

ASSESSING MEDICAL STUDENTS' UNDERSTANDING OF APPLIED ANATOMY: THE INFLUENCE OF VISUAL RESOURCES ON THEIR PREPARATION FOR ENTRY INTO THE MEDICAL FIELD

Gong Afang¹, Emad Mohamed Nafie Abdelwahab¹

¹Lincoln University College, Petaling Jaya, Malaysia.

ABSTRACT

Exams in anatomy were timed and used visual aids including cadavers, photos of cadavers, radiographs, and images of clinical findings to assess students' topographical and practical knowledge of anatomy. Information about the incorporation of drawings into written assessments was scarce. Our understanding of how people learn from both textual and visual sources has grown, however, thanks to developments in the theory of multimodal learning. The major purpose of this study was to examine the impact of including or excluding photographs from clinically-oriented single-best-answer questions on the performance of medical students. Additionally, a questionnaire was used to examine how students' characteristics and preferred ways of assessment and teaching affected their final scores. Seven hundred and fifty-five second-year medical students from six separate UK medical schools volunteered to take part. The questions were arranged by the researcher according to the stimulus type: text alone or image. In addition to the image type and deep components, the question's emphasis on the picture's soft-tissue or bone content was taken into account. Additional studies focused on the question's complexity and its geographical anatomy. The students reviewed both their test scores and questionnaire responses. Pupils' remarks bolstered this argument even more. image depth, question difficulty, regional anatomy, picture inclusion, and students' performance were all factors that were shown to be influenced by the study. How well students perform may be greatly affected by their own preferences. Crucial in medicine for analyzing and assessing a patient's anatomy, this study sought to investigate the effects of radiological and anatomical images on commonly used written assessments. Both image and student characteristics impact students' academic progress, according to this study. To make these assessments more accurate, further research may be required.

Keywords: Applied Medical Terminology, Medical Education, Visual Aids, Student Readiness.

INTRODUCTION

Everyone knows that anatomy is very important for doctors and has a big impact on how medical students work in the field. Having a solid grasp of anatomy was crucial for making precise diagnoses and safely administering a range of therapies. It is common for young doctors to depend on their anatomical knowledge while interpreting radiological images and conducting patient physical exams. This data was "encapsulated" in therapeutic concepts and used more subtly as proficiency increased. There are numerous reasons why a doctor's knowledge of anatomy is vital. These include: the reasons why certain parts of the body lose feeling or control after a lesion or fracture; how neighboring structures can worsen a patient's symptoms; the procedures used to detect healthy or damaged ligaments and vessels; the presence of different kinds of haemorrhages on CT scans; and many more (Conti & Paternostro, 2019). With the advent of new medical specialties like interventional radiology, a thorough familiarity with the anatomy and physiology of the human body became essential. The amount of time spent on anatomy in medical school courses, however, has been steadily decreasing. Other relevant subjects' development and expansion were abundant in the curriculum. Decades of contentious debate have ensued on its proper place in such a densely packed curriculum. Some have even pondered if, in later years of education, students might do better if they reviewed it to assist them better integrate clinical and other relevant sciences with anatomy. There are many who worry that changes to the undergraduate medical school curriculum in the UK have compromised the quality of future doctors since no extensive study was conducted before the changes were implemented. According to the Medical Protection Survey investigating insurance claims against surgical procedures, over half of the claims related to laparoscopic surgery were for unintended damage to surrounding tissues, most likely due to inadequate anatomical knowledge (Wickramasinghe et al., 2019).

BACKGROUND OF THE STUDY

Despite the plethora of evaluation tools, few have recorded their application to the study of anatomy. The visual resources inherent to anatomy and its numerous features are neglected in favor of more abstract ideas like validity, feasibility, and dependability, which were the subjects of the little coverage that was available (Pan et al., 2020). There are primarily three forms of evaluations: practical tests, written exams (online or on paper), and oral examinations (viva). Oral examinations were seldom utilized in the UK because to issues with bias, low reliability per testing hour, assessor unreliability, and the time they require. Nomenclature, function, and clinical/spatial links are still highly valued in these systems, which is why they are still used in the US, AU, and NZ. Essays, free-response questions, key features, extended matching questions (EMQs), and single-best-answer questions (SBAs) are common types of written exams. Some examples of practical exams are the Integrated Anatomy Practical Papers (IAPP), the Objective Structured Practical exams (OSPE), the test-tank, the think-tank, tag, and the steeplechase. These exams, which could or might not include visual aids, assess students' knowledge of the practical and theoretical parts of anatomy. Students of medicine who aspired to

become surgeons have an additional option for gauging their practical anatomical knowledge: the Membership Examination of the Surgical Royal Colleges of Great Britain (MRCS). Candidates aiming to finish their specialty training in general surgery would have done well to take the MRCS membership exam. It was a mandatory requirement for trainees to progress to specialty surgical training, as stated by the Surgical Specialty Advisory Committees (Kansal et al., 2021). A number of sections comprised the exam, including both theoretical and practical assessments. The MRCS Part A, a two-part written exam using Extended Matching Items and Single Best-answer questions, tested candidates' understanding of both basic scientific concepts and surgical procedures. The clinical case scenarios served as the foundation for these questions, which mostly concern the patient's symptoms, medical history, and diagnostic data (including results from imaging and blood tests). Next, a question was asked to set the stage for the situation. A third of the paper's forty to fifty questions include subjects related to imaging anatomy, developmental anatomy, surgical anatomy, and topographical anatomy. A combination of classroom learning and hands-on practice in the operating room makes up Part B's Objective Structured Clinical Examination (OSCE) material. The use of a series of workstations that simulate different parts of standard medical procedures allowed this to be achieved (Wickramasinghe, 2020). Each scheduled self-contained station investigates topographical, applied, and surgical anatomy using cadaveric specimens and/or radiological imaging. Part B consists of three or four stations that test the participants' practical understanding of anatomy. Using medical images, bones, and safety glasses, participants assessed their anatomical knowledge at these stations. Recent studies have preferred strategies that facilitate students' ability to apply their knowledge in undergraduate and graduate-level practical anatomy examinations. Examples of popular models for this kind of assessment are Miller's pyramid and Bloom's taxonomy. In theory, by providing clinical case scenarios and other contextual information, the researcher may move up Miller's pyramid from "knows" to "knows how" and, according to modified Bloom's Taxonomy, strive for level 3. Assessing critical thinking, knowledge application, problem-solving skills, and higher-level cognitive capacities may benefit from contextual clinical information, according to the available evidence (Duarte et al., 2020). Clinical assessment enhances the acquisition and application of anatomical information, as stated by Molyneux and Robson. Students in their first through fourth years of medical school completed an online exam that includes both traditional spotting questions and more recent ones based on clinical and functional imagery. Both quantitative and qualitative data showed that students (n=96) and clinical instructors (n=23) had a very positive response, indicating that they liked the clinically oriented anatomy questions. This result provides support for the notion that clinically oriented inquiries were superior stimuli due to their realism. In the past, spotting exams only evaluated identification; however, multiple-choice questions (MCQs) could not adequately reflect the spiral, integrated, case-based nature of the curriculum because they did not adequately portray the three-dimensionality and practicality of clinical anatomy (Chen et al., 2019).

PURPOSE OF THE RESEARCH

This study's overarching goal is to learn how medical students understand and retain anatomical concepts via the use of visual aids in the context of applied anatomy. This study set out to answer the question, "How can visual aids influence students' readiness for clinical practice?" by investigating the transition from classroom learning to practical application of medical knowledge. Ultimately, the outcomes demonstrated that medical school instructors may maximize the effectiveness of their institution's teaching tools and resources.

RESEARCH QUESTION

How does prediction of chronic kidney disease play role in the early stages of type 1 diabetes?

METHODOLOGY

RESEARCH DESIGN

This study adopted a case-control research design, utilising both discovery and validation cohorts to investigate urinary peptidomes and proteomic signatures linked to early-stage type 1 diabetes. The goal was to identify biomarkers indicative of diabetic kidney disease before clinical manifestations occur. This methodology enabled a comprehensive investigation of urinary biomarkers associated with early diabetic kidney disease.

SAMPLE

The research used the random sample approach.

DATA & MEASUREMENT

Urine samples were processed through filtration and concentration. Peptides were extracted and prepared for mass spectrometry analysis. Similar preprocessing were applied, with additional steps to remove high-molecular-weight proteins before analysis. Peptides with significant differential excretion between groups ($P < 0.05$) were identified, with a focus on uromodulin-derived peptides. Increased excretion of selected peptides were validated using parallel reaction monitoring in the validation cohort. Proteins with significant differential excretion between groups (Q

< 0.05) were analyzed. Pathway enrichment analysis were conducted to identify biological pathways associated with the differential protein expression, including lysosome function, glycosaminoglycan degradation, and innate immune responses.

LITERATURE REVIEW

First things first, the researcher reviewed all he had read for the courses and the IFS (institutional-focused study). They combed through databases and search engines including ERIC, Google Scholar, Medline, and Google in pursuit of further details. the researcher used terms like online and practical anatomy tests, visuals in applied anatomy exams, educational and anatomical evaluation, formative assessment, assessment psychometrics, and visuals in assessment. The researcher subsequently came upon literature that addressed cognitive theories of visual processing and multimodal learning. In order to create the questionnaire, the researcher sought to understand what students valued in anatomy lessons and what they hoped to gain from their study in the subject. These search engines were still rather helpful, however, since the researcher used a snowball strategy to understand the field's ins and outs after finding a few key individuals. It took a lot of effort and time to connect the dots between the educational psychology of visuals, anatomical assessments, and the function of visuals. This chapter provides a brief overview of the assessment method, which is based on anatomy and other areas of medical education. Examining the students' performance based on their ideas channeled via educational psychology and anatomy-based visual aid theories was the next stage. Assessment was an essential component of all curricula since it gauges the level of student understanding, influences their future study habits, and provides light on the effectiveness of educational institutions. Formative and summative assessments were the two most common kinds. Summative evaluations focus more on certification and accountability, while formative assessments aim at building learners' autonomy and capacity for sustained learning via the provision of constructive feedback (Naidoo et al., 2020). Just so we're clear, I'd want to define "competence" before the researcher go any further. The accrediting body for graduate medical education laid out the six domains of competency and explained how to measure them. Patient care, medical knowledge, proficiency in learning and growth via practice, interpersonal and communication skills, competency in systems-based practice, and professionalism are all part of this category. Their agreement with the concept of anatomy competence—the ability to handle a task by integrating the necessary cognitive, psychomotor, and emotional abilities—suggests that they consider anatomical competence to be a subset of medical knowledge competence. Assessments often evaluated the psychomotor, affective, and cognitive domains along two dimensions: the "knowledge/content dimension" and the "cognitive process/progress dimension" (Sriram & Subrahmanian, 2020). The content component of anatomy encompasses metacognitive domains, conceptual comprehension, proficiency in procedures and methods, and anatomical terminology and facts. One indicator of their knowledge acquisition is their "progress dimension"—their capacity to sort, compare, translate, comprehend, and apply new

information. For this assignment, the researcher utilized an online test to check for understanding of applied anatomy and how far along the researcher were in the process. Instead of seeing evaluation programs as individual examinations, a more holistic approach was increasingly prevalent in medical practice (Sadoughi et al., 2020).

RESEARCH QUESTIONS

What impact can improved comprehension have on medical students' knowledge of applied anatomy in the medical profession?

METHODOLOGY

This research used a quasi-experimental approach by recruiting from medical schools and relying on participants' voluntary participation. The students were given identical examination settings and had to answer questions using either anatomical or radiological pictures, or without visuals at all. At first, the researcher contacted ten different medical schools in the UK to ask for permission to use their students in the research. The accessibility and usage of visual aids in anatomy instruction were the deciding factors in the selection of these 10 medical institutions. Each medical school's anatomy homepage and pertinent contacts were combed through for this data. These educational institutions make use of radiographic pictures, dissecting cadavers, and pre-dissected body parts as anatomical resources.

Only six of them, however, were able to approve the request within the allotted time. A good thing is that among those six medical schools, there was a reasonable distribution of the anatomy teaching resources: three schools used radiological images in addition to dissections, two schools used radiological images alone, and one school used all three. Medical students from six different schools in the United Kingdom took part in the research. The students who volunteered to take part in the research were in their last year of college. A free revision tool for students to test their understanding of applied anatomy, this test was issued around two months before their final exams. Many students took it. Since the first two years of a medical degree explicitly teach anatomy, picking pre-clinical medical students makes sense. Since all of the students were scheduled to take their second-year final test in around a month or two, it was assumed that the group had a similar level of background knowledge. Also, the anatomical and radiological pictures might be utilised to evaluate students at this point in their medical degree since they are thought to have mental models to handle the test's visuals. In addition, the anatomy department chairs and faculty from each medical school assessed the questions and found that the students were on par with one another in terms of both the substance (questions-context and visuals) and presentation of the examination. An administration or anatomical department at each school sent an introduction email

and a leaflet advertising the study to students in an effort to avoid any appearance of coercion in their participation.

PARTICIPANTS

One way to improve group internal validity is to use the same students in both the control and test groups. This study deviates from conventional randomized controlled trials in that it does not use any intervention to distinguish between the two groups. Here, the researcher split them into three categories: controls, test 1 (which included questions with anatomical photographs), and test 2 (which contained questions with radiological images). This was done to address the possibility of group prejudice. The components mentioned in the literature are as follows: History refers to changes in the learner's environment that are unrelated to the inquiry. Changes brought forth by trial and error are what "testing" refers to. The term "instrumentation" refers to the change in measurements from one examination to another. In order to use regression, non-typical experimental groups must be used.

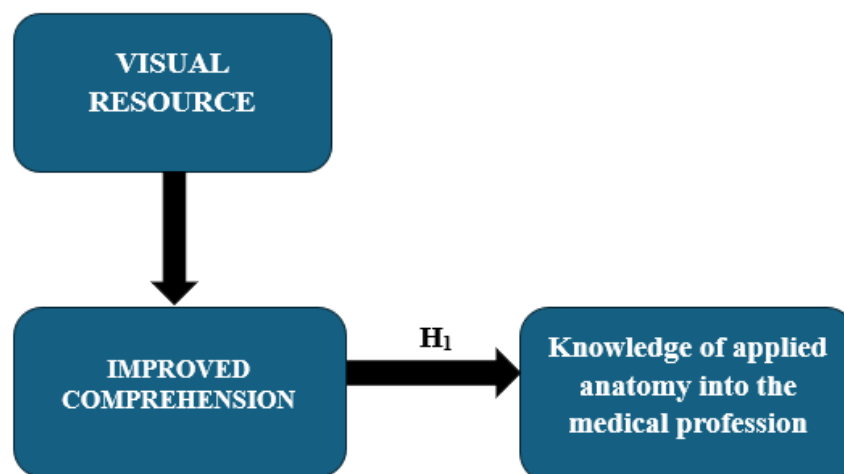
The rate at which people stop taking part in a study is called mortality. The word "maturation" is used to describe how students develop, grow, and become better over time. The process of selecting groups for further investigation begins with making initial differences between them. Groups that tend to separate as they become older are said to be subject to selection by maturation interaction.

- Concerning the real relationship, it is unclear whether A causes B or B causes A. A phenomenon known as "diffusion of therapies" occurs when components of a treatment that were intended for one group end up in another. Due to the potential for organizational pressures to emerge from preferential treatment of one group over another, compensating equalization of treatments is essential. Adapting internal processes in order to maintain competitiveness is what "compensatory rivalry" refers to. Even if the study evaluated the same students' performance, the "history" and "testing" elements still pose a danger. Problems including "instrumentation," "mortality," "diffusion of treatments," "compensatory equalisation of treatments," and "compensatory rivalry" were eliminated since the research used just one quasi-experimental design. Common assumption is that students of varied abilities made up the "Regression" group. One probable explanation for the variation in "maturation" is that people's development varied according to their experiences and circumstances. For the "selection" component, medical institutions were selected based on the visual aids used in their academic anatomy courses. For this reason, the researcher go through the anatomy websites and relevant contacts of every medical school.

PROCEDURE

Both men and women participated in the "Anatomical Man" studies. These anatomical BP experiments typically ran overnight and had an average duration of 18 to 24 hours. Following the BP approach to the letter yielded accurate results. The models were first properly landmarked using images and anatomical atlases. As part of the landmarking procedure, black whiteboard markers were used to carefully outline the various anatomical structures, including muscles, bones, organs, blood vessels, and nerves. Critical since it produced the template for the subsequent stage, this step was vital. In certain projects, this first landmarking step could take up to 10 hours to complete. The second step of any project was painting and shading. Paint and body paints of superior quality were an absolute must for every BP project due to the need for long-term durability and crack-resistance. Additionally, a wide range of cosmetic brushes and paintbrushes were used for this task. Books like Netter's Atlas of Human Anatomy served as guides for the student painters as they worked from descriptions of human anatomy. Once the paintings were complete, an aspiring photographer took high-quality photos to go along with them, publish them, and use them in advertising materials.

CONCEPTUAL FRAMEWORK



RESULTS

Parametric tests predicated on the normal distribution presuppose the independence of data points. Data on students' performance across different question types was derived from the same cohort, hence a repeated measures approach was used. Consequently, data on outcomes from many types of inquiries would be linked. The researcher concluded that, due to the almost equal degree of dependence across groups, it is plausible to assume that the correlation between pairs of performance on different question types may also be similar. The characterization of this thing as spherical defines it. When these variances, representing the differences between any two scores in a certain combination, are

almost similar, the researcher characterizes the distribution as spherical. When the variances of two out of three treatments are similar, the researcher refer to the data as demonstrating local circularity (also known as local sphericity). Below is a comprehensive summary of all sixteen extracurricular BP projects: Neurovascular Man (comprising the nervous and cardiovascular systems), Multi-colored Man (muscles represented in various hues; three projects), Process Man (four quadrants illustrating blood pressure processes), Anatomical Man (four projects related to muscles), Skeletal Man (two projects concerning bones), Anatomical Woman (two projects focused on muscles), Pregnant Woman (a depiction of a pregnant woman painted monthly until delivery), and Systems Man (visceral anatomy and organs). Most chores were completed within 24 hours; land marking required around 8 to 10 hours, while painting necessitated about 12 to 14 hours. Numerous visitors from diverse departments and programs, including anatomy, attended, along with the dean of medicine, the head of school, and the deputy vice chancellor, all of whom were invited to see the operation. These visits were essential to maintain worker motivation throughout the extended project hours. Furthermore, 87.1% of participants said that BP was pertinent to their class discussions, 93.6% asserted its relevance to their level of success, and 80.7-87.1% acknowledged its significance to their careers. Participation in the BP initiatives resulted in a 93.3% enhancement in students' short-term and long-term retention of human anatomy. The pupils' comments are rephrased, and they were mostly positive about the experience.



Figure 1.Inspiring Medical and Health Science Students to Learn Surface Anatomy

Mauchly's sphericity test is inapplicable due to the presence of just two independent factors un the dependent variable (question difficulty level). A substantial impact size (partial Eta Squared = .642) was indicated by within-subjects effects and contrasts, revealing a significant difference in question difficulty ($F(1, 172) = 308.88, p < .001$). There is a significant difference between students who scored

well and those who did not ($F(1, 172) = 320.44, p < .001$), with a partial eta squared value of .651, suggesting a very big effect size. The relationship between question difficulty and student performance groups did not achieve statistical significance. Figure 12 illustrates the degrees of question difficulty: level 1 for scores of 56 and less, and level 2 for scores beyond 56.

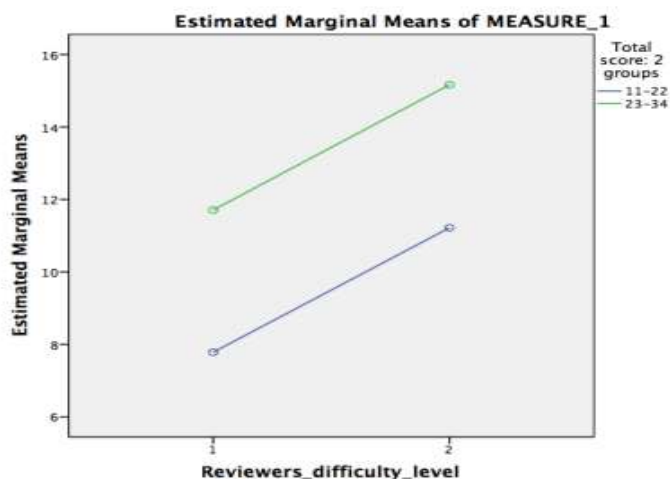


Figure 2. High and low performers' scores on easy and difficult questions

DISCUSSION

Albumin, α 1-microglobulin, retinol-binding protein (RBP), and ceruloplasmin had significantly elevated levels in persons with type 1 diabetes among the proteins identified as differentially expressed. These proteins may function as early biomarkers of diabetic nephropathy owing to their established correlation with renal impairment. Additional indication of possible early structural changes in kidney tissues was the identification of elevated levels of collagen and fibrinogen peptide fragments in the urine of people with type 1 diabetes.

CONCLUSION

This study highlights the critical importance of students having a firm grasp of applied anatomy, as well as the significant impact that visual aids have on medical students' learning and clinical preparedness. Bhandari et al say the utilization of contemporary pedagogical tools such as computer simulations, interactive visuals, and three-dimensional models has the potential to greatly enhance students' understanding of complex anatomical concepts as the medical field develops (Bhandari et al., 2020). The study shows that students benefit greatly from visual assistance while learning anatomy. Not only do they retain more information, but they also acquire important skills that will help them succeed in the medical sector. These resources help students make the transition from classroom theory to real-

world practice, which is essential for developing their critical thinking and problem-solving abilities as they prepare to become healthcare professionals. The use of various visual aids should be prioritized by medical educators as a means to captivate students and meet their unique learning styles. The goal of this approach is to train medical professionals to be more confident in themselves and their abilities so that they can meet the challenges of modern medicine and provide their patients with the best treatment possible. Research into the most effective methods of medical education may build on the findings of this research.

REFERENCES

1. Wickramasinghe N, John B, George J, Vogel D. Achieving value-based care in chronic disease management: intervention study. *JMIR Diabetes*. 2019 May 3;4(2):e10368.
2. Chen CE, Harrington RA, Desai SA, Mahaffey KW, Turakhia MP. Characteristics of digital health studies registered in ClinicalTrials.gov. *JAMA Intern Med*. 2019 Jun 1;179(6):838-40.
3. Kansal V, Ranjan R, Sinha S, Tiwari R, Wickramasinghe N. *Healthcare and Knowledge Management for Society 5.0: Trends, Issues, and Innovations*. Boca Raton (FL): CRC Press; 2021.
4. Wickramasinghe N. *Handbook of Research on Optimizing Healthcare Management Techniques*. Hershey (PA): IGI Global; 2020.
5. Sadoughi F, Behmanesh A, Sayfour N. Internet of things in medicine: a systematic mapping study. *J Biomed Inform*. 2020 Mar;103:103383.
6. Sriram RD, Subrahmanian E. Transforming health care through digital revolutions. *J Indian Inst Sci*. 2020;100(4):753-72.
7. Bhandari M, Zeffiro T, Reddiboina M. Artificial intelligence and robotic surgery: current perspective and future directions. *Curr Opin Urol*. 2020 Jan;30(1):48-54.
8. Naidoo N, Akhras A, Banerjee Y. Confronting the challenges of anatomy education in a competency-based medical curriculum during normal and unprecedented times (COVID-19 pandemic): pedagogical framework development and implementation. *JMIR Med Educ*. 2020 Oct 7;6(2):e21701.
9. Pan S, Chan LK, Yan Y, Yang X. Survey of gross anatomy education in China: the past and the present. *Anat Sci Educ*. 2020 May;13(3):390-400.
10. Duarte ML, Santos LR, Guimarães Júnior JB, Peccin MS. Learning anatomy by virtual reality and augmented reality: a scope review. *Morphologie*. 2020 Dec;104(347):254-66.
11. Conti AA, Paternostro F. Anatomical study in the Western world before the Middle Ages: historical evidence. *Acta Biomed*. 2019 Dec 23;90(4):523-5.