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Original Research Article

Analysing the Effect of Incorporating Images While Framing MCQs For Online Clinical Anatomy Assessment Among First Year Medical Students

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ABSTRACT

The disruptions caused by COVID-19 pandemic has significantly affected the assessment component of the undergraduate medical curriculum. The lack of physical ascertainment of the learning outcomes has forced the medical educators across the world to adopt online modes of assessment. Though multiple options like true / false, short answers and viva were available, the most common tool for many was multiple choice questions as they could be arranged according to the cognitive hierarchy of Miller's pyramid. The present study was undertaken to analyze the effect of incorporating images while framing MCQs for online anatomy assessment among first year medical students. The study was planned in a quasi-controlled design where a batch of 150 students were subjected to a set of 40 multiple choice questions (20 text based and 20 image based MCQs). The questions were designed following Ebel and Frisbie guidelines of MCQs and validated by three investigators independently. Three cycles of assessments were conducted, and the scores were analyzed. At the end of 3 cycles of assessment feedback was taken from the students regarding this method of assessment. The performance of students was better in image based MCQs compared to traditional MCQs in all regions. Upon documenting the percipience, students had felt that image based MCQs were interesting, improved their clinical reasoning skills, lateral thinking abilities and quest for learning applied anatomy. Thus, we postulate that image based MCQs could be considered as better assessment tool in the era of online learning

KEYWORDS: Assessment, Clinical anatomy, Image based assessment, MCQs, Online learning.

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INTRODUCTION

Anatomy remains as one of the core subjects in medical curriculum and the corner stone of basic sciences. The present generation doctors require a different knowledge of anatomy when compared to previous generations due to the development of interventional disciplines as the modality of treatment [1].

The COVID 19 pandemic has had a huge impact on the economic, social, and educational sectors worldwide with a swift change in medical education to distance learning. The whole world resorted to online mode of learning and assessment [2]. Virtual learning or E learning seems to be the only sustainable option during this pandemic but learning anatomy in this mode is quiet challenging as it requires 3-dimensional perception and students' engagement [3].

In any subject, students will benefit from the multimedia instructions if they fall in line with the cognitive theory of multimedia learning where learners process the information through separate auditory, verbal and visual pictorial channel [4]. Traditionally anatomical teaching has always relied on multiple techniques like lectures, dissection and some institutions provide a blended approach like dissection videos, recorded lectures to impart the knowledge to the students [5].

During this pandemic, the assessment component has been significantly compromised and institutes were left only with the option of conducting it online. There are various types of online assessment which can be used to check the knowledge and skills like assignments, assessment portfolios, multiple choice questions using goggle forms, open book exams and objectively structured practical/ clinical examinations and online viva examinations. Online assessments are less used because of issues of validity, reliability, and dishonesty. For robustness and integrity, an assessment needs to be valid, reliable, acceptable, and fair [2].

Similarly, the cognitive domain of an assessment has knowledge content dimension and cognitive progress dimension. In anatomy, the content dimension includes terminologies, facts, concepts, and procedural knowledge. The progress dimension demonstrates understanding of facts, ideas, and images by organising, comparing, interpreting, and applying the knowledge gained [6].

Images play a very important role in learning anatomy as it helps in retention of concepts for longer period, enables visualisation and improves the spatial ability. Images possess both perceptual surface structure and deep semantic structure. The surface structure of an image includes lines, dots, areas, and their visual features whereas as deep structure of an image is its semantic construct which expresses its meaning. Understanding images is a matter of complex interactions between several factors like perceptual surface structures, deep semantic structures and association and inference with cognitive schema [7]. The role and impact of images in the assessment component remains ambiguous. It is complex in anatomy as the traditional process of learning anatomy is from images supported by text which requires pre-existing knowledge to interpret [8].

Prior studies have investigated the responses to different types of images in medical assessment. These include extended matching questions with labelled images and textual material, spotter test with cadaveric specimens versus online resources, MCQs with cadaveric and textual material, MCQs with simplistic diagram and histology images. But these studies were lacking in terms of documenting the percipience of students as they have only focused on factual identification of the questions [9].

In the online assessment, multiple choice Questions are conventionally being used since they test the higher order category in the Miller's pyramid. With the advent of multimedia learning MCQs are commonly used for various competitive exams. Although the visual resources are preferred in anatomy its role on the effects of the performance of clinically oriented anatomy questions with and without images is inconclusive. Hence this present study is undertaken to study the effect of incorporating images while framing MCQs for online clinical anatomy assessment

among 1st year medical students.

METHODOLOGY

The present study is a quasi-controlled study where the students are exposed to text only questions and image-based questions in 3 regions of anatomy and their mean scores are compared in both the type of questions.

Settings and participants: The study design was approved by the Institute Research and Ethics committee (**ethics approval number: IEC: RC 2020/66**). All the 150 first year medical students at Pondicherry Institute of Medical Sciences who were about to give their final exams were invited to participate in the study on voluntary basis. The students were briefed about the study design, its objectives and were recruited for the study after obtaining written consent.

Design: All the participants had to undergo 3 online assessments in the following regions:

a. Extremities (upper and lower limbs)

b. Torso (Thorax, abdomen, and pelvis)

c. Head and neck including Neuroanatomy

Preparation of questions: The questions were prepared by using Ebel and Frisbie (10) guidelines with the same level of difficulty by the investigators and assessment was done by another faculty who was not a part of the study. Each assessment consisted of 40 multiple choice questions (MCQs) out of which 20 were text based and 20 were image-based questions (gross anatomy or radiologic). Text and image-based questions were related to the same structure but with different questions and same level of difficulty. Fig.1 shows few sample questions used in the study. The questions were randomly sorted up so that each participant had to attend all 40 questions within 1 hour.

Assessment: All assessment were conducted through google forms and the students were asked to give their genuine response without referring to the textbooks. After the end of assessment, the mean score of the participants in text based and image-based questions were analysed. At the end of final assessment students were given a feedback questionnaire on the new mode of image-based assessment and were asked to give their reflections in a 5-point LIKERT scale as quantitative feedback along with two open ended questions for qualitative feedback

A. A 52 years old male came with complaints of diplopia (double vision) on seeing the objects. On examination the clinical findings were as shown in the picture. What may be the probable abnormality? Which muscles are responsible for this position of affected eye?

A. Trochlear nerve paralysis, lateral rectus & inferior oblique
B. Oculomotor nerve paralysis, lateral rectus & superior oblique
C. Trochlear nerve paralysis, inferior rectus & lateral rectus
D. Abducent nerve paralysis, inferior rectus & superior oblique

B. A 45 years old male with road traffic accident was brought to the casualty. He was conscious. On examination, his right eye was nasally deviated and he complained of double vision on seeing right side. Name the probable nerve damaged and muscle paralysed related to his eye findings.

A. Right superior rectus, oculomotor nerve
B. Right inferior rectus, oculomotor nerve
C. Right lateral rectus, abducent nerve
D. Right superior oblique, trochlear nerve

C. A 35 years old woman was having complaints of severe pain in the left lumbar region which was radiating to the groin. The pain was colicky in nature. The patient had difficulty in passage of urine which relieved after taking medications. The patient was advised to take plain X-Ray KUB which is shown below.
What is the probable condition?
Why does the pain radiate to groin in this patient?

A. Renal calculus, referred pain via T12-L1
B. Ureteric calculus, referred pain via L1-L2
C. Psoas abscess, referred pain via S2-S4
D. Renal calculus, referred pain via L1-L2

Fig. 1: Sample questions used in the study material. A-gross anatomical image-based question; b-text only question; c-radiological image-based question.

RESULTS

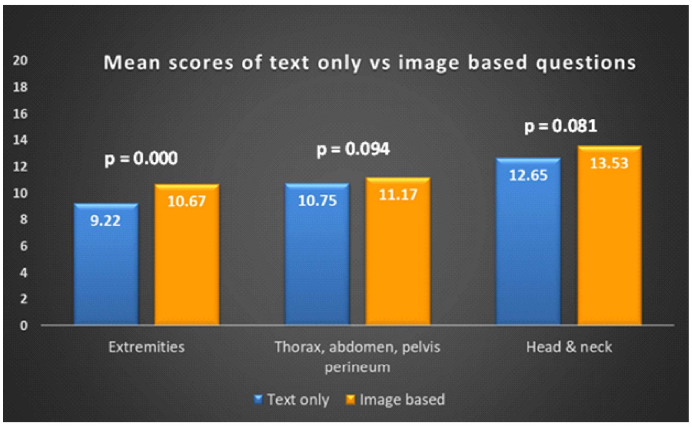

Fig. 2: Mean scores comparison of text only vs image-based questions.

Table 1: Mean score comparison between gross anatomical image-based and radiologic image-based questions.

Region	Type of image-based questions	Mean score	p value
Extremities	Gross image based	5.54	0.174
	Radiologic image based	5.13	
Thorax, abdomen, pelvis and perineum	Gross image based	6.34	0
	Radiologic image based	4.83	

Table 2: Quantitative feedback on the image-based MCQS

Questions	Students' response (in percentage)				
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Image based MCQS were innovative and interesting compared to traditional MCQs	2	0	3	28	67
This method of assessment improved my clinical reasoning and diagnostic skills	5	0	2	35	58
This method of assessment improved my lateral thinking	5	0	2	37	56
This method of assessment helps to retain the concepts of anatomy for longer periods	2	5	0	30	63
I am confident that if I come across this case in my clinical posting, I will be able to diagnose immediately	2	5	5	44	44

Table 3: Qualitative feedback of students.

What did you like about this method of assessment?
• *Pictorial representation helps in deeper understanding of the subject and learning*
• *Pictorial questions help us to think laterally and correlate the clinical aspects with basic sciences*
• *Pictorial memory of a question is very helpful for recall during examination*
• *Pictorial questions enable me easy understanding of concepts*
• *Gives me the confidence that I read clinical anatomy which may help me in diagnosis of disease*
• *Pictorial questions help me in clinical reasoning*
• *Good, innovative, and informative*
• *Helps to recollect facts in anatomy*
Give any 2 suggestions for improving the assessment method
• *To be done on a regular basis at the end of each region to help students to retain important*
• *Answer keys to be shared for self-assessment*
• *To include more radiology-based questions*
• *To be integrated with other 1 st year subjects like physiology and biochemistry*
• *Regular explanations to the answers will be useful*
• *To include more of image-based questions*

Out of 150 first year students, only 80 students have participated in the study. Their mean scores in text only and image-based questions were compared as shown in Figure 2. The mean score was high in the image based MCQS when compared to the text only questions. The p value was statistically significant only in one region (extremities p<0.0001). So, the students performed better in image-based questions rather than the text alone questions.

Table 1 shows the mean scores and p value of the students in gross anatomical image based and radiologic image-based questions. The mean score was high in gross anatomical image-based questions, and it was statistically significant only in thorax and abdomen region.

Quantitative feedback of students on the newer method of assessment was analysed and tabulated in Table.2. Most of the students agreed and strongly agreed to various aspects of the image-based questions like it improved their clinical reasoning, diagnostic skills, and lateral thinking. This method helped them to retain the concepts for a longer period and they were confident that if they come across this case in their clinical postings, they would be able to diagnose it.

Qualitative feedback collected from the students were analysed and the responses were tabulated based on the frequency of the responses and is shown in table 3.

DISCUSSION

Usually, anatomy assessments are designed for the undergraduates in such a way that it tests their knowledge with or without the inclusion of visual resources like cadaveric specimens or images, radiologic images, or clinical photographs. The evidence of the influence of images within the assessment is limited. The present study documents the influence of incorporating images while framing MCQS for online clinical anatomy assessment among 1st year medical students.

Sagoo et.al investigated the impact of including images on clinically oriented single best answers among 2nd year medical students among 6 schools in the United Kingdom and found that the students scored significantly better on questions with images when compared to questions without images (p< 0.001),on questions referring to bones than soft tissues(p<0.001) [9]. This was similar to our study where the mean scores were higher in image based MCQs when compared to the textual MCQs and in the region of limbs it was significant (p = 0.001). *Mayer et.al* cognitive theory of multimedia learning suggests that students learn more deeply from combination of words and pictures than from words alone since he proposes that there are 2 separate channels like auditory and visual for processing the information [11]. *Carney et.al* proposes that the images simplify the accompanying text and pictorial illustrations improves the students learning from the text [12]. *Vorstenbosch et.al* (2013) demonstrated that students felt image-based questions easier than the text-based questions [13] which was similar to our study where the students received it well and felt that image-based questions were easier and to include this at the end of all the regions to retain important concepts in mind.

The response format for selecting correct answers from labelled images and answer list varies. Images contain more information than answer lists. An answer list contains structure names only while an image displays structures, spatial relations and orientations offering more cues to the students. The anatomical names in the answer list holds cues which is missing in the images. In the present study also, students felt that the image based MCQs helped them in depth understanding of the subject and pictorial representation helped them in clinical reasoning and easy recall during the examinations.

The task of answering a test item is a complex retrieval process. *Vorstenbosch et.al* in his study stated that the item difficulty and item discrimination of questions can be affected when images are used instead of answer lists thus use of images as a response format may affect the validity of the test items [14].

On the other hand, *Holland et.al (2015)* showed that addition of images in undergraduate histology multiple choice questions had no

influence on item difficulty or item discrimination but in the present study students' performance was better in image based questions in 3 regions implies that students were able to interpret these images successfully based on their pre-existing knowledge and exposure to these image during learning [15].

The type of images utilised, either anatomical or radiological had no significant influence on the students mean scores in the work carried by *Sagoo et.al and Inuwa et.al* where the questions were based on immediate recall of anatomical knowledge [9,16].

However, in the present study the type of image played a major role where the students performed well in radiologic image-based questions when compared to gross image-based questions in thorax, abdomen, pelvis and perineum ($p = 0.000$). This is very important as X rays are commonly taken to interpret any clinical conditions related to thorax.

Khalil et.al evaluated the student's achievement scores between computer based interactive imagery and paper-based imagery strategies where they found no significant difference in the mean scores of both the method [17]. However, students felt that computer based interactive strategy as a better strategy in the assimilation of information than the paper-based strategy.

Some authors suggest that the question subtypes and deep structure (bones and soft tissues) showed a significant difference in the students score. They attributed this to the inability of the students to process more layers of information to answer image questions based on soft tissue rather than on bones.

The authors felt that anatomical and radiologic images focus on discrete body regions of the entire body. To identify this small part from the whole body and to identify the images with different densities requires multiple cognitive process and thereby it is essential to take the perceptual and deep semantic structure of the image into consideration.

On qualitative analysis of the students' perception, they received the image based MCQs well and felt that this image based MCQs helps in the deeper understanding of concepts, helps them to think laterally and clinical reasoning during their basic sciences. It was similar to Khalili et.al who felt that image based interactive strategy was very useful for them in assimilating the information rather than paper-based strategy which test only their recall phenomenon.

Students also preferred that such assessments on clinical anatomy to be conducted every month. This highlights the importance of assessments in the knows how category of Miller's pyramid and knowledge in modified Bloom's Taxonomy. For some the image based MCQs helped them to visualise the case scenario and develop confidence that it will help him in diagnosis of cases during their clinical years.

There is a transformation of cognition while interpreting anatomical images which requires transition of making sense of 3-dimensional structure in 2 dimensional images. The students' performance on clinically oriented anatomy depends on intricate network of factors like perceptual surface structure, deep semantic structure, orchestration between the existing schemas with external representation and item difficulty.

CONCLUSION

Based on the study, we conclude that images have an impact on the students' performance in applied anatomy online assessments and students also valued the inclusion of images and clinical information in their assessment. Owing to the recently implemented competency-based curriculum, the entire focus is on training the students more towards the skills so that they become competent practitioners. We put forth that the medical educators should take this into consideration while designing the assessment and curriculum.

Conflicts of Interests: The authors declare that they have no competing interests

Author Contributions

Magi Murugan – Concept & design, literature search, data interpretation, manuscript preparation
Jayagandhi S – Data acquisition

Dinesh Kumar V – Concept & design, intellectual input, manuscript editing, approval of final version
Rajprasath R – Concept & design, data acquisition, analysis, manuscript editing
Bhavani Prasad G – Data acquisition
Rema Devi – Intellectual input

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