

## A feasibility analysis on international open educational resource courses in secondary mathematics curricula

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**ABSTRACT:** Promoting international education is a major education policy of the government of Taiwan. In the international educational domain, the flipped classroom revolution has been made possible by the advancement of the Internet. In particular, the field of open educational resources (OERs) has recently become a new international focus. This study explored relevant OERs for high school mathematics curricula and analysed the feasibility of implementing them according to the following criteria: technical feasibility, operational feasibility, as well as student engagement and outcomes in regard to two major OER systems. The results reveal that geometry and algebra constitute the majority of OER courses for junior high school mathematics curricula. The main pedagogical methods include lectures, instructional videos, as well as computer-assisted instruction, and on-line real-time quizzes were used as the primary assessment tools. Some sites also provide forums. The findings of this study may serve as a reference for international education curricula development and teaching, as well as teacher professional growth.

### INTRODUCTION

When the Taiwanese education community considered steadily promoting the 12-year compulsory education programme, relevant technologies and network bandwidth were enhanced. This accelerated applying open educational resources (OERs), which facilitate teacher and student independence, flexibility and innovativeness in educational activities, thereby broadening educational perspectives. Moreover, updating information technologies promotes breakthroughs in international educational exchange activities, courses and teacher professional growth [1].

For example, the United States possesses the greatest abundance in OERs. Some of the platforms, such as the Khan Academy, Massive Open On-line Courses, Udacity, Coursera and edX, have combined business and academia into a network economy model that integrates the concepts of *free* and *premium*; hence, the term *freemium*. This educational design closely combines learner motivations and needs, markedly raising the standard of e-learning [2].

The improved content quality and process of promoting OERs have since contributed to the proliferation of the flipped classroom model, which has become common in educational environments. These developments fulfil the goal of real-time learning analytics, which enable ubiquitous learning (u-learning) and convenient information learning and evaluation, thereby personalising learning activities, synchronising international education exchange activities and increasing the efficiency in broadening students' worldview. This article discusses the development and feasibility of OERs and presents a practical application of open courses in secondary mathematics curricula and offers suggestions related to promoting international open education programmes.

### CHANGES IN INTERNATIONAL OPEN EDUCATION PROGRAMMES

#### E-learning

The development of e-learning content influences traditional teacher–student interactions. Previously, teachers were leaders in knowledge and learning in traditional class models, but have recently become assistive guides in e-learning education models [3].

E-learning possesses unprecedented advantages over traditional education programmes including greater flexibility in learning schedules and spaces, potential and mobility in cross-national development, more frequent real-time updates and greater convenience in modifying learning content, developing self-oriented learning environments, as well as stimulating learner motivation, autonomy and responsibility. Nadiyah and Faaizah indicated that current e-learning designs mostly adopt the analysis-design-development-implementation-evaluation model (ADDIE) model, which gradually matured between 1980 and 1990 [4].

The five design processes are applied in educational training and common e-learning content development models.

### M-learning Development

From 18 to 20 February 2013, the United Nations Educational, Scientific and Cultural Organization (UNESCO) held the Mobile Learning Week conference in Paris and published the Policy Guidelines for Mobile Learning, in which 13 advantages of m-learning were mentioned (Table 1).

Table 1: Thirteen unique benefits of mobile learning.

1. Expand the reach and equity of education	8. Enhance seamless learning
2. Facilitate personalised learning	9. Bridge formal and informal learning
3. Provide immediate feedback and assessment	10. Minimise educational disruption in conflict and disaster areas
4. Enable anytime, anywhere learning	11. Assist learners with disabilities
5. Ensure the productive use of time spent in classrooms	12. Improve communication and administration
6. Build new communities of learners	13. Maximise cost-efficiency
7. Support situated learning	

Source: Kraut [5].

### U-learning Development

Learners can seek most of their answers to any questions on the Internet as necessary without having to prepare or store knowledge in advance, which facilitates prompt learning. Specifically, u-learning, an extension of m-learning and e-learning, features just-in-time characteristics, fulfils personalised needs (i.e. *just enough and just for me*), and adopts various technologies for supporting diverse learning activities, thereby facilitating maximising the learning potential of students [6].

## FEASIBILITY OF INTRODUCING INTERNATIONAL OPEN EDUCATION PROGRAMMES

The following sections separately discuss the feasibility of OERs with respect to their technical, operational, as well as student engagement and outcomes in regard to two major OER systems.

### Technical Feasibility

In English-speaking countries, the Khan Academy is the predominant OER in secondary mathematics curricula. Understandably, most countries are dedicated to developing and designing their own OERs. Presently, as mobile and communication technologies develop, the technical aspects of OERs specifically related to cross-platform development and technologies are reaching maturity. However, the integration of educational interfaces and linkage of educational resources require further improvement. Currently, the most comprehensive and accessible course design is found in mathematics, which can be attributed to the inherent logical attributes of mathematics courses [7].

### Operational Feasibility

E-learning systems can be divided into learning management systems (LMSs) and content management systems (CMSs) according to their intended purpose. LMSs emphasise course management and staff participation, whereas CMSs focus on producing and organising course materials [8].

Moodle is an open-source platform with both LMS and CMS characteristics, created by a team of researchers led by Professor Martin Dougiamas at Curtin University, Australia. Moodle was programmed according to educational principles in order to assist instructors and educational institutions in conveniently servicing on-line learners. Educators, schools and educational institutions can download the software and modify the program by using the PHP scripting language under the general public license (GNU). In addition to providing course management, courseware downloads and post class interaction functions, Moodle features an administration interface through which teachers can upload course materials, multimedia courseware, network resources and reference data, enabling diverse teaching contents and patterns. Thus, learners can access and use the courseware content through a network connection [3].

## RESEARCH DESIGN AND ANALYSIS

Since October 2014, this study applied two major OER systems (the Khan Academy and Junyi Academy) in a simple educational action research focusing on Grade 9 students. The education units were specific secondary mathematics topics: a) planar shapes in everyday life; and b) relative positions of lines and circles. Student participants were asked to watch open education programme videos in class. After two weeks of experimental education (four classes each week), the students completed questionnaires for assessing their attitude toward, and difficulties encountered, when using the international open education programmes. The assessment results were subsequently used in the feasibility analyses.

The research participants (n = 71) were sampled from regular classes: Class A contained 35 students (19 boys, 16 girls) and Class B contained 36 students (18 boys, 18 girls). The same instructor conducted this experimental programme without informing the students in order to eliminate psychological confounders. Moreover, the experimental course content was seamlessly integrated into the current curriculum. Table 2 displays the experimental education design.

Table 2: Research design of international open education programmes in mathematics.

No.	Week	Unit	Open education programmes	Teaching methods
1.	Week 4, October (4 classes)	Relative positions of lines and circles	Junyi Academy (Chinese pronunciation)	On-line video instructions
2.	Week 5, October (4 classes)	Planar shapes in everyday life	Khan Academy (English Pronunciation)	On-line video instructions

Research Results and Analysis

- a) Descriptive statistics: basic data: Table 3 shows the descriptive statistics of students’ basic data. Using a score of 60 as the cut-off point, students who scored 61 or more on their mathematics and English term tests were deemed as demonstrating adequate performance, whereas those who scored 60 or less were deemed as requiring improvement. Thus, Table 3 shows that most of the students attained adequate performance in their mathematics and English term tests. Therefore, the ability of the students in the two classes can be considered adequate. Regarding the students’ programme preference, 21% of the students preferred the Khan Academy, 55% of the students preferred Junyi Academy, 23% of the students favoured both programmes, and 1% of the students favoured neither programme. These results indicate that international OER platforms would be suitable for ongoing use in secondary education, particularly the Junyi platform.

Table 3: Descriptive statistics (basic data).

Item	Girls	Boys	Total
Gender	34	37	71
Mathematics grades (term test)			
0%-40%	7	9	16
41%-60%	9	8	17
61%-80%	13	16	29
81%-100%	5	4	9
English grades (term test)			
0%-40%	10	12	22
41%-60%	3	9	12
61%-80%	10	6	16
81%-100%	11	10	21
On-line course of preference			
Khan Academy	8	7	15
Junyi platform	21	18	39
Both	5	11	16
Neither	-	1	1

- b) Descriptive statistics: learning attitude, learning interest and course acceptance: Table 4 indicates that the students attained average scores greater than 4.1 in the three dimensions after completing eight lessons through the Khan Academy and Junyi platforms. The exception was that the students who previously scored 0-40% in the mathematics and English tests obtained average scores less than 4.0, which were still greater than 3.7. This shows that the students had a positive attitude towards the newly introduced international OERs.

Table 4: Descriptive statistics (learning attitude, learning interest course acceptance).

Item	Learning attitude - Mean 1	Learning interest - Mean 2	Course acceptance - Mean 3	Mean	SD
Gender					
Girls	4.4	4.3	4.5	4.4	0.08
Boys	4.2	4.2	4.4	4.3	0.10
Mathematics grades (term test)					
0%-40%	3.5	3.7	4.1	3.8	0.25
41%-60%	4.1	4.1	4.3	4.2	0.10

61%-80%	4.0	4.2	4.3	4.2	0.13
81%-100%	4.4	4.3	4.5	4.4	0.14
English grades (term test)					
0%-40%	3.5	3.6	3.8	3.7	0.14
41%-60%	4.0	4.1	4.3	4.1	0.13
61%-80%	4.0	4.2	4.2	4.1	0.10
81%-100%	4.1	4.2	4.2	4.2	0.05
On-line course of preference					
Khan Academy	4.2	4.1	4.3	4.2	0.08
Junyi platform	4.4	4.3	4.3	4.3	0.06
Both	4.3	4.2	4.3	4.3	0.06
Neither	3.0	3.0	3.0	3.0	0.00

## CONCLUSIONS

This study's focus was international OER programmes and assessed the following five dimensions: technical feasibility, operational feasibility, as well as student engagement and outcomes in regard to two major OER systems. The results show that the international OER programmes provide diverse and rich content, conforming to the educational concept of multiple intelligences. This study introduced two international OER programmes, the Khan Academy and the Junyi platforms, into the secondary mathematics curriculum.

The results show that both platforms adopted the learning map approach, which stresses optimising the learning experience to enable learners and teachers to seamlessly adapt to course programmes. Additionally, the programme designs enable instructors to adopt the flipped classroom model conveniently when teaching classes.

Introducing international OERs in the secondary mathematics curriculum served as an initiator, prompting positive feedback regardless of the students' comprehension, learning attitude, learning interests and course acceptance. Despite relevant limitations and challenges, international OERs can be successfully integrated into school education through deliberate planning and implementation by teachers, administrative resource investment and school administration support.

Promoting international education fosters cross-cultural communicative competence in students. International OER programmes enable secondary students to evolve from learners into practiced communicators through internalising their newly acquired skills, thereby facilitating promoting international education. Finally, these results may serve as a reference for developing and implementing international education courses and promoting teacher professional growth.

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