on.
>
> Ph1 FG2 P2

Interventions were then put in place to ensure that the students swap the role of the dissector after each instruction. Although staff reported that this intervention improved the group dynamics, the issue of dominant characters remained in the phase two focus groups.

> So like if there is a really dominant person, then everyone else is sort of like, sit back, relax, sort of just let them do it all.
>
> Ph2 FG1 P2

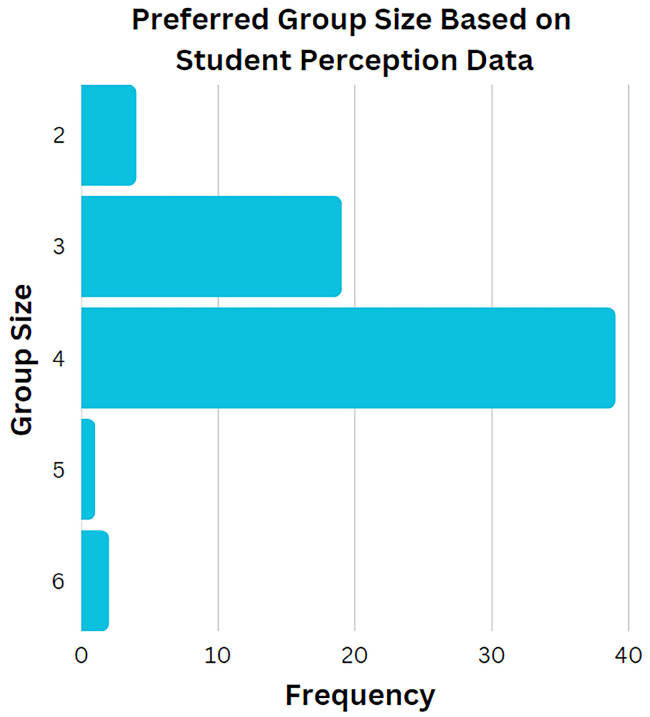

FIGURE 3 Number of students that preferred each group size. Four people per group was the preferred group size for most participants, and 5 people per group was the least preferred group size.

This dynamic means that not everyone gets comparable experience on the table and their learning may be compromised. There was also a comment about differential knowledge levels affecting whether the group worked well;

> I think if you're working in a group and most people in the group know something and understand something, you are not really gonna want to say, actually, can you explain this to me?
>
> Ph2 FG1 P1

There appears to be a barrier where students feel embarrassed if they feel they know less than the other members of the group.

Subtheme 3: Facilitator influence on group dynamics

Participants in the phase two focus groups said that staff could give the less-dominant members of the group a voice;

> I think the staff makes it so all of us as a group, like contributes because they kind of, they hear one answer. Then they kind of like turn to someone else to get an answer from someone else. And then they do it to a different member of the group. So, I think it helps allow everyone in the group speak.
>
> Ph2 FG1 P3

This implies that staff improve engagement by asking questions to the students who are not as engaged. The phase two focus group identified staff influence on group dynamics as a key factor in the student experience of the Anatomage tables, which was not a theme in the phase one data. Feedback shows that staff sometimes spend lots of time on one group, or there may be a group that needs more assistance than the others. This can negatively affect other students in the group as emphasized in the quote;

> I've had sessions where staff have been like with one group and then most of it, and then come and spoken, like to us for like 30 seconds. So I think that's both a positive and a negative because sometimes it'd be nice to have more one like group time with the staff, but then it also means that yeah, like I say, if they're busy, we can actually be getting on and doing something.
>
> Ph2 FG1 P1

Subtheme 4: Social pressure

From both focus groups' data, peer interactions heavily influence how well the students learn, with one factor being the social pressure to get the answers correct.

> There's always other people around you and you sort of then get that pressure also of people watching you and you feel like you're more likely to make a mistake.
>
> Ph2 FG1 P2

Multiple focus group participants mentioned feeling judged by their peers when working in a small group, which would often hinder the other participants. Even simply naming a structure would make them worried about what the rest of the group would think if they got it wrong.

In the phase two focus groups, the medical students had an added social pressure in the form of being ranked against each other in their examinations. One participant said;

> I don't know about you guys, but for us, like our course and stuff is ranked. And so like if you know that you're with people who score really well in exams, um, it can sort of be like, oh, I don't really want to say in front of somebody who's getting like the top marks.
>
> Ph2 FG1 P1

This study shows that the competitive nature of the assessment may be negatively impacting how students learn in groups.

Subtheme 5: Working with peers or friends

Spearman's rank correlation coefficients showed a positive association between students' ratings of peers' expectations of them to use the table and ratings of the importance of working with friends when using the Anatomage table ($r=0.403$; $p=0.005$).

However, when all 65 students were asked to rank working with friends against technical support, content support, clear instructions, adequate time and small group size, 52.2% of students ranked working with friends as fifth or sixth (the lowest ranks). When asked how much they agreed with the following statement "Working with friends is important when using the Anatomage table", the mean score was 6.49 out of 10, suggesting a small preference to work with friends.

This could indicate a group of people who attended more to what others think of them and are more sensitive to social pressures and therefore prefer to work with friends. In qualitative questionnaire feedback, this concern was captured multiple times, with one student saying.

> I feel more comfortable discussing my knowledge with people I'm friends with rather than people I do not know.

However, the data also captured students on the opposite end of the spectrum who did not consider working with friends an important factor when using the Anatomage table.

> I don't think working with friends is important cause that can easily distract you in completing the work.

Subtheme 6: Peer learning

A positive aspect of the Anatomage table shown in the data is that the interactivity promotes teamwork amongst peers.

> I think it makes it more like interactive as a, a group. And then if we don't know what this part of the body means, if someone else knew they would tell us, instead of us having to like, look it up again.
>
> Ph2 FG1 P3

Qualitative data from the phase two focus groups and questionnaire show that the tables encourage some students to collaborate and learn from each other, and that students are actively utilizing their teamwork skills during the Anatomage sessions. This other quote;

> [We're] in the same boat sometimes, like most of the time. So, we're all quite new to which part of the body we were doing so we'll like just share all the responsibilities.
>
> Ph2 FG1 P3

This suggests that the use of group learning in the context of Anatomage gives the students a shared responsibility, conflicting with other participants who felt that there were dominant characters in the group who would take over.

DISCUSSION

The aim of this action research study was to understand the students' experience of the Anatomage system so that the researchers could develop an evidence-based approach to effective integration into the curricula. This research report discusses the data specifically relating to group work, which was a prevalent theme within the data and required multiple initiatives to address the issues raised by students.

Four is the magic number

Prior to phase one, group sizes were large, with six or more students per table due to the limited number of Anatomage tables, and that only one person can touch the screen at once. Group size in cadaveric dissection is also limited by cadaver numbers and room sizes, so this is not a new problem. The students were expected to organize their own group in terms of division of labour and to naturally take turns. However, focus groups indicated that the groups were too large for everyone to engage in the activities. To address this issue, four additional tables were purchased resulting in smaller group sizes of ideally four or maximum five students per table. In the phase two focus groups, the data confirm that students prefer smaller group sizes.

Other studies have also shown that smaller groups tend to engage better in activities.[43,44] Students working in small groups around a smart device found that the groups containing four students tended to engage and enjoy the activity in comparison to students in groups of five, who were reported to be more distracted.[45] Management principles can be applied to Anatomage as organizing a team is crucial for the success of a project. Hoegl[46] explains that smaller teams are more successful as each added group member exponentially increases the interaction linkages. Adding one extra team member makes the interactions more complex (Figure 4). The average group size from the top-performing groups in this paper contained between 4 and 5 members.

A more recent meta-analysis of group size in computer-supported collaborative learning also determined that groups of four worked better than groups of two or three.[47] This aligns with

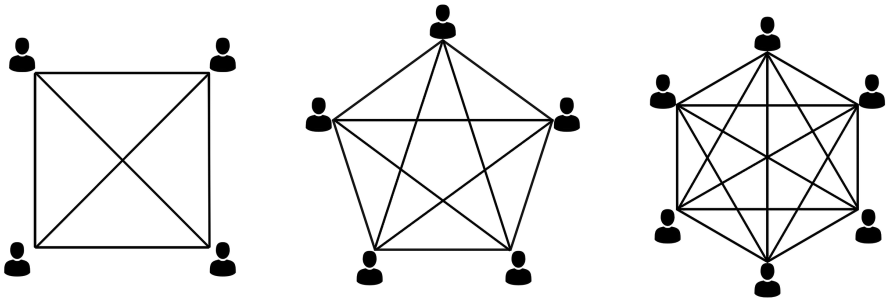

FIGURE 4 The exponential increase in interaction linkages between team members in groups of 4, 5 and 6.

data collected by the authors during a cardiothoracic Anatomage activity for first- and second-year medical students showing that groups of 4 were twice as popular as groups of 3 (Figure 1). In light of the data and literature, this intervention will remain in the curriculum.

Dealing with dominant students

Despite the improvements from reduced group sizes, group dynamics remained a concern in both the focus groups. Domineering characters can take control of group activities and influence the learning of their peers, which could be advantageous in certain situations, for example, it can be perceived as leadership if other group members lack direction.[48] However, it can leave quieter group members feeling excluded and these students may not reap the full benefits of the activity. It is important to note that "dominance" and "leadership" are not necessarily synonymous with each other here. A successful leader can delegate work to the other group members to increase the efficiency of the team,[49] whereas a dominating group member will do all the work themselves without involving the rest of the group.

In cadaveric dissection, there tends to be three natural roles; the reader of instructions, the dissector and the other group members who watch and comment on the activity at hand.[50] However, the dissecting table can become overcrowded due to cadaver availability which presents unequal opportunities to dissect.[51] Anatomage use has a parallel issue that one person can possess all these roles as you do not need to wield a scalpel and concentrate on intricate dissection techniques. To overcome this obstacle, students were assigned a specific role as either the reader, the "dissector" or an active participant. Only the "dissector" should touch the table to replicate actual dissection, and because the table cannot respond to two fingers interacting with it at once. These roles switch after each section in the activity, so everyone gets a turn. Even with these interventions, students in the phase two focus groups continued to discuss dominant group members indicating this intervention alone had not fixed the issue.

After observing small groups of medical students completing tasks and measuring their success, Channon et al.[38] found that too many dominant individuals in a group can result in disputes over the task at hand, which distract from the group work and lead to a poorer task output. On the other hand, groups with members who had good teamwork skills increased the success of the group and they had an improved task output. Often these students were able to delegate roles to each member of the group during the early stages of the task.

However, dominant members may not necessarily be the cause of poor group dynamics. The social psychological concept "fundamental attribution error" (FAE) states that personality is often blamed for negative behavior over social and environmental factors that have more influence in actuality.[52] If the domineering student was placed into a different group with different dynamics, their behavior may change, or "domineering" may not be a characteristic invoked to explain their behavior. FAE demonstrates how the learning environment can impact perceptions of individual behavior, no matter the personality type, and implies that changing social and environmental factors can have a positive effect on group dynamics and student perceptions. Perhaps placing these students into different groups, with or without friends, might help this issue, or more support is needed for these students to learn how to work effectively in a group. Further testing is needed to determine the best intervention for this problem.

Facilitation and friendships

In the phase two focus groups, participants emphasized how facilitators can play a crucial role in improving group dynamics by encouraging quieter members to participate and balancing their time equally amongst groups. Dolmans et al.[53] agree that facilitation can have an encouraging or detrimental impact on small group work depending on how they interact with the students. They say that a good facilitator stimulates self-directed learning and keeps the students on task. They should regularly probe for knowledge and test the students' understanding of a topic. However, if the facilitator is too dominant or too relaxed, this can cause the group to resent the groupwork task. De Grave et al.[54] explain that positive facilitator interaction is even more important if the group is finding interaction with each other difficult. The anatomy team have implemented two interventions to improve facilitator interactions; firstly, the number of staff members facilitating sessions will be increased due to

additional fifth-year student demonstrators and clinical demonstrators who are gaining educational experience as part of their placement or contract. In addition, every demonstrator will be trained on "how to be a good facilitator" by sharing good practice and giving teaching observations to help them develop their facilitation skills. They will be instructed to ask open-ended probing questions to less dominant members of the groups and regularly rotate around groups to avoid spending too much time in one place.

Participants also expressed that the anxiety of getting answers wrong in front of their group was acting as a barrier to their engagement with Anatomage. A study showed that over 10% of students at the University of Plymouth have social anxiety,[55] however, this value is most likely higher as anxiety rates in the UK have increased exponentially since.[56] Working with other students can exacerbate social anxiety and make the sufferer feel like they are being judged by their peers.[55] This may also be the case for those with neurodiversity. Facilitators can support students by advising them to thoroughly prepare before sessions. Students interviewed in the 2012 study used preparation as a tool to feel less anxious when participating in group work, thus supporting the flipped classroom approach[57] for Anatomage use.

Secondly, White et al.[58] suggest that allowing students to choose their own groups may positively affect their attitudes toward group work. Previously, the facilitators had been putting students into groups apart from their friends as they believed it would minimize misbehavior and encourage integration of students. However, qualitative data collected from the researchers' Anatomage cardiothoracic dissections showed that students were divided on this—some found working with friends distracting and others found it greatly reduced their anxiety and they were able to contribute more to the group. There is also evidence to suggest that diverse teams are more effective in completing tasks within healthcare,[59] which means that friendship groups would be less optimal to complete the Anatomage tasks. Overall, the quantitative data showed a slight preference for students working with their friends so the intervention will be to allow students to choose their own groups. However, this will be re-evaluated in the future as some literature does not support this course of action.

Under (social) pressure

Interestingly, comments pertaining to social pressure affecting engagement with the table were made exclusively by a BMBS student and were not agreed with by DR students. Within the UK, medicine is a subject that attracts competitive applicants, with 28,690 total applicants in 2021[60] meeting the exacting entry requirements. Prior to 2023, many medical schools also had rank-ordered assessments to constructively align with the system by which the deaneries for Foundation programs are allocated based on the student's foundation program score.[61] This method is no longer used which questions whether rank-ordered assessments are still constructively aligned. Although rank ordering can be motivational for some students, it also puts students under increased social pressure, especially those that are lower performing[62] as assessment drives learning.[63] The focus on the relative performance of students over each achieving a criterion of competency also negatively affects other attributes that contribute to being a "good healthcare professional", like teamwork; ranking is inherently competitive, whereas teamwork and good healthcare provision is inherently cooperative. Putting the students into groups with others they are familiar with could make them more likely to participate as they would feel more comfortable in the learning environment.

A juxtaposing view from the focus groups was that Anatomage encouraged collaboration amongst peers. These views predominantly arose from DR students. Peer learning has been demonstrated to be an effective learning tool as it allows students to share perspectives and learning styles with each other. It also helps create a friendlier learning environment away from the pressure of academics, which can make students feel more comfortable sharing their true thoughts.[11]

Differences between the BMBS and DR courses may have influenced whether they felt social pressure while working at the Anatomage tables. Firstly, there are only 40 students in the DR cohort as opposed to 160–200 students in each year of BMBS. This makes the course more intimate, encouraging closer friendships. The chance of DR students being in a group with their friends is also statistically increased and social anxiety would be decreased. Secondly, the course and assessment structure between the two is very different. The BMBS course contains four Applied Medical Knowledge (AMK) tests per year of study. These exams have norm-referenced pass marks, and so a certain percentage of students will always fail. The DR assessments have a standard 40% pass mark so students may feel more inclined to collaborate with peers as they do not see them as competition.

Next steps

After completing the study, there remained further challenges that students faced when interacting with Anatomage which will require more initiatives to be created. This includes mitigating social pressures caused by program structure, determining whether students work more optimally when placed in groups with friends, and aiding facilitators to create a supportive learning environment for small groups. The researchers have suggested potential interventions in this paper and will need to collect more data in the future to determine whether those new initiatives are effective. This produces an active research cycle where this learning tool is continuously evaluated and adapted to the diversifying cohorts of students through widening access like foundation programs and apprenticeships, aligning with the NHS Long Term Workforce Plan.[64]

Limitations

Only a small percentage of the total students taught participated in the focus groups and questionnaires (Table 1). This limits how representative this data is of the entire cohort of students taught using

the Anatomage tables. There were no Physician Associate students in the focus groups so their view especially is only represented by the questionnaire data. Monetary rewards for participation can often help increase participant numbers,[65] however, this was not offered for this study due to potential conflict of interest. There will also be selection bias on the students who volunteered for this study. Most of the phase two focus group data came from the first focus group as the second focus group did not discuss groupwork in detail. More specific focus groups with more participants could be carried out with groupwork prompts to strengthen the results.

The population of students changed between phase one and two which may have also influenced the results. Although, other than the interventions mentioned, the anatomy curriculum and learning outcomes did not change significantly between the two phases, differences between themes in phase one and two could have been affected by factors other than the interventions created. One example is that phase two participants had studied through the pandemic which greatly influenced them as they had been learning online for a proportion of their studies. In addition, due to centre-assessed grades after COVID, the cohort size for BMBS was increased by 25% so group sizes were larger which could alter the student experience. Despite this, the researchers still ensured that group sizes around the Anatomage tables did not exceed 5 students.

The method of conducting the focus groups changed between phase one and phase two data collection as video conferencing became more popular after the COVID-19 pandemic. Although the authors thought video conferencing would encourage more students to participate if they did not need to leave their homes, it may have influenced their behavior in the focus group. For example, subtle visual interactive cues may be lost and there may be technical issues that make communication less effective.[66] Also, the research team changed between phase one and two, as one member went on maternity leave and the research assistant was only hired for phase one with internal funding. This results in different approaches to coding, with coders in phase one using NVivo software, whereas coders in phase two coded manually.

All data collection approaches have their limitations. For qualitative approaches, Ochieng[67] describes how ambiguities in language may be misinterpreted by the coder, especially as all the data were transcribed and anonymised to make the student participants feel more comfortable sharing their opinions. They add that the results are not tested for statistical significance so cannot be extrapolated to the wider population, and that there is a risk of emphasizing rare phenomena equally to more frequent phenomena. In addition, student perception does not always equate to academic success, so further research is required to show the impact of effective groupwork while using Anatomage on assessment.

Practical recommendations

Based on these data, the authors recommend considering the following interventions while using Anatomage, or similar virtual anatomy platforms;

- Groups of four are optimal for learning around the Anatomage table
- Roles can be given to the students in the instructions and rotated to ensure every group member interacts with the platform, and gains experience of acting in every role.
- Facilitators can ask quieter students in the group questions to make sure they are equally engaged
- Avoid spending too much time facilitating any one group
- Using a flipped classroom may help decrease social anxiety about using the tables
- Putting students in groups with their friends may help to reduce social anxiety
- Consider how course size and assessment structure could affect group dynamics

CONCLUSIONS

To conclude, this action research has had a positive effect on curriculum development based on student and staff feedback. The study shows that integrating Anatomage into the curriculum can provide opportunity for an effective group working experience, valued by healthcare regulators like the GMC and HCPC. It presents a valuable opportunity to reflect on individual roles in a team, how this affects the efficacy of the group overall, and what educators can do to influence this.

While some of the challenges highlighted in this research mirror those seen in other group work settings that is cadaveric dissection labs, the use of virtual anatomy also raises its own unique challenges. This research is one of a series of papers produced by this research team exploring good practice in virtual anatomy education.

ETHICS STATEMENT

This research was approved by the University of Plymouth Faculty of Health Research Ethics and Integrity Committee (project IDs 17/18-833 and 3130).

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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