

Engaging first year students with diverse mathematics background

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Abstract

We discuss the measures to engage first year students with diverse mathematics background in their mathematics learning. Practices on curriculum design, class arrangement, learning activities, assessments and extended resources to enhance teaching-learning effectiveness will be presented.

Introduction

The first year students of the College of Science and Engineering (CSE) of City University of Hong Kong (CityU) are required to take the core course *MA2176 Basic Calculus and Linear Algebra* offered by the Department of Mathematics (MA). With over 700 students, the course aims to provide them with essential mathematical training for all further study in mathematics and its applications. The entry mathematics background and learning interest of students are diverse.

Diversity

Entry mathematics level of students

The majority of students admitted to Hong Kong universities have taken the Hong Kong Certificate of Education Examination (HKCEE) and the Hong Kong Advanced Level Examination (HKALE) (JUPAS Office, 2009). Students in science stream are allowed to choose from several mathematics subjects with various scopes and difficulties in their studies. Table 1 lists the number of HKALE candidates in mathematics subjects (HKEAA, 2009).

Year	2005	2006	2007	2008	2009
Mathematics and Statistics (M&S) # ^	5954	6496	6566	6682	6598
Pure Mathematics (PM) # ^	7375	7462	7653	7848	7748
Number of candidates who sat and obtained a pass or above in either M&S or PM ^	9919	10726	10841	10730	10677
Total number of HKALE candidates ^	33829	34977	36608	38263	38647
Percentage of candidates who obtained a pass or above in either M&S or PM	29.3	30.7	29.6	28.0	27.6

Table 1 Number of HKALE candidates in mathematics subjects

Mathematics and Statistics and Pure Mathematics are two of the HKALE mathematics subjects with greatest numbers of candidates.

A student cannot take both Mathematics & Statistics and Pure Mathematics concurrently.

^ Reference: Hong Kong Examinations and Assessment Authority Exam Reports (HKEAA, 2009)

The mathematical background and ability of students enrolling in *MA2176* differ considerably, since a pass in a HKALE mathematics subject is not an admission requirement of some CSE programmes.

Besides entering the university after completing the matriculate level in secondary education, the university admits students with other academic qualifications. Those students normally completed HKCEE and their training in higher-level mathematics varies. In recent years, about one-third of students admitted to CSE have not taken any HKALE mathematics course. Extra resources are necessary for *MA2176* in bridging knowledge gap of students and ensuring that they attain the required standard.

Learning interest of students

The *MA2176* students concerned come from six disciplines and about twenty academic programmes in CSE. The topics, scope and depth of mathematics required for each programme are quite different. The percentage of the number of *MA2176* students in each discipline is shown in Figure 1. Students are generally less motivated to those topics which are less relevant to their own discipline. Engaging students in the course is challenging.

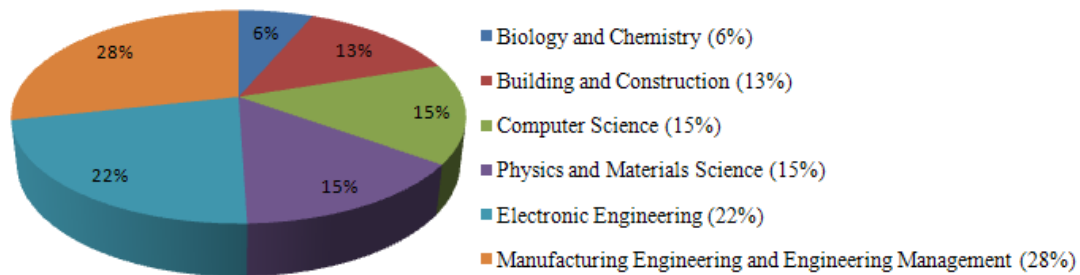


Figure 1 Percentage of the number of *MA2176* students in different disciplines

Measures

Curriculum design

MA2176 is a pre-requisite course of many higher level mathematics courses for CSE students. Constructive alignment (Biggs, 2003) is being implemented in the course. The teaching and learning activities as well as the assessment tasks are aligned to the Intended Learning Outcomes. The curriculum was carefully designed: the six topics (functions, limit, continuity and differentiability, applications of derivatives, integration and its applications, vectors, matrices and determinants, complex numbers) covered (ARRO, 2010) are all fundamental to further studies in CSE. A custom-published textbook (MA, 2007) is adopted for the course.

Class arrangement and learning activities

Around 25% of undergraduate students of CityU are admitted on the basis of non-HKALE qualifications. Placement Test is conducted to determine whether the individual student is streamed into or exempted from *MA2176* classes.

With the help of the Academic Regulations and Records Office of CityU, MA assigns students of *MA2176* to appropriate lecture sessions based on their mathematical background. Table 2 describes the groupings of students accordingly. In principle, students with

comparable background belong to the same lecture session. Apart from holding lectures with class size of about 80-120, tutorials in the form of small interactive classes are conducted. Students with moderate or least background benefit from additional tuition hours.

Group	Classification	Lectures	Tutorials
A	The greatest mathematical background attained (e.g. a pass or above in a HKALE math subject)	2 ½ hrs/week	1 hr/fortnight
B	Moderate mathematical background attained (e.g. slightly beyond the level of HKCEE math)	3 hrs/week	1 hr/week
C	The least mathematical background attained (e.g. with only one HKCEE math subject)	3 hrs/week	1 hr/week

Table 2 Groupings of students in MA2176 (Lo et al., 2009)

Blackboard, the official website of MA2176, is used for course lecturers to disseminate up-to-date messages, course materials and information instantly (Lo et al., 2009). Students are encouraged to do the self practice assignments posted on the Blackboard and are welcome to raise questions during the tutorials.

Extended resources

Pre-Calculus course is offered both in summer and fall semester for students whose mathematics background is weak. The course covers topics which are fundamental to the study of MA2176. It aims to refresh, enhance and consolidate students' mathematical knowledge and skills. Extra weekly tutorial classes are also arranged, in which additional examples will be illustrated.

To motivate students' learning and to relate the content to their own discipline, more than a hundred discipline-oriented applications that illustrate techniques in applying mathematical knowledge learnt in MA2176 to real-life problems are provided (Lo et al., 2009).

MA operates the Math Help Centre in each semester to further assist students with difficulties in studying MA2176. Students are encouraged to make appointment and have face-to-face consultation with tutors.

Assessments and monitoring students' performance

Students' understanding on the course materials are well monitored regularly by conducting short quizzes in every alternate week. Remedial exercises will be given to students who fail the quiz. Individual consultation will be arranged if necessary. Students' academic profile in MA2176 is also well monitored by the course coordinator: Extra consultation will be available to students who failed MA2176 in preceding semesters. Hands-on exercises and common mistakes will be discussed. A reading project on practical issue that extending knowledge of MA2176 classes is also assigned. It is hoped that their motivation on the course is enhanced.

The measures adopted help cultivating the learning environment for students to build their learning experience, supported by useful resources and timely feedback on their performance.

Evaluation

Students generally find the arrangement supportive and become more motivated in learning. Students who attended the pre-calculus course for 70% or above find the course useful in refreshing their mathematical skills. They achieve considerably higher score in the attainment test conducted in the last lesson, compared to those who attended less than 70% of the classes. Students also welcome extra tutorial lessons and individual consultation as their misconception is diagnosed.

MA2176 succeeded in maintaining a satisfactory passing rate. Students' performance in further mathematics courses upon completion of *MA2176* is also well monitored. Table 3 shows the mathematics courses required by students from different programmes upon completion of *MA2176*. They generally performed satisfactorily, indicating that *MA2176* successfully serves the purpose of providing students with essential mathematical training for all further study in mathematics and its applications.

Programmes	Mathematics Course(s) upon completion of <i>MA2176</i>
Applied Chemistry, Environmental Science and Management	Mathematical and Statistical Laboratory
Building Services Engineering	Numerical Methods
Computer Engineering, Information Engineering	Linear Algebra and Multi-variable Calculus, Advanced Engineering Mathematics, Probability and Stochastic Processes
Electronic and Communication Engineering	Mathematical Analysis, Advanced Mathematical Analysis
Computer Science	Linear Algebra and Multi-variable Calculus
Design and Technology, Manufacturing Systems Engineering, Mechatronic Engineering, e-Logistics and Technology Management	Engineering Mathematics and Statistics
Industrial Engineering and Engineering Management	Mathematical Methods for Engineering
Materials Engineering, Applied Physics	Linear Algebra and Calculus, Numerical Methods

Table 3 Mathematics Course(s) for students of different programmes upon completion of *MA2176*

The *MA2176* team will evaluate, make adjustments and look for further development on the measures to enhance teaching-learning effectiveness of the course based on different student compositions as well as feedback from students and hosting departments.

It is believed that the practice of grouping students according to their background is also applicable and beneficial to the teaching and learning of other disciplines with large student population and diverse background. It is crucial to seek for co-operation among students' hosting departments so that the timetable scheduling can be well arranged for providing extra fundamental courses, teaching and contact office hours.

The N&B session plan

In the session, we will present our practice and propose further development to enhance teaching-learning effectiveness. The outline of the N&B session plan is as follows.

Presenter (5 mins): Overview of the course and students' diverse background

Presenter (7 mins): Measures to engage students with diverse background in their studies

Discussion and feedback from the participants (15 mins): Participants consider one or more of the following issues:

- Do you encounter similar problems in your case? What aspect is your major concern?
- Which measure discussed has been/is easier to be adopted in your case? Did you experience / do you anticipate the same effect?
- Are there any suggestions on further development to enhance teaching-learning effectiveness for first year students having diverse background? For example, is it necessary to set different assessment criterion for students from different disciplines?

Presenter and participants: Conclusion and further comments (3 mins)

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