

EXAMINING THE KNOWLEDGE OF APPLIED ANATOMY THAT MEDICAL STUDENTS POSSESS: THE IMPACT OF VISUAL RESOURCES ON THE PROCESS OF PREPARING THEM TO TRANSITION INTO THE MEDICAL PROFESSION

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**ABSTRACT**

Anatomical exams were timed tests that evaluate students' topographical and practical understanding of anatomy using visual aids such as cadaveric materials, cadaveric pictures, radiography, and clinical findings images. There was little data on the usage of drawings inside written assessments. However, improvements in multimedia learning theories have increased our knowledge of how humans process textual and visual material during learning. Examining whether medical students' performance was significantly affected by the inclusion or absence of pictures inside clinically-oriented single-best-answer questions was the main objective of this research. The impact of students' traits and preferred methods of instruction and evaluation on their final grades was also investigated via the use of a questionnaire. A total of 175 second-year medical students from 6 different UK medical colleges willingly took part. The researcher sorted the questions according to whether the stimulus type was only text or whether there was an accompanying picture. The question's focus on the picture's soft-tissue or bone content, as well as the image type and deep components, were also considered. The question-difficulty and question-regional anatomy were the subjects of further research. After collecting the students' questionnaire replies, they examined their test results as well. The comments made by the pupils served to further demonstrate this point. picture inclusion, picture depth, question complexity, and regional anatomy all affected students' performance, according to the research. Students' tastes can have a significant impact on how well they do. This research aimed to examine the impacts of radiological and anatomical pictures on regularly used written evaluations, which were crucial in the medical field for evaluating and assessing a patient's anatomy. The results of this research demonstrate that both image and student variables influence the academic achievement of the pupils. These analyses might need further study to help them become more precise.

**Keywords:** Applied anatomy, Medical education, Visual resources, Student preparedness.

## INTRODUCTION

It was well acknowledged that anatomy plays a crucial role in medicine and has a significant influence on the clinical careers of medical students (Morris, 2018). To provide an accurate diagnosis and perform a wide variety of treatments without risk, an understanding of anatomy was essential. During patient physical examinations and radiological image interpretation, junior physicians often rely on their anatomical expertise. This information was "encapsulated" in clinical ideas and utilised more implicitly as one gains competence. A doctor's understanding of anatomy was crucial for many reasons, such as the following: the reason why certain areas of the body lose sensation or motor control after a fracture or lesion; the role that nearby structures play in exacerbating a patient's symptoms; the tests used to determine whether ligaments and vessels were healthy or damaged; the presence of various types of haemorrhages on computed tomography (CT) scans; and so on. More and more medical subfields, such as interventional radiology, were emerging, necessitating in-depth understanding of the human body's structures and systems. However, there has been a steady decline in the amount of time allotted to medical school curricula for anatomy instruction and examination (Laird-Fick, 2018). The curriculum was filled with the development and growth of other pertinent fields. The result has been decades of heated controversy over whether or not it belongs in such a packed curriculum. Also, others have wondered whether students might benefit from reviewing it again in later years of school to help them better integrate anatomy with clinical and other applicable disciplines. Some believe that the UK's undergraduate medical school curriculum have been altered without doing thorough research, and that this has had an impact on the competency of the physicians of the future. Inadvertent injury to nearby tissues, likely caused by insufficient anatomical understanding, accounted for around half of the claims connected to laparoscopic surgery, according to the Medical Protection Survey into insurance claims against surgical operations (Wynter, 2019).

## BACKGROUND OF THE STUDY

Despite the abundance of assessment methods, very few have documented their use in anatomy. What little coverage there was focuses on more abstract concepts like validity, feasibility, and reliability rather than the intrinsic visual resources inherent to anatomy and its many facets (Mutschler, 2020). Three main types of assessments include practical exams, written exams (either paper-based or online), and oral examinations (viva). In the United Kingdom, oral exams were seldom used because of concerns about prejudice, poor dependability per testing hour, unreliability of assessors, and the time they take. The US, AU, and NZ still use them, nevertheless, because of the importance they place on nomenclature, function, and clinical/spatial linkages. Common forms of written examinations include multiple-choice questions (MCQs), essays, free-response questions, key features, extended matching questions (EMQs), and single-best-answer questions (SBAs). Integrated Anatomy Practical Papers (IAPP), Objective Structured Practical Examinations

(OSPE), test-tank, think-tank, tag, and steeplechase were all examples of practical examinations. These tests evaluate candidates' understanding of both theoretical and practical aspects of anatomy, and they may or may not include visual aids. For medical students interested in specialising in surgery, the Membership Examination of the Surgical Royal Colleges of Great Britain (MRCS) was another way to test their practical understanding of anatomy. For those seeking to complete the general surgery component of their specialist training, the MRCS membership test was an appropriate choice. According to the Surgical Speciality Advisory Committees, it was an essential step that trainees must take to advance to speciality surgical training. There were several parts to the test, including theoretical and practical evaluations. Examining both general surgical sciences and applied fundamental scientific knowledge, Part A of the MRCS was a two-part written test that uses Extended Matching Items and Single Best-answer questions. Patient symptoms, medical history, and diagnostic data (such as findings from imaging and blood tests) form the basis of these questions, which were based on clinical case scenarios. After this, a scenario-related lead-in question was posed. The topics of topographical, surgical, developmental, and imaging anatomy make up one-third of the paper, out of forty to fifty questions. The content of Part B, the Objective Structured Clinical Examination (OSCE), combines theoretical understanding of surgery with practical experience in the operating room. This was accomplished by using a set of workstations that mirror various aspects of routine healthcare procedures (Ikonne, 2018). With the use of cadaveric specimens and/or radiological images, each timed self-contained station asks questions on topographical, applied, and surgical anatomy. A total of three or four stations assess participants' practical anatomical knowledge in Part B. Anatomical knowledge was tested at these stations using medical photographs, bones, and protection. Recent research has favored methods that make it easier for students to apply what they've learnt in practical anatomy exams for both undergraduates and graduates. Common frameworks for such evaluations include Bloom's taxonomy or Miller's pyramid. Contextual information, in the form of clinical case scenarios, might theoretically raise the knowledge assessment level from "knows" to "knows how" according to Miller's pyramid and aim for level 3 according to modified Bloom's Taxonomy. Evidence suggests that contextual clinical information might be useful in assessing higher-level cognitive abilities, knowledge application, problem-solving capacity, and critical thinking. Assessment in a clinical setting improves the development and use of anatomical knowledge, according to Molyneux and Robson. From first to fourth year MBBS students took an online test that included both conventional spotter-type questions and newer ones based on functional and clinical images. Students (n=96) and clinical teachers (n=23) gave a resoundingly favourable reaction, meaning they enjoyed clinically orientated anatomy questions, according to quantitative and qualitative data. Because they were more realistic, clinically orientated enquiries were better stimuli, and this finding lends credence to that idea. The previous spotting examinations solely tested identification, and multiple-choice questions (MCQs) failed to capture the three-dimensionality and practicality of clinical anatomy, which meant they could not represent the curriculum's case-based, spiral, integrated character (Derazin, 2018).

### PURPOSE OF THE RESEARCH

This research aims to examine medical students' comprehension of applied anatomy and the impact of visual aids on their ability to grasp and remember anatomical principles. The purpose of this research was to find ways to help students go from studying medicine in the classroom to practising it by looking at how visual aids affect their readiness for clinical practice. At the end of the day, the results was show teachers how to make the most of their medical school's resources and instructional methods.

### LITERATURE REVIEW

To start, the researcher went back over all the books and articles he had read for my classes and for my institutional-focused study (IFS). In order to get additional information, they used search engines and databases such as Google, Google Scholar, Medline, and Educational Resources Information Centre (ERIC). Educational and anatomical evaluation, formative assessment, visuals in assessment, assessment psychometrics, online and practical anatomy exams, and visuals in applied anatomy exams were some of the keywords utilised (Harris, 2020). At a later point in time, the researcher came across works that discussed cognitive theories of multimedia learning and the cognitive psychology of pictures. The researcher aimed to find out what factors students thought were important in anatomy classes and what they wanted out of their anatomy education in order to shape the questionnaire. The researcher used a snowball method to learn the ins and outs of the field after identifying a few important players; these search engines were still very useful, however. Connecting the dots between visuals' function, anatomical evaluations, and the educational psychology of visuals was a challenging and time-consuming process. Anatomy and other medical education disciplines make up the evaluation system, which they was quickly describe in this chapter. The next step was to analyse the student's exam scores by channelling their thoughts via theories of visual aids in educational psychology and anatomy. Because it evaluates students' knowledge and skills, helps shape their learning habits for the future, and provides insight into how well educational institutions were doing, assessment was a crucial part of every curriculum. There were two main types of evaluations: formative and summative (Diaz, 2019). The main differences between formative and summative assessments were that the former was on developing learners' autonomy and capacity for sustained learning via the provision of constructive feedback while the latter was more concerned with accountability and certification. My definition of the term "competence" was something I'd want to clarify before they continue. The six areas of competence and methods for evaluating them were outlined by the Accreditation Council for Graduate Medical Education. These areas include: systems-based practice, medical knowledge, interpersonal and communication skills, competence in learning and improvement through practice, professionalism, and patient care .

Anatomical competence, in my view, was a subset of medical knowledge competence; more specifically, they agree with the definition of anatomy competence, which was the capacity to manage a task by combining the appropriate cognitive, psychomotor, and emotional abilities. The "knowledge/content dimension" and the "cognitive process/progress dimension" were two ways in which assessments often evaluate psychomotor, affective, and cognitive domains. Metacognitive domains, conceptual understanding, knowledge of techniques and processes, and anatomical language and facts make up the content dimension in anatomy. The ability to organise, compare, translate, interpret, and apply new information was the "progress dimension" that shows how well they grasp facts and concepts. An online assessment was being used in this project to evaluate both the content and progress components of applied anatomy knowledge. It was more common in medical practice to see evaluation programs holistically rather than as individual assessments (Volk, 2019).

### RESEARCH QUESTION

What impact can visual aids have on medical students' understanding of applied anatomy and readiness for entering the field of medicine?

### 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, we 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 prosections, 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**

Using the same students for both the control and test groups increased the group's internal validity. Unlike traditional randomised controlled trials, this one does not use an intervention to separate the experimental and control groups. In this case, I divided them into three groups: controls, test 1 (which included questions with anatomical pictures), and test 2 (which included questions with radiological images). Because of the potential for group bias, this was done. The following are the parts listed in the literature:

Changes in the learners' surroundings that are not directly related to the inquiry are referred to as history. "Testing" means the modifications that happen due to experience and practice. "Instrumentation" means the shift in measurements from one test to another. Regression relies on experimental groups that are not typical.

Mortality is defined as the rate at which research participants discontinue participation. The term "maturation" describes the process by which pupils progress, evolve, and improve. Initial distinctions between groups before they are involved in the inquiry are referred to as selection. When groups have a propensity to drift apart as they mature, this is called selection by maturation interaction.

- The question of whether A causes B or B causes A is vaguely related to the actual association.

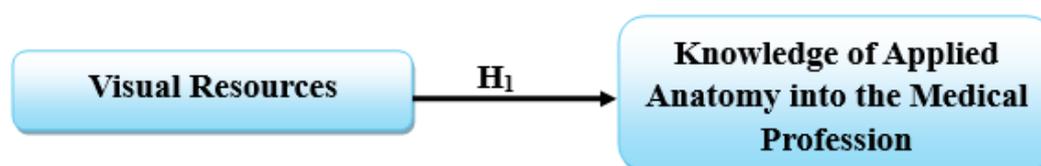
When parts of a therapy that were meant for the test group wind up in the control group, it's called diffusion of therapies. Organisational pressures might arise if one group is given particular care, which is why compensatory equalisation of treatments is necessary. "Compensatory rivalry" is implementing changes inside a company to stay competitive. The "history" and "testing" factors still offer a risk, even if the research used the same students to assess their performance. Due to the study's

reliance on a single quasi-experimental design, all potential confounds such as "instrumentation," "mortality," "diffusion of treatments," "compensatory equalisation of treatments," and "compensatory rivalry" have been removed. According to popular belief, the "Regression" group consisted of pupils with varying degrees of skill. Regarding the "maturation" part, it's possible that people's growth differed based on their background and activities. The medical schools were chosen for the "selection" part according to the visual aids used in their academic anatomy courses. The anatomy webpages and pertinent contacts of each medical school are combed through for this purpose.

### PROCEDURE

Research for the "Anatomical Man" initiatives included both sexes. The average runtime for these anatomical BP studies was 18-24 hours, and they were usually executed overnight. Accurate findings were obtained by strictly adhering to the BP method. Anatomical atlases and photographs were used to precisely landmark the models first. The muscles, bones, organs, blood arteries, and nerves were precisely delineated with black whiteboard markers during the landmarking process. Because it made the stencil for the second phase, this step was crucial. This first stage of landmarking might take as long as eight or ten hours to complete in certain projects. Painting and shading made up the second stage of any project. Every BP project required the use of high-quality paint and body paints because of the durability and resistance to cracking of the final result. A variety of paintbrushes and cosmetic brushes were also used for this purpose. The student painters were guided by anatomical illustrations found in books like Netter's Atlas of Human Anatomy. An aspiring photographer captured high-quality images to supplement the paintings, publish them, and utilise them in promotional materials after the painting stage.

### CONCEPTUAL FRAMEWORK



### RESULTS

The independence of the data points is assumed in parametric tests that are based on the normal distribution. Here, however, data on students' performance on various question kinds has come from the same set of students, hence a repeated measure design was used. Accordingly, information about results from various sorts of questions would be connected. I reasoned that because the degree of reliance across groups is almost equal, it's reasonable to suppose that the connection between pairs of performance on various question types may be comparable as well. The idea that this object is spherical describes it. When these variances, which are the differences between any two scores in any given combination, are almost identical, we say that the distribution is spherical. When two of the three treatments' variances are comparable, we say that the data exhibit local circularity (also called local sphericity).

Following is a list of all sixteen of the extracurricular BP projects: Neurovascular Man (half nervous system, half cardiovascular system), Multi-colored Man (muscles in multiple colours; three projects), Process Man (four quadrants to depict the process of blood pressure), Anatomical Man (four projects involving muscles), Skeletal Man (two projects involving bones), Anatomical Woman (two projects involving muscles), Pregnant Woman (a pregnant woman painted once a month until birth), and Systems Man (visceral anatomy, organs). Within 24 hours, the majority of tasks were finished; land marking took around 8 to 10 hours and painting took roughly 12 to 14 hours. We had several visitors from various departments and programs, including anatomy, as well as the dean of medicine, the head of school, and the deputy vice chancellor, all of whom were invited to see the procedure. In order to keep the staff motivated throughout the long hours of the projects, these visits were vital. In addition, 87.1% of participants said that BP was relevant to their class discussions, 93.6% said that it was relevant to their level of achievement, and 80.7-87.1% said it was relevant to their career. Among the many benefits that students gained by taking part in the BP projects was an improvement in both their short-term and long-term recall of human anatomy (93.3%). The students' remarks are paraphrased, and they were quite favorable of the experience.



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

Since there are just two independent variables in the dependent variable (question difficulty level), Mauchly's sphericity test does not hold. A very high effect size (partial Eta Squared =.642) was shown by tests of within-subjects effects and contrasts, which demonstrated a significant difference in question difficulty ( $F(1, 172) = 308.88, p < .001$ ). Students who performed well and those who did not vary significantly ( $F(1, 172) = 320.44, p < .001$ ), with a partial eta squared value of .651 indicating a very large effect size). The correlation between question difficulty and low-high-performing student groups, however, did not reach statistical significance. Figure 12 displays the question difficulty levels: 1 for 56 and below and 2 for 56 and above.

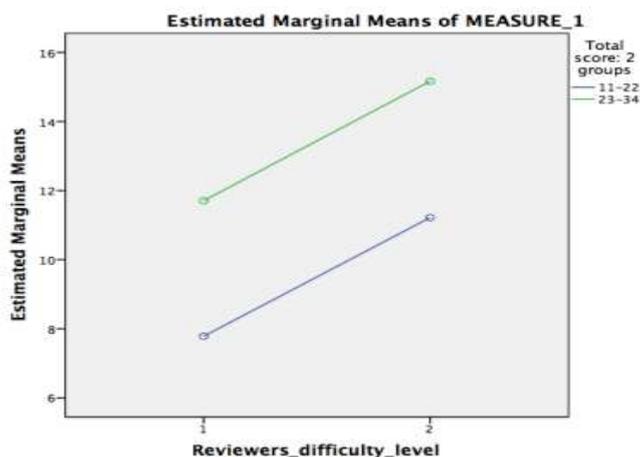


Figure 2. High and low performers' scores on easy and difficult questions

## DISCUSSION

An evaluation of medical students' applied anatomy knowledge reveals the critical need of good teaching methods, especially visual aids, in training the next generation of doctors and nurses. Knowing how these tools affect learning outcomes was crucial in medical education because of the growing use of technology and novel teaching approaches. Anatomical models, computer simulations, and interactive infographics all help students better understand complicated anatomy via visual aids. Students may better understand the interconnections between buildings with the use of these tools, which have been shown to improve spatial awareness and memorisation. Having a solid grasp of both theoretical concepts and how to apply them in real-world clinical settings requires this enhanced comprehension. In addition, there were several obstacles that medical students must overcome as they

go from classroom instruction to actual patient care. Teachers may help their students learn more practical skills, such how to read diagnostic pictures and conduct surgical operations, by using visual aids in the classroom. A critical thinker and problem solver, essential for good patient care, must be able to make connections between anatomical diagrams and real-world clinical situations. Also, different people have different learning styles, so visual aids may work better for some than others. While some students may do better with more modern forms of instruction, others may do better with more conventional methods. This variety highlights the need for a wide variety of materials to meet the needs of students with varying learning styles. Medical educators may benefit from this study's results by learning more about the importance of using visual resources in their lessons. Institutions may improve their teaching approaches by acknowledging the favourable influence these tools have on information retention and practical application. This was better prepare students for the demands of the medical field and improve patient outcomes.

### CONCLUSION

This research emphasises the vital role that visual aids have in medical students' learning and clinical readiness, and it stresses the fundamental necessity of students' understanding of applied anatomy. Students' grasp of intricate anatomical ideas may be substantially improved with the use of modern teaching methods like digital simulations, interactive graphics, and 3D models as the medical industry progresses. According to the research, visual aids help students not only remember and understand anatomy, but also develop crucial abilities that make entering the medical field easier. In order to assist students acquire the critical thinking and problem-solving skills needed for good patient care, these tools help bridge the gap between theoretical knowledge and practical application. To better engage students and cater to their individual learning styles, medical educators should make the use of a variety of visual tools a top priority in their lessons. Taking this route has the potential to produce doctors and nurses who were more self-assured and capable, who was be better able to handle the demands of contemporary medicine and provide better care to their patients. The results of this study provide the groundwork for investigations on the best ways to teach future doctors.

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