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How to Construct the 3-Stage Training Mechanism to Tap Students' Scientific Research Potential

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Abstract
The Outline of China's National Plan for Medium- and Long-term Educational Reform and Development (2010-2020), issued by the Ministry of Education in 2010, defined the road map to become a society with strong human resources and high innovation abilities by 2020 (Xie, 2009; Zhang et al. 2012; Pang and Plucker, 2013). To respond to this policy, Guangdong University of Foreign Studies has launched reforms to develop stronger undergraduate programs to cultivate innovation and capture the creative talents of undergraduate students. Our research, within the context of this education reform, investigates the construction of a 3-stage training mechanism for implementation from the students' freshman year to junior year, with the objectives: (1) to assist students with scientific reading and writing in English; (2) to improve students' learning outcomes in core academic courses (for majors under discipline of applied economics, the core academic courses are Mathematical Analysis, Statistics & Probability Theory, Econometrics, Financial Engineering, and Risk Management, etc.); and (3) to guide students in the preparation of literature reviews, and in research methods related to data collection and numerical analysis. For students able to contribute new research output, research grants will be provided on a selection basis to support their projects. To evaluate the effectiveness of the training outcomes, undergraduate students should be encouraged to take part in academic contests highlighting research and innovation. In addition to enhancing the scientific potential of students, the 3-stage training mechanism also provides key benefits for faculty members through the establishment of a learning community.

Key words: Course design; 3-stage method; Scientific research potential; Higher education; Academic ability; Innovation; Creativity

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INTRODUCTION

Many scholars have analyzed major higher education reforms related to creativity and innovation in China over the past two decades. Under the top-down policymaking approach, both national and local educational strategies have experienced dramatic revolution during this period. Landmark initiatives, such as, Plan 985, Plan 211, The Project of Quality Assessment of Undergraduate Programs 2007, The Outline of China's National Plan for Medium- and Long-term Educational Reform and Development (2010-2020), and Plan 2011 (Xie, 2009; Zhang et al. 2012; Pang and Plucker, 2013) have been launched as part of these reforms. It is worth noting that, China launched its first talent plan, i.e. The National Medium- and Long-term Talent Development Plan (2010-2020) in 2010, which aimed to transform China from a manufacturing hub to a world leader in innovation (Pang and Plucker, 2013). These intensive actions highlight China's determination to cultivate creative and innovative talents to drive its sustainable economic development, and to transform its labor-intensive economy to one that is driven by knowledge and innovation (Xie, 2009; Zhang et al. 2012; Pang and Plucker, 2013).

To respond to the national innovation strategy, the nationwide higher education system, including Guangdong University of Foreign Studies (GDUFS), has launched reforms over the past decade, to develop stronger undergraduate programs which cultivate creativity and innovative thinking as focal points. Works by Wang and Zheng (2007), Yang et al. (2018), Chen et al. (2019), and Yao and Raguthu (2019) discuss these initiatives in terms of teaching reform based on specific courses. Our aim is to broaden the scope of these reforms through developing a more specific and feasible training mechanism that includes a series of core courses to tap students' scientific spirit, creative thinking, and innovation ability. GDUFS is a major internationalized university recognized for its global-minded faculty/students and its research on international languages, applied economics, and finance. Leveraging these strengths to construct an efficient training mechanism to better enhance students' scientific research potential is the core topic of this study.

1. METHODOLOGY

The design of the 3-stage training mechanism stems from the educational philosophy of GDUFS, which emphases the integration of professional skill studies and foreign language training. GDUFS is the only institution in southern China that offers a variety of foreign language programs and its foreign language and literature disciplines are among the best in the nation. Applied Economics and Business Administration, ranking second are other key disciplines at GDUFS. The corresponding author is a course instructor for compulsory and elective courses for sophomores majoring in Finance, under the discipline of Applied Economics. Therefore, investigation of the 3-stage training mechanism described herein is based on the author's teaching and research experience, in conjunction with information collected from other academic disciplines at GDUFS.

Following the innate rules of learning, specifically speaking the 3-stage training mechanism consists of three stages. Stage 1 occurs in the students' freshman year, when the "English for specific purpose (ESP)" course is offered to help students enhance their general language capability and cross-cultural communication skills (Jordan, 1997). In stage 2, major-related courses in bilingual teaching modes are offered in the sophomore year to help students enhance their academic skills and critical thinking. Stage 3 occurs in the junior year when students who are interested in research have the opportunity to join a supervised research team and undertake a major-related project. A flowchart highlighting specifics of the 3-stage training mechanism for majors under the discipline of Applied Economic is presented in Figure 1. To improve learning efficiency, course instructors should ideally apply various instructional techniques while teaching (Marshall, 2013; Dawson, 2015), examples being the, flipped classroom model, massive open online courses (MOOC), small private online courses (SPOC), micro-lectures, and case studies. Actually, because of the outbreak of COVID-19 infection in China, higher education mode has been reshaped toward a combination of online- and offline- courses.

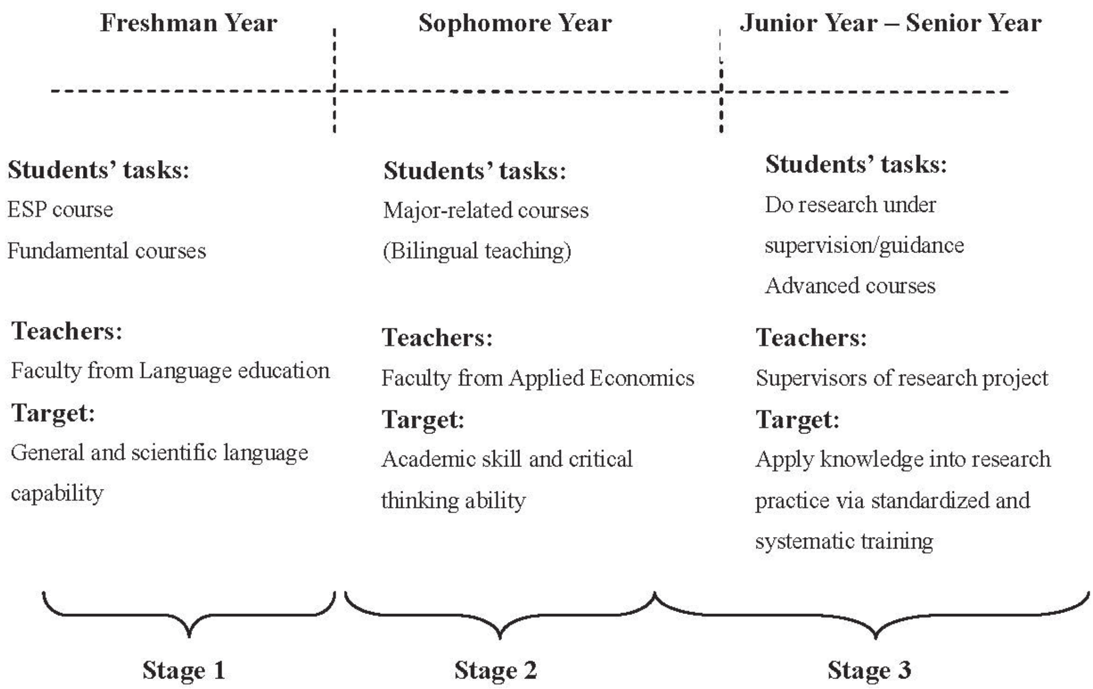

Figure 1
Flowchart of 3-stage training mechanism

Although the three stages are highlighted as separate entities in Figure 1 there exists flexibility in the mechanism such that they need not be strictly separated. For example, stage 2 and stage 3 can be run concurrently in that students may get involved in research projects since the beginning of the sophomore year, such as being laboratory assistants. As students accumulate experience, there may be scope for them to undertake more important tasks. The advanced analysis techniques obtained from junior year courses also help students conduct research. In principle, overlapping stages is a two-way choice between students and supervisors. In stage 2 and 3, the course instructors can link research with teaching and lead talented students to undertake research projects after they finish the necessary coursework (Kauchark and Eggen, 2003; Eggen and Kauchark, 2006).

2. FINDINGS

In the trial implementation phase, students under almost all disciplines are required to take ESP courses in their freshman year. GDUFS launched the bilingual teaching/English teaching program for non-language majors in 2017. Since then, a large proportion of compulsory and elective courses are taught in the bilingual teaching/English teaching mode. From junior year to senior year, course instructors usually design in-class learning activities and continue to guide talented students to do research. Since its inception, there have been two important findings from implementation of the 3-stage training mechanism.

Firstly, as explained in Section 1, the 3-stage training mechanism consists of three interlocking and interacting processes, which works like an organic system, for a term of 3 years. The assessment of students' learning outcomes is conducted at the end of each stage. In the first two stages, students are required to study compulsory and/or elective courses according to curriculum design, and the course instructors are in charge of the assessment. In the third stage, students are encouraged to join a supervised research team and undertake a project. At this point, professors from the corresponding faculty are responsible for supervision and research guidance. Students who complete the whole training term and participate in research activities usually excel academically, as they have the necessary skills to collect and analyze information, acquire new knowledge, and to analyze and solve problems. Some of them have published academic articles in peer-reviewed international scientific journals during their undergraduate studies as first- or coauthor, and continued to pursue advanced degrees in prestigious universities after graduation. Guo et al. (2014), and Ye and Chen (2019), analyzed the impact of scientific research participation on students' innovative quality based on project information of the "Great Innovation Plan" and "Challenge Cup", in Huazhong University and Guangzhou universities respectively. In GDUFS, we strive to take full advantage of our international language educational resources and develop students' academic writing skills, and research outputs related to projects undertaken by undergraduate students from 2017 to 2019 is shown in Table 1.

Table 1
Students' published research articles (2017 to 2019)

	Major	Title	Journal
1	Computer Science & Information Technology	An Automated Method for Gender Information Identification from Clinical Trial Texts	5th International Conference on Health Information Science, Proceedings
2	Computer Science & Information Technology	Visual Tracking via Clustering-Based Patch Weighing and Masking	Advances in Computer and Computational Sciences
3	Computer Science & Information Technology	Application of Big Data on Formative Assessment System for Foreign Language Learning	Fuzzy Systems and Data Mining III Book
4	Business	Analysis on Influence of Stock of Education Capital and Fixed Assets on GDP Based on Three Types of Regression Model	EURASIA Journal of Mathematics Science and Technology Education
5	Business	Acceptable if building electricity price trend change to some biology trends	Journal of Intelligent & Fuzzy Systems
6	Finance	A driving force for sustainable economic growth in China from the wave like effects	Applied Economics Letters
7	English & Education	Why Quitting Double-degree Programs: Students Perceptions in China	Higher Education Studies
8	Interpreting & Translation	On C-E Translation of Relic Texts in Museums from a Functional Equivalence Perspective: A Case Study of Hubei Provincial Museum	English Literature and Language Review
9	Art	Study on Multimedia Visual Design of Intangible Cultural Heritage in Lingnan	Education Research Frontier
10	Economics & Trade	Visual Communication Design of Intangible Cultural Heritage based on Internet+	Journal of Literature and Art Studies

Secondly, generally speaking, the 3-stage training mechanism is applicable to students in all majors, for example, International Languages, Economics and Trade, Business, Management, Finance, Accounting, Mathematics and Statistics, Computer Science, and Information Technology. Considering the funded "Big Innovation Plan" research training projects over the past three years (Table 2), students in non-language majors contribute more scientific research outcomes than students studying language majors. These results are consistent with those of Liu and Gao (2018), in their analysis of project information from the National College Student's Innovation Training Program. Similarly, the majority of winning teams from the university "Challenge Cup" competition are students from non-language majors (Economics, Finance, Computer Science & Information Technology and Accounting), as summarized in Table 3. In summary, students majoring in science and engineering perform better than students majoring in language studies, both on a quantitative and qualitative basis.

Table 2
Funded "Big Innovation Plan" scientific research training projects (2017 to 2019)

	2017	2018	2019
Non-language major	42	42	41
Language major	12	20	11

Table 3
Teams obtaining "Challenge Cup" awards (2017 to 2019)

	Special class prize	First class Prize	Second class prize	Third class prize
Non-language major	26	49	65	135
Language major	3	5	11	30

3. DISCUSSIONS

This study highlights a key finding that students majoring in science and engineering perform better than students in language studies majors, both quantitatively and qualitatively, based on project information from the "Great Innovation Plan" and "Challenge Cup" initiatives. A possible reason for this is that students majoring in science and engineering have made more effort on "Great Innovation Plan" and "Challenge Cup" competitions than students majoring in language studies. In addition, they also participate in "National Mathematical Contest in Modeling", "National College Students Statistics Modeling Contest", and "International/National Programming Contest". Students majoring in language studies usually take part in various language-related competitions to develop their professional skills. The prestige of awards from the notable competitions (Table 4) can profoundly impact their future career, enhancing their academic prowess and marketability for employment after graduation. Therefore, a high-efficacy training scheme design should link with the characteristics of the major. We suggest that periodical evaluation and adjustments should be arranged, so as to keep improving the efficiency of the 3-stage training mechanism.

Table 4
Competitions having emphasis on language skill

	Competition	Level
1	National English Competition for College Students (NECCS)	National: A Level
2	Star of Outlook Talent Competition	National: A Level
3	National Interpreting Competition	National: A Level
4	"FLTRP" National English Public Speaking Contest	National: A Level
5	"FLTRP" National English Debating Competition	National: A Level
6	Literary Translation Competition	National: B Level
7	Shanghai Business English Debate Contest	National: B Level
8	Multilingual Relay Interpreting Contest	National: B Level
9	National Academic English Vocabulary Contest	National: B Level
10	Five-Minute Research Presentation Competition	National: B Level

In our view, the 3-stage training mechanism benefits both students and faculty members. For students, it is beneficial in tapping their scientific research potential, while for faculty, it provides them with valuable opportunities to set up networks via a professional learning community (PLC). As shown in Table 5 and Table 6, both students and faculty most value interdisciplinary communication /collaboration as part of their professional development. Other benefits, as indicated by students and staff, are those highlighted in past studies by Kinkel and Henke (2006), Santonen (2009), and Heather et al. (2011).

Joining an interdisciplinary team serves to broaden students' horizons and provide them with networking opportunities, which allow them to improve their learning efficiency through diversity. Community initiatives to aid learning, such as PLC, have attracted attention in educational research circles for decades. Stoll et al. (2006) summarized five key beneficial characteristics of PLCs: (1) shared values and vision between members; (2) collective responsibility; (3) reflective professional inquiry; (4) enhanced opportunities for collaboration, and (5) promotion of group and individual learning. In contrast to traditional PLCs which are usually composed of professors in the same major, PLC in terms of the 3-stage training mechanism relates to a community of faculty having diverse multi-major backgrounds. These PLCs offer additional features over their traditional counterparts, specifically that (1) members' expertise and knowledge base are completely different, fostering diversity; (2) they offer a multidisciplinary resource for teaching and research collaboration; and (3) their makeup presents new challenges in terms of management. The challenges in an educational sense are to understand the benefits and drawbacks of the 3-stage mechanism PLC, and ensure that these are used to enhance organizational effectiveness and allow for higher levels of faculty development to be attained.

Table 5
Selected feedback from students in regards to the 3-stage mechanism

Question	What is the most valuable gain from the training?
Rank 1st	Join an interdisciplinary research team and learn a lot from other students;
Rank 2nd	Develop relationships with professors and learn how to do research step by step;
Rank 3rd	Enhance knowledge from textbooks and improve competence;
Rank 4th	Develop interests and explore prospective field;
Rank 5th	Academic writing skill and oral presentation skill

Table 6
Selected feedback from faculty in regards to the 3-stage mechanism

Question	What are your suggestions about the training mechanism?
Rank 1st	Faculty should be encouraged to set up professional learning community for interdisciplinary collaboration;
Rank 2nd	It is too late for some students to take part in research project;
Rank 3rd	Without persistence, some students give up easily;
Rank 4th	The efficiency is reduced under flawed assessment system;
Rank 5th	Fund should be financed to support the first two training stages.

CONCLUSION

China is very determined to cultivate creative and innovative talents to respond to its needs for sustained development transforming its labor-intensive economy to one that is driven by knowledge and innovation (Xie, 2009; Zhang et al. 2012; Pang and Plucker, 2013). Tapping the scientific talent and drive of undergraduate students is an essential strategy to enhance innovation in science and technology, and to ensure the country is best placed to address future challenges. The 3-stage training mechanism we have introduced allows for identification of key talent in the undergraduate student pool, and allow for such talent to be nurtured to enhance its future potential. In addition to the benefits to undergraduate students, university faculty benefit from the 3-stage training mechanism in terms of learning and networking, specifically through the development of professional learning community (PLC) environment.

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