

Project Title : Developing Active Learning Pedagogies and Mobile Applications in University STEM Education

Leading University : The Hong Kong Polytechnic University

Participating UGC-funded University(ies) : Hong Kong Baptist University, The Chinese University of Hong Kong, The University of Hong Kong

Project Leader(s) : Dr Fridolin TING Sze-thou, Teaching Fellow, Department of Applied Mathematics, Faculty of Applied Science and Textiles, The Hong Kong Polytechnic University

Summary of Proposal

Science, Technology, Engineering and Mathematics (STEM) education is crucial to continuing Hong Kong's worldwide competitiveness in our modern society. With the implementation of the 3-3-4 system in Hong Kong, however, tertiary institutions found that many STEM students lack the necessary background and skills to integrate and apply their knowledge to solve problems practically and creatively. One possible solution to this dilemma is to introduce “active learning” to our Hong Kong STEM university students. Active learning is simply anything other than traditional passive teaching. However, despite extensive evidenced based research on the benefits of active learning strategies to our students in STEM, the majority of STEM instructors in Hong Kong do not put these teaching methods into practice due to (i) lack of incentives or support from their tertiary institutions; (ii) instructor’s own background education is in, and contrasting deeply held beliefs in, passive learning and teaching; and (iii) the fact that STEM education in Hong Kong has not been advocated until recently, and is routinely emphasized more for secondary or high schools than in tertiary institutions.

A positive approach to the above dilemma of increasing active learning in STEM education in Hong Kong universities is based on the following four observations: (i) approximately 98% of our Hong Kong students today carry a mobile phone, tablet or laptop to the classroom; mobile applications (m-apps) for education (ii) enable teachers to improve their teaching practices; (iii) engages and highly motivates students by providing them with new opportunities to participate and construct their own learning, individually or collaboratively; and (iv) improves students’ achievement, understanding

and application of concepts. These four observations, coupled with a meta-analysis which indicates that active learning increases Asian student examinations scores by more than an average of 6% in STEM university subjects, suggests that increasing active learning with the aid of m-apps can greatly enhance Hong Kong students' learning outcomes in STEM tertiary education.

Therefore, the main objectives of this proposal are to explore and develop new pedagogies to increase active learning in STEM Hong Kong education and to cultivate innovative m-apps to enhance active learning. Increased engagement and collaboration between teacher and students in STEM education will equip our students with the necessary practical/social skills and theoretical foundation essential to tackle our current economic, scientific and technological challenges.

Summary of Final Report

Science, Technology, Engineering and Mathematics (STEM) education is crucial to continuing Hong Kong's worldwide competitiveness in our modern society. Extensive evidenced based research has shown the benefits of active learning strategies to our STEM students' motivation, conceptual understanding and academic performance. Therefore, the main objectives of our project (<http://palms.polyu.edu.hk/>) are to explore and develop new pedagogies to increase active learning in STEM Hong Kong education and to cultivate innovative mobile apps to enhance active learning. Increased engagement and collaboration between teacher and students in STEM education will equip our students with the necessary practical/social skills and theoretical foundation essential to tackle our current economic, scientific and technological challenges.

With support from the UGC and a collaborative inter-institutional effort involving over 30 instructors and professors, educational specialists and technicians from 4 universities, we were able to develop over 10 novel pedagogies with supporting apps and platforms to increase active learning and engagement in the classroom. For example, (1) YoTeach! app to facilitate enhanced "question and answer" pedagogy; (2) problem-based learning and the Badaboom! app (3) collaborative problem-based learning and peer assessment (Co-PBLa-PA) supported by interactive online whiteboards; (4) inquiry-based learning and the ChemEye app; (5) collaborative case-based learning and Dissection Peer Support System (DPSS) System and (6) game-based learning and the Cell-Game.

With our project's new pedagogies and apps, we have engaged and increased active learning and teaching to over 130,000 students and teachers locally and internationally, from over 70 countries and 280 cities, in approximately 700 institutions (universities, schools and corporations). We have gathered learning analytics which indicates that students' learning outcomes were improved by active teaching methods, e.g., our Co-PBLa-PA active pedagogy has doubled students' conceptual understanding of Calculus, and our YoTeach! app increases students' questions and comments by three times. In addition, our pedagogies and tools saw an increase in demand around the middle of March 2020, and doubled in users (students and teachers) during the pandemic when teachers were forced to teach online. We have garnered over 10 international educational awards in recognition of our efforts and impact.

We will continue to promote and develop active teaching pedagogies, sustain and extend our work to non-STEM subjects, K12 and UGC sectors through continuous exploration and improvement of our active pedagogies and supporting apps, through QEF projects and the Hong Kong Teaching Excellence Alliance's Community of Practice on the "Innovation and Future of STEM Education".