QUESTION-BASED LEARNING (QBL): AN INNOVATIVE APPROACH TO TEACHING CLINICAL ANATOMY IN MEDICAL EDUCATION

Omid IRAVANI
Department of Anatomy

Introduction

Anatomy is one of the most important subjects in medical education. In many schools, learning anatomy is mandatory for medical students (Older, 2004). Students gain basic knowledge of the human structure by learning anatomy and correlating it with various clinical conditions (Bay & Ling, 2007). At the National University of Singapore (NUS), the anatomical sciences, comprising gross anatomy, histology and embryology, are taught at the Yong Loo Lin School of Medicine's Department of Anatomy. The medical students there benefit from a variety of teaching methods such as lectures, practical sessions and tutorial classes.

Overview of the Anatomy Curriculum

Currently, the School teaches anatomy to first-year medical students through a three-step process. First, students learn the basics of human anatomy during a two-hour lecture, where they become acquainted with each anatomical region and the basic theoretical concepts which focus on the structure of the body for that specific region. The lectures help them gain a quick yet comprehensive introduction to the subject by providing a "guideline map" of the human body.

The second step involves students receiving hands-on training during the practical sessions, during which they have to identify the human structures on prosected (ready to examine) cadavers. The sessions are valuable opportunities for students to apply the knowledge they have acquired during the lectures on human specimens (also known as "silent mentors"). Working on a real-time simulation of the human body is beneficial to students and enhances their knowledge of anatomy. During the practical sessions,

students are also trained in chest and abdomen ultrasonography by the clinical anatomist, skills they need to cultivate in order to correlate the internal structures with surface landmarks.

The final step involves reinforcing the knowledge acquired. This is done during the tutorials where students discuss what they have learnt with their peers and tutors. At this point, they may still be unclear about certain structures, relationships and their clinical significance. The tutorials are where students get to fill in any gaps in their knowledge and clarify ambiguities they might have about the course content through active interaction with each other and their tutors. More importantly, these sessions help them integrate basic anatomical knowledge with clinical applications, and serve as a guide in helping them determine what they need to know when it comes to applied anatomy and clinical scenarios. For example, when teaching students about the lymphatic drainage of the tongue, they were first shown a few clinical figures illustrating patients with metastasis of tongue carcinomas. A discussion about potential lymphatic drainage routes would follow. Such discussions give students a better sense of how they can apply basic anatomical concepts (in this case, lymphatic drainage of the tongue) to a clinical scenario.

Current Approaches to Teaching Anatomy

According to the literature, several methods have been used. They range from traditional lectures to interactive methods such as case-based, problem-based, and team-based learning (Turney, 2007; Ganguly, 2010). Each method has its advantages and disadvantages. For example, while lectures are effective when it comes to disseminating information to a large number of students within a limited time, they tend to become passive recipients of the course content. Meanwhile, more interactive methods such as problem-based learning are effective in engaging small groups of students, even if they can be more time-consuming compared to conducting lectures.

What then is the best method to teach anatomy? It would seem that there is no single ideal method and a combination of various interactive models comprising active directed discussions and demonstrations using teaching aids might be preferable (Davis *et al*., 2014).

Applying Question-based Learning (QBL) to the Tutorials

To fulfil the curriculum's learning outcomes more effectively, we introduced question-based learning (QBL) into the tutorials. In QBL, the lecturer designs objective-oriented questions which students discuss in a systematic manner during their respective tutorial sessions. Such questions would help students navigate the vast amounts of anatomical information in the curriculum. QBL is based on aspects of inquiry-based learning, which Virginia S. Lee and her colleagues define as "a range of strategies used to promote learning through students' active and increasingly independent investigation of questions, problems and issues, often for which there is no single answer" (Lee *et al.*, 2004, p. 6). According to Feletti (1993), as cited by Lauren M. Antsey and her colleagues, it is an interdisciplinary approach to learning that "fosters problem-solving and critical thinking, and requires that students assume a greater degree of responsibility as they guide and manage their own learning" (Antsey *et al.*, 2014, p. 64).

Questioning is a typical form of formative assessment ("Assessment for Learning"), and is "one of the most common methods of checking learner understanding" (Jones, 2005, p. 10). A set of well-constructed questions can help students organise their thoughts and highlight parts of the curriculum content that they do not know or might require further clarification. For the lecturer and tutors, such questions are not only useful in helping to evaluate their students' progress and levels of understanding, but it is also

a useful in giving immediate feedback to students about their learning. In fact, well-designed questions and guided discussions can help the lecturer and tutors create "an inquiry-based learning environment in which students are confident about approaching their inquiry, that they can find things out for themselves through the use of appropriate questioning and provision of support materials to discover their own path" (McKinney, 2010, p. 23). Such an approach would help first-year medical students feel more confident about deciding what is clinically essential as they sift through the anatomical information presented in the curriculum.

Methodology

QBL was developed for the first year medical students' tutorial groups in Academic Year 2014/15. During this period, three tutorial groups were taught using QBL, with an average number of 18-21 students in each group. The QBL process was set up as follows:

Step 1: Designing objective-oriented questions

This was one of the most important steps in QBL, in which the lecturer had to design questions based on the tutorial objectives provided under the School's curriculum. Students were first presented with a fascinating clinical condition in form of a simple figure of a normal or abnormal manifestation, X-ray or sound. The students were not involved in the diagnosis of any disease. They were then asked if they could see any abnormality in the figure, X-ray etc. Once the students' attentions were on the clinical scenario, the lecturer asked them about the relevant normal structures which might be affected by the particular disease condition. The author coined the term "clinification" to describe this process of teaching basic science under the shadow of clinical conditions.

Step 2: Pre-tutorial test

Students were given a list of 10 statements in a pre-tutorial test sheet called "Assessment for Learning". The statements were designed based on the principles of good feedback practice outlined by Nicol and Macfarlane-Dick (2006). The students had to indicate whether the pre-tutorial statements were "True" or "False" on the test sheet. As an example, the students were give the following statement regarding the motor innervation of the tongue: "In unilateral damage of hypoglossal nerve, the tongue deviates toward the lesion."

Getting students to attempt the test sheet before the tutorial was beneficial to their learning in a few ways. Firstly, the statements provided high quality objective-oriented information which helped students to proactively consider the learning point and discuss it with their peers. Secondly, attempting these test sheets before the tutorial (and repeating the test post-tutorial) helped them assess their own understanding of the course content and provided a form of "self-feedback" on their learning. They could track their own progress and clarify any ambiguities they might have had about important learning points. For the lecturer and tutors, the results of the pre- and post-tutorial tests provided a valuable source of feedback to evaluate the students' learning and the teaching atmosphere.

Step 3: Brainstorming amongst the class

This was followed by a session of brainstorming for the entire class. Each student had to present a simple term or structure learnt from the lectures and practical sessions they attended in the beginning of the week. This part of the tutorial was a good opportunity for students to share their knowledge and clarify any doubts they had about the topic covered.

Step 4: Students form discussion groups

Following the brainstorming session, the class was divided into discussion groups. Students were randomly assigned groups according to the name list (2-3 students per group). The groups were given pre-designed topics and allowed to discuss their respective topics for 5-10 minutes. The pre-designed topics consisted of objective-oriented questions which helped guide the students from a general to more specific concepts. For instance, when the students were supposed to learn about circulation and reabsorption of the cerebrospinal fluid (CSF), they were shown CT[1] images of a normal and a hydrocephalus[2] brain. First, they had to indicate which CT image was the normal brain. Next, they had to pinpoint the observed abnormality (with or without assistance). Once they understood that one or more brain ventricles were abnormally dilated, they had to point out the potential causes of the hydrocephalus. At this juncture, the groups had to discuss the routes of CSF flow in the central nervous system.

Step 5: Group presentations

Based on the pre-designed sets of questions, each group had to present their answers within a limited time. The other groups were able to openly interact with the presenting group and ask questions. At the end of each presentation, the presenting group gave a summary of their own topic. In case the presenting group was not able to answer the questions, the members would interact with the other groups and discuss the questions as a class. The lecturer and tutors were on hand to facilitate these discussions and address any ambiguities about the topic.

Step 6: Post-tutorial test and feedback

In this step, students had to re-read the statements they received at the start of the tutorial and indicate in the post-tutorial test sheets if these statements were "True" or "False". In this step, the students were expected to imbibe important learning points from the statements. After that, they had to complete an anonymous questionnaire in which they gave anonymous feedback about QBL and whether the teaching methods implemented made an impact on their learning of anatomy (*See Table 1).*

They were also asked to write down any questions or doubts they might have about any of the topics covered. Once this was done, the tutor collected the questionnaires for analysis.

Step 7: Concluding discussions for the tutorial

The tutorial session concluded with a discussion about the correct answers for the pre- and post-tutorial statements.

Step 8: Discussion on the questionnaire results

This was done at the beginning of the next tutorial, where the lecturer discussed the results of the questionnaire with the tutorial group. This included addressing the feedback students gave (both negative and positive) and any clarifications they needed regarding the tutorial content.

Question	1	2	3	4	5
- How much did you learn from the tutorial sessions?	Nothing	A bit	Something	Much	Very much
- How did you like the QBL?	Really disliked	Disliked	No idea	Enjoyed	Really enjoyed
- How often do you use your tutorial notes?	Never	Rarely	Sometimes	Often	Always
- How do you rate your interactions in the tutorial sessions?	Zero	Weak	Moderate	Interactive	Very interactive
- Do you agree that QBL made you more interactive than before?	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
- How did you like "Assessment for Learning"?	Useless	Rarely useful	Somewhat useful	Useful	Very useful
- When would you prefer to receive the tutorial notes (slides)?	Before class	After class	-	-	-

Table 1. Sample of the questionnaire that students had to complete.

Statistical Analysis

Paired *t*-test was used to compare the pre- and post-tutorial test results with the correct answers. We performed a correlation analysis to assess the correlation between the pre- and post-tutorial test results with the correct answers. $p < 0.05$ was considered statistically significant.

Results

An analysis of the results showed that students' learning significantly improved after the QBL tutorial sessions. Using paired *t*-test, the results indicate that there was a statistically significant difference between the results of the pre-tutorial tests with the correct answers ($p < 0.039$). Correlation analysis revealed a weak correlation between the results of the pre-tutorial tests with the correct answers ($p < 0.001$, correlation coefficients (CC)=0.502). On the other hand, statistical analysis showed no significant difference between the results of the post-tutorial test with the correct answers ($p=0.059$). There was also a high correlation between the results of the post-tutorial tests with the correct answers ($p < 0.001$, CC=0.920).

An analysis of the questionnaire results revealed that students responded positively to the introduction of QBL during tutorials. The feedback indicated that they had fun during the tutorials and QBL led to improvements in their classroom interactions and overall understanding of anatomy. 100% of the students believed that they learnt "much" and "very much" from the tutorial sessions. 88.9% of the students declared that they really enjoyed the QBL, 5.6% enjoyed the sessions while 5.6% were neutral. Meanwhile, 22.2% of the students indicated that they always used the tutorial notes, 22.2% often used them, while 44.4% and 5.6% indicated that they used the notes "sometimes" and "rarely" respectively. In terms of their level of class interaction, 77.8% of the students evaluated themselves as being "very interactive" and "interactive", 16.7% as "moderately interactive" and 5.6% confessed to being "weak" when it came to class

interactions. In addition, 50% of the students "strongly agreed" that QBL made them more interactive than before, and the rest "agreed" that QBL had a positive effect on them. For "Assessment for Learning", all the students evaluated (100%) found it to be "useful" and "very useful" respectively. Finally, 66.7% of the students preferred to receive the tutorial slides (notes) after the class, while the rest preferred to receive it before class.

Conclusion

An engaging teaching method can connect students to areas of learning in such a way that they may easily solve any questions that arise. In this case, QBL was used effectively to teach anatomy to first-year medical students during their tutorial classes. In these sessions, sets of objective-oriented questions were continuously used to trigger the students' curiosity about the subject. Through these questions and the various QBL activities, they learnt how to apply basic anatomical concepts to clinical conditions. Tackling these questions made the subject interesting and relevant to them. In addition, activities such as the pre- and post-tutorial tests ("Assessment for Learning") ensured that students' attentions were more attuned towards learning important clinical anatomy topics. These activities were also useful in providing the lecturer with invaluable information about their learning. The students also provided feedback which revealed gaps in their knowledge, queries they might harbour about the topic and their level of satisfaction towards the teaching strategies employed by QBL.

So far, this article has highlighted how QBL can make positive contributions to students' learning. However, there are some concerns which should be considered for future iterations of QBL. For example, educators need to consider an optimal strategy when it comes to designing analytical questions which serve as effective guides in helping students navigate the massive amounts of information they have to contend with in the anatomy curriculum. Secondly, due to time constraints this method may be more suitable for small classes (<30). Lastly, running a successful QBL requires good time management since there are several learning activities the class would need to complete during the tutorial. In conclusion, QBL can be easily applied to other subjects in the medical curriculum, although further research is needed to evaluate its effectiveness.

Endnotes

1. A computed tomography (CT) scan refers to an imaging method that uses X-rays to create pictures of cross-sections of the body.

2. Hydrocephalus refers to the build-up of too much cerebrospinal fluid in the brain. (Source: _http://www.nlm.nih.gov/medlineplus/hydrocephalus.html_)

Acknowledgements

References

Anstey, L.M., Michels, A., Szymus, J., Law, W., Ho, E.M.-H., Qu, F., Yeung, R.T.T. & Chow, N. (2014). Reflections as near-peer facilitators of an inquiry project for undergraduate anatomy: Successes and challenges from a term of trial-and-error. *Anatomical Sciences Education, 7*, 64-70.

Bay B.H. & Ling E.A. (2007). Teaching of anatomy in the new millennium. *Singapore Medical Journal Editorial, 48*(3), 182-183.

Davis, C.R., Bates, A.S., Ellis, H. & Roberts, A.M. (2014). Human anatomy: Let the students tell us how to teach. *Anatomical Sciences Education, 7*(4), 262-272.

Feletti, G. (1993). Inquiry-based and problem-based learning: How similar are these approaches to nursing and medical education? *Higher Education Research & Development, 12*(2), 143-156.

Jones, C.A. (2005). *Assessment for Learning.* Learning and Skills Development Agency. Retrieved from *http://dera.ioe.ac.uk/7800/1/AssessmentforLearning.pdf*.

Lee, V.S. (2012). What is inquiry-guided learning? In V.S. Lee (Ed.), *Inquiry-Guided Learning.* New Directions for Teaching and Learning, no. 129, (pp. 5-14). San Francisco, CA: Jossey-Bass.

McKinney, P. (2010). Inquiry-based learning and information literacy: A meta-analytical study. CILASS (Centre for Inquiry-based Learning in the Arts and Social Sciences), University of Sheffield. Retrieved from *http://www.sheffield.ac.uk/polopoly_fs/1.122797!/file/IL_meta-analysis_PM-FINAL.pdf*.

Nicol, D.J. & Macfarlane-Dick, D. (2006). Formative assessment and self-regulated learning: A model and seven principles of good feedback practice. *Studies in Higher Education, 31*(2), 199-218.

Older, J. (2004). Anatomy: A must for teaching the next generation. *Surgeon, 2*(2), 79-90.

Ganguly, P.K. (2010). Teaching and learning of anatomy in the 21st century: Direction and the strategies. *The Open Medical Education Journal, 3*, 5-10.

Turney, B. (2007). Anatomy in a modern medical curriculum. *Annals of the Royal College of Surgeons of England, 89*(2), 104-107.

About the Author

Dr. Iravani is a medical doctor and cancer biologist who teaches clinical anatomy, histology and embryology in the Department of Anatomy.

He subscribes to the philosophy that education is transformative for both students and teachers when they believe in "learning to teach and teaching to learn". He also believes that if the students can assess their own learning, they will be able to regulate their studies independently and proactively.