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Integrated Pedagogy for Specialty Courses in Chinese Engineering Education*

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Specialty courses bridge a student's university education and future occupation. This paper discusses an integrated pedagogy to cultivate a broader, global engineering perspective among Chinese students to enhance their critical thinking and research skills. Two kinds of pedagogies based on the curriculum order are integrated with traditional lectures: English language literature review and Project-Based Learning (PBL). This integrated pedagogical approach was applied in three different kind of engineering courses at three different schools in three different Chinese universities. Student feedback and self-evaluation shows that the literature review method helps them improve their specialty area English level, as well as gain a better grasp of textbook theories and concepts. Meanwhile, PBL helps students develop process-oriented approaches to real-world problem solving and collaboration. Findings show that Chinese students experiencing the integrated pedagogy accept the method, and report a better understanding of textbook content than through passive lectures alone.

Keywords: integrated pedagogy; Chinese higher education; collaboration; evaluation

1. Introduction

Engineering students must cultivate the critical thinking and collaborative skills needed to solve new problems and find better solutions to old challenges. Critical thinking includes problem solving skills as well as an ability to stay up-to-date, alert to cutting-edge techniques and theories arising across the globe and across disciplines that might be applicable to their field. Engineering students therefore, need to develop a global perspective; engineering education is called upon to instill the skills necessary to search, discover, and critically assess the international literature. Research relevant to pressing engineering challenges occurs all over the developed and developing world, and is generally reported to the global community largely in English language publications. Therefore, a working knowledge of scientific English, regardless of mother tongue, is a component of a global engineering perspective. Reading and understanding the literature however, is not enough, an ability to engage in a creative process to define or solve a problem is essential for engineering students to succeed. Students must also cultivate the ability to collaborate on projects and solve problems in a team environment. Solving even simple problems often requires more expertise beyond the capability of a single individual. For freshmen majoring in mechanical engineering, it has been shown that the implementation of a trans-disciplinary mechanical design project is an effective way to cultivate these skills [1].

In China, engineering education specialty courses can be a vehicle to impart these professional skills to the next generation of practical engineers. Specialty courses, unlike fundamental courses such as mathematics and physics, and fundamental specialty courses such as circuits, and analog and digital electronic techniques, bridge the gap between theoretical knowledge and the accelerated technological development they will encounter in the future. Most Chinese undergraduates do not realize that the recent technical literature is an invaluable aid in specialty courses that focus on real world applications of theory and concepts [2]. In addition, the Chinese one-child policy has led to significant number of single-child university students with less spirit of cooperation.

The integrated pedagogical approach as adopted in specialty engineering courses and described in this article promotes critical thinking in a way suited to the diverse educational environments in China. Students are guided through extended reading to search the English language literature according to keywords found in textbook content; keyword based schemes could define engineering education

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[3]. Subsequent assignments are adjusted in response to student feedback to lead students in a process of guided discovery [4]. This English language literature review approach supports a Project-Based Learning module that focuses on problem solving skills. These methods have been deployed widely abroad; but in China, these two approaches have not been applied together in a synergistic way to promote critical thinking and awareness of the literature relevant to the field of engineering. A key concern for educators is student acceptance of the integrated pedagogical approach and its emphasis on problem solving rather than rote learning. China still has a long way to go, but engineering education specialty courses however, can be a vehicle to impart these critical thinking skills to the next generation of practical engineers.

The rest of paper is organized as follows. In Section 2, an overview of Chinese universities, students, and their special challenges are presented. The conceptual and practical contents of the integrated pedagogy carried out in Chinese three universities are described in Section 3. An evaluation and analysis of the questionnaires is discussed in Section 4. Section 5 summarizes the results and insights drawn from this study as well as its limitations and directions for future work.

2. Special challenges in Chinese engineering education

Integrated pedagogy combines two educational methods: Project-based Learning (PBL) and literature review [5]. PBL provides students with generic professional skills such as problem-solving ability, team skills, adaptability, communication skills, self-directed learning, and self-assessment skills [6]. PBL has been applied worldwide in engineering education and has proven to be an effective and innovative pedagogy [7]. It emphasizes student centered instruction in realistic working conditions and scenarios, and is as relevant to Chinese engineering students as it is to students elsewhere in the world.

Many educators have introduced Project Based Learning (PBL) in their teaching and applied it widely in the training of international engineering students [8, 9]. Proper use of PBL makes it possible to deliver both technical content and generic professional skills, such as in a specialized course [10]. For example, a design project that provides students a real engineering experience through a hands-on, Lighter-Than-Air (LTA) vehicle project is a way to support engineering students in their ability to think creatively and work together [11]. PBL in electrical power systems engineering education might be a means to develop collaborative work styles. Embedded systems can only be learned through cooperative and progressive design experiences [12]. Numerous studies have focused on suitable ways to provide these experiences [13, 14], while initiatives and cooperation is leading trends in embedded systems [15]. The teaching objective is to bring embedded software closer to computer science students [16]. This pedagogy is adaptable and applicable across the disciplines, but especially useful in engineering education.

Our integrated pedagogy links PBL to a search and review of the international engineering literature published in English. A guided English literature review benefits Chinese university students because it broadens their specialty knowledge as well as exposing them to the writing styles and vocabulary common in scientific English. Chinese undergraduates have a long history of learning English out of context, as a subject in its own right, not as a research tool integrated into science and technical classroom environments. Subsequently, Chinese students do not have enough application environments to practice these specialized oral and written English language skills, leaving them ill-prepared for the professional workplace they will encounter after graduation.

Literature reviews are a normal part of coursework in western higher education [17, 18] but is relatively rare in Chinese universities. To address this deficiency, Chinese universities have purchased access to scientific literature databases focusing especially on those from abroad. Responding to the importance of the literature in scientific and technical fields, many databases have been made more systematic and easier to use [19]. However, without guidance, Chinese undergraduates have no enthusiasm or motivation to read scientific or technical papers since they lack the advanced English and the general domain knowledge required to understand the content. Research [20] shows that while a few undergraduates do make use of the scientific literature for mathematical modeling and architecture design; nevertheless, the majority of Chinese students have never searched Chinese, let alone the English databases. Our integrated pedagogy makes searching and using information a priority and therefore makes English language competency relevant in relation to problem solving tasks.

There are progressive steps to help students learn to review the English literature. First, all students must have better command of English fundamentals and related specialty theories, both are learning objectives in their junior year coursework. During this year, students will finish their College English coursework and will have completed several fundamental specialty courses. The second prerequisite for an English language literature review is abun-

dant free access to electronic databases. The origin and history of each university in China is distinctive and each school implements the educational strategy of Chinese government in a unique way, reflecting its pattern of development. Thus, every university has its own approach when buying databases to cover all of its major research areas. This will in turn, shape the range and depth of electronic resources available to students at any particular institution.

Chinese universities are divided into five levels according to their history and prestige: C9 League, Project 985, Project 211, public universities, and private universities. The first four categories are managed by Ministry of Education of China, other ministries, and local governments as a nested hierarchy. Private universities are supervised by local government or public universities. The respective numbers of universities are shown in Table 1. Electronic databases were introduced to China less than thirty years ago but have been acquired by every university; although there are differences in database categories due to prestige, specialties taught, and economic support. The numbers and types of literature databases for selected universities in each category are shown as examples in Table 1. Different universities have their feature specialties, so the electronic databases available are based on the university's own relative emphasis. All in all, the databases are enough for faculty and students to do high level research.

Despite availability however, these resources are rarely put to good use by students in Chinese universities. A survey of Chinese universities showed that only 5% of undergraduate students search foreign language databases (96% of the databases are English) as compared with 63% of faculty and 71% of graduate students. Understanding foreign language databases demands both professional knowledge and fluent English, only junior and senior undergraduates have that ability [21]. Chinese collage students however, study English because they are compelled to pass the Collage English Test (CET) band 4 organized by Education Ministry of China. The majority, especially those attending key universities, must pass CET band 6 with a vocabulary of 5500 words. Theoretically, this vocabulary should enable students to read specialty literatures, but students however, are exposed to literary not scientific materials. Thus, even if they have high CET-6 scores, the overwhelming majority of students encounter obstacles when reading scientific literature since they have no systematic training in reading technical papers. Therefore, training in scientific English writing is important in Chinese university settings.

Our integrated pedagogy ties together three elements; problem solving, collaborative learning, and guided search and discovery of the international engineering and technical literature. This approach applies well-tested techniques in ways specifically adapted to the Chinese academic setting and the characteristics of Chinese students. The objective is to impart critical thinking skills necessary in the contemporary workplace. A key concern is student acceptance of the integrated pedagogical approach as opposed to traditional methods of instruction that focus on memorization and rote learning. We suspect this problem is not unique to China and therefore examples of localization and adaption of advanced educational methods is relevant across the developing world.

3. Integrated pedagogy experimental design

Our integrated pedagogical approach was first applied at Wuhan University (WHU). In order to verify its wider adaptability, the authors in WHU invited two other Chinese universities, Wuhan University of Technology (WUT) and Hubei University of Technology (HBUT), to join this project. These two universities are classified as Project 211 and Public Universities, respectively, while WHU is classified as Project 985 as defined in Table 1, so this assessment can reasonably represent the utility of our pedagogical approach across the spectrum of Chinese universities. We consciously applied the integrated pedagogy in different courses in different schools at these three universities. At Wuhan Uni-

Table 1. Example of Literature Databases in Chinese Universities*

		C9 League	Project 985	Project 211	Public Universities	Private Universities
Number of universities		9	39	116	1684	674
Type of database universities have (one example from belong)	Abroad	325	98	46	17	2
	Chinese	176	73	41	29	31
	temporary	0	13	54	36	6
	Sum	501	184	141	82	39

* Update of August, 2014.

versity, the approach was applied to an Over-voltage in Power System course in Electrical Engineering, At Wuhan University of Technology it was applied to Application of Embedded Systems in Computer Science Technology, while at Hubei University of Technology it was applied to Foundational Industrial Engineering in Mechanical Engineering.

Collaboration and teamwork are central to the integrated pedagogy as Chinese students have little experience with group learning and working environments, due to the one-child policy. We found that 71% students in the over-voltage power system class in Wuhan University are the only child in their families, 67% in the assembly system class at Wuhan University of Technology are only children, and 65% in Foundational Industrial Engineering class at Hubei University of Technology are the only child in their families. In class therefore, the students are encouraged to organize groups by themselves and help each other in the project processes.

The detailed structure of the integrated pedagogy includes: (1) four time slots reserved for literature review labs during the course. The topics are determined by the textbook and subject matter. During each lab students listed keywords and are asked to look for English language texts related to those keywords in the databases. The students are required to finish a review in Chinese of an English article in two weeks time, (2) a PBL assignment for students in groups of less than four is to be finished by the end of the course. At the last lecture, the representatives of each group give presentations about their own project to be assessed by a faculty jury. The specific procedures are detailed in the Power System Over-Voltage and Application of Embedded Systems subsections as follows.

3.1 Power system over-voltage (WHU)

This junior course runs 54 hours from early February to Mid-June in the School of Electrical Engineering. The aim of this course is to introduce the over-voltage on power systems caused by lightning and inner operations such as switch and fault. The physical theory and solutions for over-voltage are discussed in this course. In this course, concrete applications of theory are found in electronic databases. In 2013 and 2014, 54 and 142 students were placed in this educational project approach; overall 325 and 344 students took this course during those two years.

In this course, every student finished the literature review one week after the task had been assigned. During the extended reading project, every students' participation style was different, so were the keywords they were given. During this procedure, students could ask questions from instructors and assistants about the literature through class communication tools: email, online chat, phone calls, and office visits.

Students used the Electromagnetic Transient Program (EMTP) for simulation of over-voltage in power systems during the course. EMTP was written originally by Dr. Hermann Dommel in Germany in the mid-sixties [22]. Since then, different companies have developed different versions. The ATP (Alternative Transients Program)-EMTP is the most widely used version for switching and lightning surge analysis, insulation coordination and torsion oscillation studies, protective relay modeling, harmonic and power quality studies, HVDC and FACTS modeling [23].

Despite its age, EMTP is still used to analyze over-voltage phenomenon in power systems. [24–27] The EMTP simulation project at Wuhan University was linked to actual cases in a way that enabled students to apply their previous knowledge to strengthen their practical problem solving ability in the power system domain. Fig. 1 shows an example of a group students' outcome of ferroresonance from an end of term presentation.

3.2 Application of embedded systems (WUT)

The Application of Embedded Systems is a compulsory course in the School of Computer Science and Technology with 40 hours required, including six

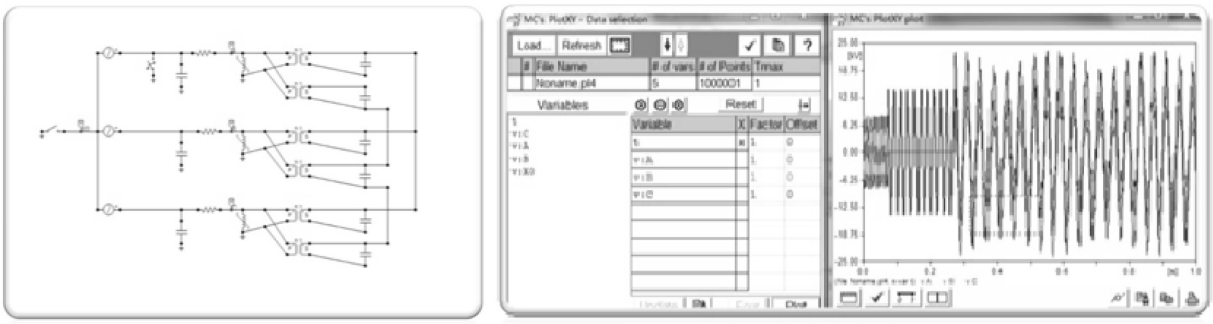

Fig. 1. An Example of PBL based on EMTP presented Ferroresonance, Model and Waveshape.

hours of lab experiments. Embedded systems are becoming widely applied in the areas of auto-control, household and medical appliances, and smart instruments. Thus there is a growing need to teach and train engineers to be well-versed in the design and development of these systems [28].

Teaching embedded systems as an integrated topic however, is a difficult task since it is diverse and multidisciplinary, ranging from micro-controller basics and real-time concepts to hardware/software co-design, distributed processing, reconfigurable computing, and system-level architecture design. To address this issue, the Application of Embedded Systems introduces the ARM architecture and application. The ARM framework is dedicated to solving electronic auto-control, computer science, and technology and communication applications.

In second term of the 2013–2014 academic year, 138 junior students were included in this project-based course out of a total 208 students taking this course overall.

Every period of literature review was the same as described in previous sections. There was considerable focus on students understanding what they were doing, why it is important, and how they will be assessed.

The PBL in this course at WUT was the design of a remote monitoring system based on a Wireless Sensor Network. Fig. 2 shows a screen-shot illustrating the software debugging interface.

3.3 Industrial engineering fundamentals (HBUT)

This course introduces the theory and knowledge of classical industrial engineering with 40 hours required; it is the core course for students majoring in industrial engineering. The teaching objectives are to ensure that students understand the formation and development of industrial engineering; help them grasp the overall concepts and master the knowledge, technology, and skills to improve production efficiency. In this course, every student completed a literature review in the same way as described previously; students also used the Industrial & System Engineering (ISE) software package, containing workplace videos, to analyze assembly line operations and assess productivity. Additionally, PBL at Hubei University of Technology challenges students with actual cases giving them an opportunity to apply theoretical knowledge to practical workplace problems.

4. Evaluation

This exploratory evaluation study sought to answer several questions about the participating student's

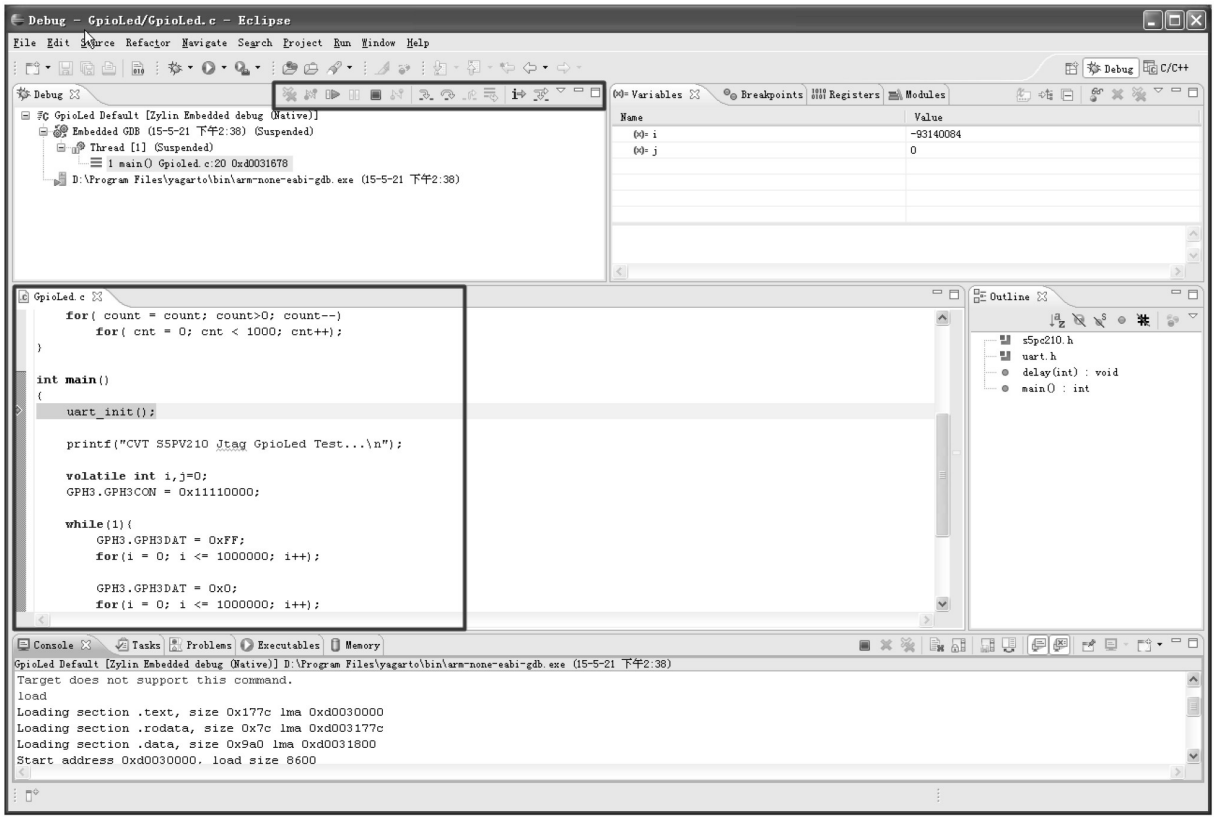

Fig. 2. Screen-shot Software debugging interface of PBL process.

attitudes towards the integrated learning experience combining PBL and English language literature review:

1. Are there differences in these students exposure to PBL and English scientific literature?
2. Would integrated learning experience change student attitudes about English language competency?
3. Would this integrated pedagogy change student attitudes about the importance of the English language literature to their studies and careers in their respective fields?
4. Would this integrated pedagogy benefit student perceptions of their understanding of textbook concepts?

To answer these questions a two part questionnaire was designed to be administered before and after their integrated pedagogical experience including dichotomous, Likert-type, and opened ended questions at the three universities. It was impossible to assign students to the experimental classes using an entirely random method. Students however, were assigned to the experimental classes in a standard way thus ensuring representativeness.

This study was a preliminary evaluation of student acceptance of the integrated pedagogical method to determine if wider application and more rigorous evaluation are warranted. We argue that while students at different universities differ in terms of exposure to the literature, course of study, and nature of the integrated program; nevertheless, their attitudes about PBL and exposure to the English language literature was similar after experiencing the integrated pedagogical approach.

4.1 The questionnaire

As shown in Table 2 and 3, two questionnaires to be administered before and after courses were created, based on the existing research [29–31]. One questionnaire was administered at the beginning of the first class (Before) to assess their abilities to fit to the pedagogies, while a second questionnaire was administered during the last class (After) emphasizes the feelings and achievements the students obtained. In Table 2, Question 1(Q1) and Question 5(Q5) are dichotomous with only ''yes'' and ''no'' response categories; indicated by the words 'yes' and 'no' in the columns for Q1 and Q5, the other questions shown in Table 2 are Likert-type questions with 'Strongly Disagree', 'Disagree', 'Neutral', 'Agree' and 'Strongly Agree' response categories. In Table 3, all questions are, multiple-choice with 'Strongly Disagree', 'Disagree', 'Neutral', 'Agree' and 'Strongly Agree' response categories. As shown in Table 2, 3, and 4, Question 3(Q3) of the ''Before'' survey and question No 2 (Q2) of the ''After'' survey was the same. Question 4 (Q4) of the ''After'' survey echoes question 3 (Q3) in the ''After'' survey that asks the students about their English proficiency. The last question of the ''After'' survey is an open ended question to obtain richer qualitative data.

Table 2. The ''Before'' survey results by university

	No.	Questions	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
WUT	Q1	I have looked for literatures before. If yes, why?	78.3% no				21.7% yes
	Q2	I think the literatures are benefit for my learning of textbook	2.60%	6.10%	26.10%	52.20%	13.00%
	Q3	I think the English Language literatures are important for my course study and future research	7.80%	7.00%	17.40%	41.70%	26.10%
	Q4	I believe my English Level now is enough for me to wholly understand the English Language literature?	11.30%	40.90%	35.70%	10.40%	1.70%
	Q5	I know the concept of PBL (Project-based Learning) before.	82.60% no				17.40% yes
	Q6	Expectation	0.80%	9.60%	27.00%	50.40%	12.20%
	Total						115
WHU	Q1	I have looked for literatures before. If yes, why?	50.0% no				50.0% yes
	Q2	I think the literatures are benefit for my learning of textbook	5.80%	4.40%	10.90%	44.50%	34.40%
	Q3	I think the English Language literatures are important for my course study and future research	5.80%	3.60%	13.20%	42.30%	35.10%
	Q4	I believe my English Level now is enough for me to wholly understand the English Language literature?	14.60%	54.00%	23.40%	6.60%	1.40%
	Q5	I know the concept of PBL (Project-based Learning) before.	83.90% no				16.10% yes
	Q6	Expectation	2.90%	2.90%	16.10%	54.70%	23.40%
	Total						137
HBUT	Q1	I have looked for literatures before. If yes, why?	85.7% no				14.3% yes
	Q2	I think the literatures are benefit for my learning of textbook	2.10%	2.90%	20.70%	30.70%	43.60%
	Q3	I think the English Language literatures are important for my course study and future research	3.20%	3.60%	15.40%	37.70%	40.10%
	Q4	I believe my English Level now is enough for me to wholly understand the English Language literature?	15.20%	61.30%	22.50%	1.00%	0.00%
	Q5	I know the concept of PBL (Project-based Learning) before.	90.60% no				9.40% yes
	Q6	Expectation	2.10%	2.40%	18.40%	63.70%	13.40%
	Total						105

Table 3. The "After" survey results by university

	No.	Questions	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
WUT	Q1	I think the literatures are benefit for my learning of textbook	5.02%	3.61%	12.05%	62.45%	16.87%
	Q2	I think the English Language literatures are important for my course study and future research	2.41%	6.64%	15.66%	48.78%	26.51%
	Q3	I believe my English Level now is enough for me to wholly understand the English Language literature?	6.02%	44.58%	42.17%	7.23%	0
	Q4	I prefer this pedagogy to conventional courses	2.41%	2.41%	20.69%	68.67%	5.82%
	Q5	This task stimulated my interest in learning in contrast to conventional lecture-based courses	3.61%	2.41%	14.45%	69.88%	9.65%
	Q6	What's your opinion about improving the extended education? (OA)					
	Total						113
WHU	Q1	I think the literatures are benefit for my learning of textbook	4.67%	1.87%	9.35%	54.20%	29.91%
	Q2	I think the English Language literatures are important for my course study and future research	4.67%	0.93%	7.48%	42.06%	44.86%
	Q3	I believe my English Level now is enough for me to wholly understand the English Language literature?	3.74%	50.47%	40.38%	5.41%	0
	Q4	I prefer this pedagogy to conventional courses	1.87%	1.87%	20.52%	60.76%	14.08%
	Q5	This task stimulated my interest in learning in contrast to conventional lecture-based courses	0.93%	1.87%	14.95%	69.17%	13.08%
	Q6	What's your opinion about improving the extended education? (OA)					
	Total						137
HBUT	Q1	I think the literatures are benefit for my learning of textbook	1.54%	2.48%	18.75%	58.20%	19.03%
	Q2	I think the English Language literatures are important for my course study and future research	1.35%	2.54%	7.48%	48.38%	40.25%
	Q3	I believe my English Level now is enough for me to wholly understand the English Language literature?	7.12%	65.47%	26.46%	0.95%	0
	Q4	I prefer this pedagogy to conventional courses	3.84%	4.06%	23.57%	58.28%	10.25%
	Q5	This task stimulated my interest in learning in contrast to conventional lecture-based courses	0.87%	2.62%	21.50%	64.89%	10.12%
	Q6	What's your opinion about improving the extended education? (OA)					
	Total						105

Given the exploratory nature of this study and its focus on understanding student acceptance of our pedagogy rather than educational outcomes, each survey question is treated independently rather than as a cumulative score. The frequencies of the answer categories are considered as ordinal level data for analysis, such as a comparison of the distribution of frequencies for answer categories between universities and before and after the integrated learning experience

4.2 Survey of WUT, WHU and HBUT students before the course

Table 2 shows a comparison of the responses to survey questions from students at Wuhan University of Technology (WUT), Wuhan University (WHU) and Hubei University of Technology (HBUT) at the beginning of the integrated learning experience. The individual responses were tallied and normalized for comparison. A Kruskal Wallis test on the "Agree" frequencies showed that for the three groups, WUT, WHU and HBUT were homogeneous as they have the same distribution for the Likert type questions 2, 3, 4, and 6; $\alpha = 0.05$, Significance = 0.368. However, looking at the distributions reveals subtle differences in the attitudes and expectations of students in these three universities and three different programs of study.

As seen in Table 2, students at WUT, WHU and HBUT all agreed that reading the English language literature is beneficial (Q2), 65.20%, 78.90% and 74.3%. They also reported that using the English Language is important to them and their studies (Q3), 67.80%, 77.40% and 77.8%, respectively.

Most students were not aware of PBL (Q5), 82.60% at WUT, 83.90% at WHU, 90.60% at HBUT, the three independent groups, showed little difference. Students at three schools had relatively high expectations from the course (Q6) but students at WUT and HBUT were not as strongly inclined to have high expectations from PBL (12% and 13.40%) as WHU students (23%).

This study showed that despite differences in exposure to English literature review methods, 50% of Wuhan University electrical engineering students and only 21.7% and 14.3% of Wuhan University of Technology and Hubei University of Technology students reported such experience; the majority of students, regardless of school or program, responded positively to this non-traditional (for China) teaching method

4.3 Survey of students at WUT, WHU and HBUT after the course

Table 3 shows a comparison of the responses to survey questions from students at Wuhan University of Technology (WUT), Wuhan University (WHU) and Hubei University of Technology (HBUT) after the integrated learning experience. All five questions out of six were Likert type questions with five categories. The individual responses were tallied and normalized for comparison. A Kruskal Wallis test on the "Agree" frequencies showed that for the three groups, WUT, WHU and HBUT were homogeneous as they have the same distribution for the Likert type questions 2, 3, 4, and 5; Alpha = 0.05, Significance = 0.368.

Nevertheless, differences do appear among the three schools, as WHU students were more likely to strongly agree (29.91%) on Q1, the importance of the English language literature than WUT students and HBUT students, 16.87% and 19.03% respectively. This was also apparent in the frequencies of the other questions, save for Q3, the student's self-assessment of their English language capacity, HBUT students (65.47%) were more likely to disagree that their English was enough than WHU and WUT students, 50.47% and 44.58%, respectively. In the case of Q5, students at WUT, WHU and HBUT agreed (69.88%, 60.76% and 64.89%) or strongly agreed (9.65%, 14.08% and 10.12%) that the PBL tasks stimulated their interest. In general, as Q 4 concerning student preferences shows, students preferred the integrated pedagogy at WUT, WHU and HBUT, agreeing (68.67%, 60.76% and 58.28%) or strongly agreeing (5.82%, 14.08% and 10.25%) with the statement, "This task stimulated my interest in learning in contrast to conventional lecture-based courses".

4.4 Analysis of two questions for "before" and "after"

In order to self-assess the students' improvement of their own ability after they apply the Integrated Pedagogy, the "Before" and "After" questionnaires ask the same questions. Question number 3 (Q3) in the "Before" questionnaire emphasizes the importance of the English language literature is the same as question number 2 in the "After" questionnaire while question number 4(Q4) in the "Before" questionnaire of English self-assessment is the same as question number 3(Q3) in the "After" questionnaire. Table 4 shows a comparison of domain specific English language proficiency before and after survey results combining the WUT, WHU, and HBUT disagreed, neutral and agreed frequencies.

Approximately 9% of the combined WUT and WHU participants became more aware of the importance of English to their studies and career. At the same time, their positive self-assessment of their English competency dropped by about 3% after experiencing the pedagogy, a result of a more accurate self-assessment encouraged through our integrated pedagogy approach.

5. Conclusions

Two kinds of pedagogies were integrated with traditional lectures in Chinese specialty courses: Project-Based Learning (PBL) and English language literature review. This integrated pedagogical approach was applied in three different kind of engineering courses at three different schools in three different Chinese universities.

Student feedback shows that students believe the integrated pedagogy featuring a literature review combined with PBL helped them gain a better grasp of textbook theories and concepts as well as experiencing an improvement in their specialty area English level. The questionnaire results show that: (1) Although there are three different universities with varying specialties, students responded positively to the integrated pedagogy; (2) A comparison of the

Table 4. A comparison of the combined WUT, WHU and HBUT agree and disagree response categories

Before and After Survey Results				
English Language literature is important to my studies *				
	Disagree	Neutral	Agree	Total
Q3. Before	10.34%	15.13%	74.53%	357
Q2. After	6.19%	10.32%	83.49%	339
My English level now is enough**				
	Disagree	Neutral	Agree	Total
Q4. Before	65.57%	27.18%	7.25%	357
Q3. After	58.41%	36.87%	4.72%	339

* $\chi 2 = 8.5366$, The P = 0.014006, significant at $p < 0.05$.
** $\chi 2 = 8.4526$, P = 0.014606, significant at $p < 0.05$.

before and after survey results shows that regardless of school, WHU, WUT, and HBUT, course participants became more aware of the importance of English to their studies and career; and (3) and student self-assessment of their English competency became more realistic. After experiencing our integrated pedagogy, students better understand the limitations of non-domain specific English instruction when the objective is not English competency per se; but rather an understanding of global literature and dynamic research areas useful for solving engineering problems. Thus, we believe the integrated learning experience will stimulate student enthusiasm for focused English self-learning relevant to engineering as well as providing them the tools to do so, through PBL. PBL helps students develop process-oriented approaches to real-world problem solving. Our results suggest that student's self-assessment of their abilities to analyze and handle problems increased. In this process, students can not only grow their expertise, but also strengthen their communication skills and develop their ability to collaborate.

This exploratory study extended the use of the integrated pedagogy to assess student acceptance of the integrated pedagogical approach. Our findings show that students gain a better understanding of textbook content than through passive lectures alone. However, successful PBL requires a great deal of instructor involvement; our results might be an artifact of this fact. Future research will include more students and more rigorous testing and evaluation of the approach, including a comparison to students in traditional classes with longitudinal studies of students after graduation.

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