Feasibility Research on an EAP Course for Science and Engineering Students in China

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Abstract—**With the growing internationalization of higher education and talents cultivation, EAP has been debated extensively in recent years in China with respect to its form, content and function in the system of college English. Under these new circumstances, a research-oriented polytechnic university in Beijing has launched an EAP course for the science and engineering students since 2013 based on its discipline strengths, talents cultivation goals and students' needs analysis. This paper first introduces the course design in detail, and then investigates its feasibility and effectiveness, with empirical data analyses indicating that this course could considerably promote students' basic language skills and academic communicative competence, activate their intrinsic motivation and help them prepare for the future academia.**

Index Terms—**EAP course, science and engineering students, feasibility and effectiveness, academic communicative competence**

I. INTRODUCTION

With the growing internationalization of higher education and talents cultivation, EAP has been debated extensively in recent years in China with respect to its form, content and function in the system of college English. Meanwhile, China's National Plan for Medium and Long-term Education Reform and Development (2010-2020), issued by China's Ministry of Education, has placed a strong emphasis on developing college students' practical academic communicative competence, stating that "large numbers of talents shall be cultivated that are imbued with global vision, well-versed in international rules, and capable of participating in international affairs and competition". Under these new circumstances, college English teaching, as an integral part of higher education, if still sticking to basic language skills development as the major objective, could no longer satisfy college students' expectation of high-quality foreign language education, meet the demands of internationalized quality education and keep up with the nation's social and economic development. In addition, with the credit hours of English curriculum to be slashed soon, it is essential to redefine the role of college English teaching and establish a more competence-targeted system. In fact, many Chinese scholars (Zhang, 2011; Wang, 2013; Shu, 2013; Cai, 2014) have pointed out that college English teaching could shift from general English to English for Academic Purposes (henceforth EAP) to cultivate students' academic English proficiency and communicative competence in support of their future academia and career development. Similar voices also have been reflected in the administration of many Chinese colleges and universities. A survey conducted in 2010 by the National Foreign Languages Teaching Advisory Board under China's Ministry of Education found that among the surveyed 120 "985 Project" and "211 Project" universities, 66.6% laid down "the cultivation of academic English proficiency" as their "important" and "quite important" college English teaching objective (Wang & Wang, 2011).

As a branch of English for Specific Purposes (henceforth ESP), EAP refers to the teaching of English with the specific aim of helping learners to study, conduct research or teach in that language (Flowerdew & Peacock, 2001), and includes two sub-types: English for General Academic Purposes (henceforth EGAP) and English for Specific Academic Purposes (henceforth ESAP). The former focuses on common features of broad academic texts while the latter emphasizes the disciplinary differences in language use (Ye, 2013). In China, English courses are primarily delivered in the first two years of college study, and most students are not intensely exposed to technical knowledge and scientific research. Compared to ESAP, therefore, EGAP in theory is highly appropriate to be the content of college English teaching and bridge the gap between general English and ESAP.

Based on discipline strengths, talents cultivation goals and students' needs analysis, a research-oriented polytechnic university in Beijing has launched an EGAP course for the science and engineering students since 2013 to replace the traditional general English, with the aim of developing their academic English proficiency through the exposure and practice of common language features embodied in broad academic discourses. This EGAP course has been designated as compulsory for an elite program with top students selected upon their entry into the university, and also made available to other undergraduates as optional. In terms of contents and characteristics, there has been no similar course designed by other universities in China and no direct reference for consultation. Thus this paper attempts to investigate the feasibility and effectiveness of this EGAP course, in the hope of providing feedback and reference for the burgeoning EAP teaching especially in broad disciplines at home and abroad.

II. CONTENTS AND CHARACTERISTICS OF THE EGAP COURSE

The ultimate goal of EAP teaching is to enable students to meet the literacy demands of the academy through text and context (Johns, 2014). Both textual and contextual perspectives should be drawn together especially in academic writing (Flowerdew, 2011; Tardy, 2011). If students don't study textual variety and disciplinary ideologies that infuse genres, they can, and do, fall on their faces when they attempt to read and produce texts in their classrooms (Johns, 2008). Thus students need to learn what matters most in their areas of study and what are the expected ways in which they should behave in their performance (Butler, 1990) as academic writers in the cultures and texts of their specific disciplines (Johns, 2016). They also need to learn how to present themselves to their readers in their disciplinary contexts (Ochs, 1992; Strauss & Feiz, 2014), and in doing this they can gradually be involved in their academic community as they perform and position themselves. In addition, students should be viewed as researchers (Johns 1997, 2014) and encouraged to correlate the EAP learning with their disciplinary research. In other words, for an EAP course, the ideal practice is that the language input and output are closely related and drive each other forward.

The theoretical ideas above are reflected in the EGAP course design and implementation by the research-oriented polytechnic university in Beijing. The course, tailored for science and engineering students, is aimed at: 1) developing students' basic language skills such as academic reading, academic listening, note taking, question raising and oral presentation, 2) cultivating their generic cross-disciplinary academic skills, for instance definition, description, explanation and argumentation of terms and concepts, formulas and symbols, tables and figures, systems and mechanisms, processes and procedures, and 3) imbuing them with the core elements of major academic discourse genres encompassing structural models, discourse features, rhetorical strategies, discourse community, communicative purposes etc. Its contents and major objectives are presented in Table 1. To realize the objectives, a genre-based approach is taken to acquaint the students with the most common target genres in their academic career development, including but not limited to research/grant proposal, lab/research report, literature review and research paper. In addition, a task-based approach is also incorporated into in-class and after-class writing assignments and oral presentations to consolidate the learning effect. At the end of this course, students are required to submit a final paper in the form of literature review, lab report, research proposal, or engineering designs, and present it orally within study groups to be teacher-and-peer assessed.

TABLE 1
CONTENTS AND MAJOR OBJECTIVES OF THE EGAP COURSE

Unit	Contents	Major Objectives
1	Terms and Concepts	1) Use various ways of defining unfamiliar terms and concepts within texts; 2) Get acquainted with the basic syntactic structural pattern and its variations of an intensional definition; identify the types of information in an extended definition; 3) Give an intensional definition and an extended definition of a technical term or concept; 4) Enhance stylistic awareness of written and spoken academic discourse; 5) Understand definitions of terms and concepts when listening to a report, talk, or interview.
2	Symbols and Formulas	1) Acquire basic skills to read and write mathematic symbols and formulas; 2) Get acquainted with syntactic structures to explain symbols and formulas; 3) Get acquainted with verbs, prepositions, adverbs, and connectives frequently used in texts containing symbols and formulas; 4) Follow grammatical rules when writing sentences containing symbols and formulas; 5) Distinguish technical and semi-technical vocabulary from general vocabulary in textbooks.
3	Tables and Figures	1) Understand that visuals such as tables and figures should interact with verbal texts to achieve effective communication; 2) Use various expressions and structures for making reference to tables and figures; 3) Use accurate words, expressions, and structures to describe trends, patterns, comparisons, increase, decrease, etc.; 4) Interpret the data from tables and figures for different purposes; 5) Develop students' skills to take notes when reading a lengthy report.
4	Overviews and Reviews	1) Identify the types of information and common structural patterns of overviews and reviews; 2) Explain the various purposes of citing references in academic texts; 3) Increase awareness of consistency in citing and documenting references; 4) Distinguish critical evaluation from descriptive summary of sources; 5) Note down the main points of university lecture introductions.
5	Systems and Mechanisms	1) Identify the typical structural pattern of texts that describe engineering systems and their components; 2) Identify the common types of information included in the description of components of engineering systems; 3) Use accurate expressions and structures to describe components of an engineering system and their functions; 4) Describe processes in explaining how an engineering system works; 5) Note down the main points of university lectures.
6	Processes and Procedures	1) Use a variety of sentence structures to define various manufacturing processes; 2) Identify the basic elements or types of information included in defining a manufacturing process; 3) Identify the procedures or steps of various CO_2 capture and storage processes; 4) Use the right words, expressions, and structures to describe the sequence of procedures; 5) Use accurate verb-noun collocations in describing the procedures of CO_2 capture and storage processes.
7	Properties and Characteristics	1) Understand engineering variables that are used to describe properties of materials; 2) Develop language skills to inquire about properties and characteristics of materials; 3) Use accurate language to describe properties and characteristics of different types of materials; 4) Develop the awareness of optimizing material selection based on engineering requirements; 5) Understand talks and interviews which discuss properties and characteristics of chemical elements.
8	Tests and Experiments	1) Increase students' stylistic awareness of textbooks, lab manuals, and lab reports; identify language features in the descriptions of experiment or test procedures in textbooks, lab manuals, and lab reports; 2) Explain the reasons for tense switching in the descriptions of tests and experiments; 3) Increase students' accuracy in using verbs and verb forms when describing test procedures or test methods; 4) Increase students' accuracy in using propositions when describing test setups and test procedures; 5) Note down the main points when listening to talks and interviews.
9	Types and Classifications	1) Increase students' awareness of organizing complicated information by classification; 2) Develop students' note-taking skills when reading academic texts and give oral summaries with the help of the notes; 3) Use diagrams to describe the complicated structures of texts; 4) Distinguish the authors' generalizations from citations of specific studies; 5) Distinguish the main points from redundant details when taking notes of a talk or interview.

In response to course design initiatives, the teaching materials embody four distinguishing features: authenticity, relevance to science and engineering disciplines, genre varieties and great teaching value, as shown in Table 2. Reading materials are extracted from original English textbooks, monographs, reports etc., and listening materials are from authentic interviews, lectures, reports and open courses of some world's prestigious universities. The majority are strongly related to broad science and engineering disciplines, and the rest are intended for developing students' critical thinking and awareness of cross-disciplinary stylistic differences. To genre varieties and teaching value, both material selection and task design aim for the multi-facet manifestations of the course contents. For example, on how to compose literature reviews, written and spoken materials cover narrative, argumentative, critical and analytical literature reviews from various sources. In terms of communicative purposes and discourse community, micro-linguistic features and macro-structural patterns in various genres of literature reviews are exposed to students at the levels of word, sentence, paragraph and discourse. Moreover, what students read and listen to would be reflected in their writing and oral performance. The input and output knit together to consolidate students' learning and develop their dynamic view of language use via the observation of various academic discourses and the completion of target tasks. As a whole, it is expected to cultivate students' accuracy in language use, stylistic consciousness, and pragmatic and communicative competence.

Apart from the textbook plus supplements at around 10,000 words in every unit, students are encouraged to read and refer to academic papers in their own research interest for writing and speaking tasks, in order to satisfy their extra needs and activate intrinsic motivation.

TABLE 2
TYPICAL READING TEXTS AND LISTENING MATERIALS IN THE EGAP COURSE

Unit	Contents	Reading texts	Themes of listening materials
1	Terms and Concepts	· Lasers · Defining Critical Thinking · Critical Thinking in Every Domain of Knowledge and Belief	· Carbon · Geo-engineering · Nano particles · Magnetism
2	Symbols and Formulas	· Electrical Circuits · Fundamental Physical Dimensions · The Newtonian Modification of Kepler's Third Law	· University course introduction · Newton' assumptions · The equation $E=mc^2$ · Fibonacci numbers
3	Tables and Figures	· Status of the US Science and Technology Workforce · U.S. Manufacturing in International Perspective · The 2007-2009 Recession	· Statistic parameters · Progress of human health · Global climate change · Carl Friedrich Gauss's experiences
4	Overviews and Reviews	· Manufacturing Engineering · Overview and Issues for Implementation of the Federal Cloud Computing Initiative · Urban Ecology as an Interdisciplinary Field	· Introductory lectures of university courses · A lecture about environmental protection · Urban planning
5	Systems and Mechanisms	· The Internal-Combustion Engine · GPS Receiver Technology · Battery Manufacturing for Hybrid and Electric Vehicles	· An introductory lecture about biomedical engineering · Working mechanism of a hybrid car · Solar energy system
6	Processes and Procedures	· Manufacturing Processes · Overview of CO2 Capture Technologies · Alternative Fuel Vehicles: Which Shall Win the Race to Commercialization?	· Manufacturing process of an automobile · Working process of a 3D printer · Power generation of a PC plant · Production of plastic bags
7	Properties and Characteristics	· Electrical, Mechanical, and Thermal Properties of Materials · Engineering Materials · Materials for Consideration and Use in Automotive Body Structures	· Properties and applications of aluminum · Supply of phosphorus · Properties of uranium and its applications
8	Tests and Experiments	· Modulus of Elasticity, Modulus of Rigidity, and Bulk Modulus of Compressibility · Results of Material Properties Testing for Aluminum Specimens · Electric Potential, Electric Field	· Newton's experiment-based mathematical thinking · The story about Newton and Leibniz · Georg Cantor's insight and achievements
9	Types and Classifications	· Health Impacts of Liquid Biofuel Production and Use: A Review · Robot Control Architectures and Motion Autonomy · History and Overview of Vehicle Structure Types	· Types and applications of GPS · Features of different types of robots · Fuel types · Significance of industrial design

III. RESEARCH METHODS

In order to grasp a global view of the course's feasibility and effectiveness, this study tracked all 64 students in the elite class and 101 students in two optional classes, and collected data on their course learning via classroom observation, interview and questionnaire. Classroom observation, together with interviews, was conducted to each class once a week to provide feedback on constructing the questionnaire. After a pilot test, the adapted questionnaire employed a 5-point Likert scale with overall reliability at 0.83, and was composed of four parts: personal information, learning process, study feelings and gains. At the end of the course, the questionnaires were administered to both types of classes, with 164 valid ones returned. Afterwards, follow-up interviews were conducted to complement questionnaire data.

Collected data was analyzed from a quantitative and qualitative perspective. Frequency analyses and independent-samples T test were applied to questionnaire data by SPSS 17.0, and the statistical results were tested against observation notes and interview scripts.

IV. STATISTICAL ANALYSES AND RESULTS

A. Learning Process

SPSS frequency analyses show that for reading materials plus supplements, 32% of the elite class finished reading around half and 56% completed more than 3/4, in which 5% read all. For optional classes, the corresponding figures are 44%, 41% and 2%. It indicates that most students could finish the majority of weekly 10,000-word academic discourses at their own learning pace. Besides textbook materials, students were encouraged to search for and read academic papers in technical fields interesting themselves. Statistical results demonstrate that 81% of the elite class read at least 3 extra papers while completing each writing task, with 60% 3-4 papers and 21% more than 5. To optional classes, it is

91% reading at least 3 extra papers, including 42% 3-4 papers and 49% more than 5. The figures above indicate that most students could handle the large quantity of language input with relatively high motivation and autonomy.

Listening materials in this course are selected from authentic academic interviews, lectures, reports, seminars etc. For every unit, the total length of listening materials is about 40 minutes. Most Chinese college students have rarely been intensively exposed to such oral discourses before when it comes to whether language difficulty or academic content. Frequency analysis reveals that 28% of the elite class finished about half of all listening materials. 50% finished no less than 3/4, with 6.5% completing all. For optional classes, the corresponding figures are around 40%, 40% and 11%.

Data analyses above indicate that academic genres and the large quantity of language input are feasible and workable to most students in both classes. They could adjust their autonomous learning pace to satisfy their individualized needs, which is further verified by the extra reading of at least 3 academic papers every week.

B. Learning Gains

Frequency analyses were also conducted to investigate students' feelings and attitudes towards the course effectiveness in promoting their overall academic English proficiency.

For the course effectiveness in reading abilities development, the number of students stating almost no help is zero in both classes. 76.2% of the elite class and 87% of optional classes chose the scales "quite helpful" and "very helpful." Similarly, almost all the students thought that this course was helpful to enhance their oral English proficiency, with 71% of the elite class and 69% of optional classes claiming "quite helpful" and "very helpful."

It thus can be concluded that a vast majority of students held a very positive attitude to the course learning, and agreed that their academic reading abilities and communicative competence were considerably fostered and promoted.

C. Significant Differences between the Elite and Optional Classes

Independent-samples T test was used to determine any significant difference between the two classes in course learning. Test results show that there is no significant differences in three variables: the learning process of reading and listening materials and the effectiveness of group presentation in improving students' oral English competence. As calculated in frequency analyses, almost half of the elite and optional classes finished more than 3/4 reading and listening materials, and nearly all students confirmed the form of group presentation was conducive to their oral English.

Independent-samples T test reveals that significant differences exist in five variables, as indicated by two-tailed significant levels far lower than 0.05 in Table 3. For the first three variables, t-value and mean difference are all negative, which means compared to the elite class, optional classes regarded reading materials and writing tasks as more difficult and had more study pressure. This is probably due to the fact that the elite class were selected with relatively higher English levels as a whole. On the other hand, in spite of the differences, optional classes finished the reading and listening materials almost as well as the elite class with no significant difference in the learning process found, which further proves the feasibility of providing this EGAP course to students with different English proficiency.

For the last two variables in Table 3, t-value and mean difference are also negative, which shows optional classes read more extra academic papers while completing each writing task and thought of this course learning as more helpful in bettering their academic reading abilities. In other words, as well as reflected in frequency analysis results, both types of classes have benefited considerably from this course, while optional classes stated more gains.

TABLE 3
SIGNIFICANT DIFFERENCES BETWEEN THE ELITE AND OPTIONAL CLASSES

Elite class vs Optional classes		Levene's Test for Equality of Variances		t-test for Equality of Means			95% Confidence Interval of the Difference	
		F	Sig.	t	Sig. (2-tailed)	Mean Difference	Lower	Upper
1. Difficulty of Comprehending reading materials	Equal variances assumed	1.825	.179	-3.398	.001	-.57609	-.91105	-.24113
	Equal variances not assumed			-3.355	.001	-.57609	-.91582	-.23635
2. Study pressure	Equal variances assumed	.038	.846	-3.167	.002	-.41775	-.67838	-.15712
	Equal variances not assumed			-3.100	.002	-.41775	-.68453	-.15097
3. Difficulty of Completing writing tasks	Equal variances assumed	5.744	.018	-4.341	.000	-.74603	-1.08558	-.40648
	Equal variances not assumed			-4.196	.000	-.74603	-1.09817	-.39389
4. Effectiveness in promoting academic reading competence	Equal variances assumed	1.878	.172	-3.189	.002	-.31117	-.50387	-.11847
	Equal variances not assumed			-3.276	.001	-.31117	-.49892	-.12343
5. Extra reading of academic papers	Equal variances assumed	4.519	.035	-2.959	.004	-.44916	-.74887	-.14945
	Equal variances not assumed			-2.983	.003	-.44916	-.74692	-.15140

D. Student Interview and Classroom Observation

The recordings of student interview were taken down and merged with classroom observation notes. The summation of students' responses presents that despite some complaints of rigorous course requirements with insufficient credit hours, the majority of students have claimed considerable gains in their overall language competence. First, their basic language skills have developed enormously with language use accuracy improved and technical and semi-technical vocabulary accumulated. Second, they have acquired some generic academic skills such as defining a term, describing a table and explaining a mechanism. Third, they have had a stylistic and functional consciousness of discourse genres, structural patterns, rhetorical strategies etc. while composing academic texts for different communicative purposes. Next, their consciousness of academic norms has been established especially when it comes to in-text reference citation and styles. At last, extra reading of academic papers has promoted their literature search and summation abilities, and moreover, teaching materials covering broad science and engineering disciplines have expanded their academic horizons and activated their interest in scientific research.

V. CONCLUSION AND IMPLICATIONS

This study investigated the feasibility and effectiveness of the EGAP course launched by a research-oriented university in Beijing for its science and engineering students, since there is no similar course at home for quick reference. Data was collected through questionnaire, student interview and classroom observation, and analyzed from a quantitative and qualitative perspective. Results demonstrate that this course is feasible, workable and effective to both the elite class and optional classes. Most students could finish a large proportion of the authentic science-and-engineering discourses in the textbooks and extra read every week at least 3 academic papers in their own research fields. Consequently, they have reported considerable gains in overall language competence and acquired some certain basic language skills, vocabulary and generic academic skills. Moreover, their stylistic and functional consciousness of academic discourse genres has been developed through the observation and analyses of authentic materials at discourse and metadiscourse levels, and further consolidated in completing targeted tasks. Surprisingly, compared to the elite class, optional classes have stated more gains through the course learning, which implies that this course would be feasible and effective to more science and engineering students in more universities.

This study primarily focused on empirical data analyses, and did not further research into students' written and spoken discourses for more evidence. Since there has been no similar EGAP course specifically designed for science and engineering students in China and thus no direct reference, students' language competence development also needs to be verified in comparison with general English teaching in future study.

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