Medical Science Educator (2021) 31:1729–1730
https://doi.org/10.1007/s40670-021-01405-9

INNOVATION

# Using a Machine Learning Architecture to Create an AI-Powered Chatbot for Anatomy Education

**Yik Sum Li**[1] · **Cynthia Sin Nga Lam**[1] · **Christopher See**[2]

Accepted: 14 September 2021 / Published online: 21 September 2021


**Abstract**
Artificial Intelligence chatbots allow interactive dialogue-driven teaching of medical sciences. Open-source tools allow educators to adapt existing technology to create intelligent learning systems. We utilised an open-source machine learning architecture and fine-tuned it with a customised database to train an AI dialogue system to teach medical students anatomy.

**Keywords** Anatomy education · Artificial intelligence · Machine learning · Chatbot · Natural language processing · Pedagogical innovation

## Report

Medical educators know and love in-depth individual conversations with students as a form of learning [1]. From the pedagogical standpoint they allow real-time feedback, assessment of initial starting point for students, correction of errors and identification of misconceptions. The limiting factor of student–teacher conversations is often one of numbers—there simply are not enough teachers, particularly in large cohorts such as medical students. Artificial intelligence (AI) agents conversing through dialogue systems offer a way to capture this prized pedagogy and make it scalable for each and every student.

Conversational AI technology can seem daunting but developments in recent years mean that it may be more accessible than some educators might believe. There has been a propagation of open-source AI tools which researchers can use as a basis for intelligent systems. One such product produced by Google's DeepMind research centre is the 'Bidirectional Encoder Representations from Transformers', known affectionately as BERT [2]. It is a machine learning architecture usually used for natural language processing—a field which examines computer-based understanding of human language. A model based on BERT or its variants and trained on millions of books and articles can be used in summarisation, question and answering and other tasks that require contextual representation and understanding of language.

BERT may be capable of general language tasks but medical subjects such as human anatomy are a language unto themselves. Not only does the discipline use its own archaic Latin and Greek-derived nomenclature but also it has a complex manner of describing the three-dimensional relationships between structures, as well as myriad clinical implications. In its original form BERT certainly cannot teach human anatomy; it does not know enough about it, or indeed how to talk about it.

Therefore, we used this open-source architecture as a base and fine-tuned it with a customised database to better understand both the language and the context of human anatomy. This has allowed us to build a system which can have meaningful educational conversations with students and assist their learning of anatomy both in and out of the dissection laboratory.

To develop our system, entitled the Artificial Intelligence Support System (AISS) chatbot, we used BERT with a question-answering head pre-trained with Stanford Question Answering Dataset (SQuAD 2.0) [3]. We developed our training database centred on two primary sources: the UK Anatomical Society Anatomy Syllabus for Medical Graduates [4], which is a detailed consensus syllabus constructed by 39 anatomy teachers. This was cross-referenced with our institution's own anatomy syllabus from the Chinese

✉ Christopher See
christophersee@cuhk.edu.hk

[1] LKS Faculty of Medicine, University of Hong Kong, Pokfulam, Hong Kong

[2] School of Biomedical Sciences, Faculty of Medicine, The Chinese University of Hong Kong, Shatin, N.T, Hong Kong

University of Hong Kong (CUHK). We conducted the fine-tuning process in a machine-learning platform (TensorFlow, Google) to improve anatomy-orientated language tasks. Finally, we added a neural network module (RNN. CNN Seq2seq) [5], which was a model trained specifically to generate complete sentences given the main context and sentiment, to facilitate more human-like output. These multiple different modules working together comprise one single AI system, resulting in the AISS chatbot.

The AISS chatbot allows a two-way conversation with students, both answering their questions on the subject of anatomy and asking questions of them whilst providing instant feedback. Students have access to the algorithm through a web portal and converse with the chatbot in a manner similar to social media or messaging platforms with which they are familiar. Students are freely able to ask questions ranging from simple factual statements *(what is the blood supply of…?)* to clinical significance and spacial relationships of structures. Our initial findings are from a pilot study of 23 second-year medical students who engaged in a 1-hour session of educational conversation with our AI about upper limb anatomy. Participants responding to a pre-post survey noted increased self-reported confidence in anatomy knowledge from 2.10 to 3.84 on a Likert scale of 5 following this session. In their qualitative feedback, students reported that they were more comfortable making mistakes conversing with the AI compared to conversations with human teachers. We also noted a high level of student engagement with the chatbot. These findings will be investigated further via a quantitative trial of learning impact and a qualitative study examining the learning processes of AI-human dialogue in anatomy education from the student perspective.

We believe that our system is a significant innovation in the field of autonomous AI agents for medical education. It is a system which can generate intelligent, educational conversations and has a vast range of responses to students engaging it with their own natural language. We hope that this innovation report encourages educators to consider building intelligent AI systems based on open-source resources for medical education.

**Funding** This study is kindly supported by a Teaching Development and Language Enhancement Grant from The Chinese University of Hong Kong.

## Declarations

**Ethics Approval** This study has been approved by the Institutional Review Board of The Chinese University of Hong Kong (SBRE-20–043).

**Informed Consent** Participation was undertaken on a voluntary basis by students who signed a written consent form as their agreement to participate.

**Conflict of Interest** The authors declare no competing interests.

## References

1. Chan LK, Wiseman J. Use of the one-minute preceptor as a teaching tool in the gross anatomy laboratory. Anat Sci Educ. 2011;4:235–8.
2. Devlin J, Chang MW, Lee K, Toutanova K. Bert: Pre-training of deep bidirectional transformers for language understanding. arXiv preprint. 2019, 1810.04805
3. Dong L, Yang N, Wang W, Wei F, Liu X, Wang Y, Gao J, Zhou M, Hon HW. Unified language model pre-training for natural language understanding and generation. Adv Neural Inf Process Syst. 2019, pp. 13063–13075.
4. Smith C, Finn G, Stewart J, McHanwel S. Anatomical society core regional anatomy syllabus for undergraduate medicine: The delphi process. J Anat. 2015;228. https://doi.org/10.1111/joa.124024.
5. Zhang Y, Li D, Wang Y, Fang Y, Xiao W. Abstract text summarization with a convolutional seq2seq model. Appl Sci. 2019;9(8):1665.