EVOLUTION OF AN ACADEMIC ENGLISH COURSE FOR SCIENCE RESEARCH POSTGRADUATES (RPGS): A CASE STUDY AT THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY (HKUST)

Wei-Wah Claudia Wong

ABSTRACT

The demand for communication skills training for science research postgraduates (RPGs) has been increasing over the years. Many potential scientists and researchers in the industry are under enormous pressure to get published (Cargill, O'Connor & Li, 2012) and to attend conferences and seminars. In light of the aforementioned needs, all first-year HKUST science RPGs enrolled after September 2012 are required to take a discipline-specific academic English course entitled "Postgraduate English for Science Studies". It aims at providing science RPGs with academic writing and oral presentation training. This paper presents the evolution of this science ESP course, with a focus on the impact of course design and class activities on RPGs' learning. Data collected over two academic terms, including post-course questionnaires and other course materials, will be presented. Results suggested science RPGs found the ESP course most beneficial when more advanced topics were covered, such as title writing in manuscripts and dissertations, analyzing features of different science writing genres, as well as learning how to use analogies in science presentations. Authentic text analyses, individual consultations and presentation rehearsals are shown to be effective means to deliver learning materials to RPGs. ESP teachers should act as managers, facilitators and collaborators. Pedagogical implications and areas for further research will also be discussed.

Key Words: science ESP course, academic writing, academic presentation, Research Postgraduates (RPGs), curriculum development

Wei-Wah Claudia Wong

INTRODUCTION

Issues in ESL Academic Writing at the Postgraduate Level

Past research studies have shown that students who use English as a Second Language (ESL) appear to have difficulties in referring to sources and using them properly in academic writing (Davis, 2013; Pecorari, 2003; Pennycook, 1996; Petrić, 2012; Shi, 2012). Moreover, many publications on academic writing focus largely on plagiarism, recycling of source materials and/or student identity or voice (Abasi, Akbari & Graves, 2006; Flowerdew & Li, 2007; Li, 2012; Li & Casanave, 2012; McCulloch, 2013). However, most tend to be exploratory in nature, revolving around the difficulties and needs of language learning among research postgraduates (RPGs) in general but seldom on the effectiveness of the corresponding language support offered in a university setting. For example, Bitchener and Basturkmen (2006) reported that RPGs had limited understanding of the discussion of results section (DRS) in thesis writing. While all the participants in the study had completed a research methods course before they wrote their dissertations, they still wrestled with dissertation writing due to the ambiguous understanding of the functions of each section. Plakhotnik and Rocco (2012) quoted some studies that show the commonality of postgraduates' lack of academic writing skills that is essential to their studies. In the study of Coşkun, Baksi and Özçakmak (2013), they examined 168 postgraduate theses on writing education in Turkey and found that most of them researched linguistic forms of writing, e.g., grammar and vocabulary, instead of other kinds of writing issues such as the delivery of subject knowledge to different readers. As the number of postgraduate theses increased sharply from 2006–2010 in Turkey, the authors recommended that "more detailed studies which analyze the theses in terms of method, measuring instruments and findings should be conducted" (Coşkun, Baksi, & Özçakmak, 2013, p. 1530). This study implies that there is an urgent need to explore the type of language support that can facilitate English academic writing learning at the postgraduate level as the number of RPGs has been increasing worldwide over recent years. In short, more research should be carried out to understand the impact of curriculum design and class activities on RPGs' learning.

Language Education for Science RPGs

Scientists have to write and speak about science to both professional and lay audiences very often. Those who are non-native English speakers have to learn both the subject knowledge as well as the scientific language to communicate within and outside the science community. Courses that aim to cater to such needs of the science RPGs are usually categorized as English for Specific Purposes (ESP) courses. According to Dudley-Evans (1998), ESP courses mainly serve students who have specific needs and focus on language aspects that are tied with discipline-specific activities. In response to the surging need of science communication training among postgraduates, more and more ESP courses are being offered. Over the last decade, studies have been reporting the major difficulties faced by RPGs in the Middle East and in Asia (Al Fadda, 2012; Huwari & Aziz, 2011; Maros, Stapa & Yasin, 2012). In the study of Maros et al. (2012), RPGs expressed the importance of learning English because they have to read and write in English as well as to communicate with others at seminars, lectures and conferences. Similar challenges have been encountered by the research and development (R&D) workforce in China.Cargill et al. (2012) revealed that Chinese researchers who work in academia and industry are under pressure to publish (Qiu, 2010). Given the fierce competition for jobs and publications in the science sector, there is indeed a pressing need for institutions to train their RPGs to write academically before their graduation. As Weiss and Newman (2011) suggested, writing is often challenging to scientists as there is "insufficient training at universities" (p. 3941). Another reason that RPGs might end up wrestling with academic writing is their lack of awareness of the importance of English in their science research life. Many perceive obtaining outstanding research results as the only and ultimate goal during their study. To summarize, "writing likely presents a weak link in the communication of…science in general" (Weiss & Newman, 2011, p. 3941) and there is an urgent need to formalize language education in the science postgraduate curriculum. Yet, research on such ESP program evaluations is scarce and somewhat outdated (Hutchinson & Waters, 1987; Swan, 1986; Tsou & Chen, 2013). In 2013, Tsou and Chen proposed a revised framework for ESP program evaluation. The major assumption of the framework lies in the belief that ESP program evaluation should be done based on the stakeholders' goals, which can

be realized by three elements: course evaluation, learner assessment and teacher participation and empowerment. As the authors mentioned in the paper, the scale of this type of research is large as the aim of this framework is to provide a comprehensive evaluation of the ESP course. This could lead to difficulties in measuring all the items simultaneously. Nevertheless, this framework still provides a basis for educators and researchers to evaluate future ESP courses.

Besides writing, RPGs also have to equip themselves with appropriate speaking skills to communicate professionally with others in different academic contexts. M. Davis, Davis and Dunagan (2012) purported that public speaking skill is gaining importance among RPGs, as they have to present at different academic meetings and/or conferences. Back in 2007, Tomazou and Powell examined how science doctoral students' communication and transferrable skills could be developed through organizing and presenting at a doctoral symposium. Both the faculty members as well as the students found the experience beneficial as they could seek relevant information through talking to professionals in the field while presenting their research work to an expert audience. From this brief review, it can be seen that more training with a focus on explaining scientific concepts to both lay and expert audiences is gaining importance in the RPG curriculum. In light of all these issues and needs arising from the increasing number of science RPGs, universities should provide English language support in order to equip them with the necessary communication skills.

Science Curriculum at HKUST

Given the aforementioned demand for English training for science RPGs, all students admitted to the School of Science of the Hong Kong University of Science and Technology (HKUST) after September 2012 have to take a compulsory academic English course in their first year. The objective is to learn manuscript and dissertation writing as well as presentation skills that are critical to their RPG study. Since this is a seminal RPG academic English course for the School of Science, some fine-tuning has been made over the year in order to better accommodate students' learning needs. In addition to taking the compulsory English course, science RPGs can also sign up for writing or speaking workshops in their leisure time to focus on a specific skill in which they are weak. Due to the limited scope of this paper, details about the workshop will

not be elaborated upon, and the focus will be on the development of the academic course.

Objectives of the Study

The main objectives of this study are to illustrate the evolutionary process of this English course and to explore the impact of curriculum design, class activities and assessments on RPGs' learning. It is hoped that language teachers at the university level can be more aware of the urgent needs of science RPGs and the possible pedagogies to be adopted if they are to develop an English course for their students.

METHODS

As stated in the previous section, one of the key objectives of this study is to examine the impact of such a course on science RPGs' English learning; therefore, the nature of this study is exploratory rather than experimental. As a result, the curriculum set out for two semesters and the students' responses to the course were collected and scrutinized closely. In the following sections, the design of the course curriculum will be presented, followed by the description of the data collection of RPGs' responses to the course and their perceptions of their own learning. The section will end with a brief description of the data analysis method.

Design of the Course

Before designing the course curriculum, a meeting with the liaison person of the School of Science was set up with an aim to learn about the science RPGs' learning needs. Together with the information obtained from the meeting and research findings, an outline for the course was drafted. In fall 2012, there were 14 weeks and each week had two lessons of 80 minutes each; while in the fall of 2013 there were only 13 weeks in total. As the School of Science expressed concerns repeatedly about their students' writing, more time was dedicated to teaching writing than speaking. Out of the 14 weeks, almost seven weeks were spent on teaching academic writing, and each lesson incorporated guided reading and analysis of different text samples to accommodate students' divergent writing needs because they were from different majors.

Students were required to write a summary and a mini-literature review on their own. Individual writing consultations were scheduled for each student in the middle and at the end of the term. The aim was to give students time to raise questions and issues about what had been covered in the course.

As for speaking, four weeks were dedicated to the training and preparation of science presentation skills, including presentation rehearsals before the assessments. Students came in small groups to present once in front of a small audience. Feedback was given immediately based on their rehearsal performance as well as visual aid design. They could then return and revise their presentation contents and visuals before the assessment. As the presentation assessment was video-recorded, a link to the students' presentation video was sent upon the completion of their assessment so that they could identify areas for future improvement.

Another speaking assessment, namely micro-teaching, was introduced in fall 2013. Students had to take turns to teach a small group of fellow classmates with similar academic backgrounds about the writing features of a particular section in a paper. For example, a student might teach the group how to write the discussion section of a paper in physics in the micro-teaching assessment. Through this activity, RPGs could develop their English communication skills that are essential when they become Teaching Assistants (TAs) in their departments. Another change was with the teaching materials. In fall 2012, a textbook named *Writing Scientific Research Articles: Steps and Steps* by Cargill and O'Connor (2009) together with self-written materials were adopted for the class. However, the RPGs' responses to the use of this textbook were mixed, and they did not find it particularly helpful. Therefore, self-written materials and supplementary readings were used in fall 2013. The summary of the two course schedules is shown in Table 1.

Table 1.

Summary of the Fall 2012 & Fall 2013 Curriculum

Time spent	Fall 2012 Topics	Fall 2013 Topics
7 weeks	Manuscript and dissertation writing skills: including the writing of introduction, methods, results, discussion, conclusion and abstract.	Manuscript and dissertation writing skills: including the writing of introduction, methods, results, discussion, conclusion and abstract. Micro-teaching assessment
1 week	Summary writing individual consultation	Summary writing individual consultation
3 –4 weeks	Pair presentation training, rehearsal, revision of contents and assessment	Pair presentation training, rehearsal, revision of contents and assessment
1 week	Critique writing individual consultation	Critique writing individual consultation

Data Collection

As the nature of this study is exploratory rather than experimental, both quantitative and qualitative data were collected and analyzed. Qualitative studies usually aim at gaining a holistic comprehension of the target phenomenon (Polit, Beck, & Hungler, 2001), and this study shares the same goal. To understand the impact of curriculum design and class activities on RPGs' learning, university-administered and self-administered post-course questionnaires were used in order to elicit RPGs' views towards the course design, course activities and their learning. The former questionnaire includes more general questions about the course and teaching measured by a Likert-scale of five and two open-ended questions, while the latter one yields more information about

the RPGs' perceptions towards specific class activities and assessments on their learning. Traditionally, questionnaires are suitable for collecting general views about a certain topic but are often criticized for the lack of the "underlying meaning of the data" (Gable, 1994). In light of this shortcoming, some "follow-up" questions were added to the questionnaire which functioned as a written interview in the hope of getting a better understanding of the information collected. The first round of interviews took place in the last class of fall 2012 while the second round was conducted through a Google Survey in fall 2013. No face-to-face interviews were conducted with the RPGs due to the limited time for data collection and their hectic schedules, which made them unavailable to spare extra time for this research project. The course had three classes offered in both fall 2012 and fall 2013 and were taught by two teachers. I taught two classes while the other teacher taught one. Due to privacy concerns, only questionnaires administered in the author's two classes are presented in this paper.

Data Analysis

Coding was used to identify the patterns emerging from the data set. Keywords and RPGs' responses from the questionnaires were first identified and were compared across RPGs enrolled in different semesters. RPGs' background information will also be highlighted when comparing divergent responses towards different class activities. The main purpose is to understand the factors or the types of activity that are conducive to learning among science RPGs.

RESULTS AND DISCUSSION

In this section, results of both the university-administered and self-designed course evaluation results will be presented and discussed. Students' comments and assessment samples will be provided whenever necessary to support the discussion. The aim is to understand the factors that might have impacted the RPGs' learning during the process.

General Course Evaluation Results

There were 39 students enrolled in both of my classes in fall 2012 and fall 2013. Thirty-three and 32 RPGs responded to the university-

administered questionnaires, respectively, while 35 and 30 responded to the self-administered questionnaires. The university-administered questionnaires did not record students' academic background, whereas the self-administered questionnaires did record students' academic background. Students signed up for the section at their preferred time slot. Please see Table 2 for the distribution of RPGs in the self-administered surveys.

Table 2.

Academic Background of RPGs Who Responded to the Self-Administered Questionnaires

Major / Semester	Fall 2012	Fall 2013
Life Science	10 (28.6%)	10 (33.3%)
Chemistry	5 (14.3%)	4 (13.3%)
Physics	10 (28.6%)	6 (20%)
Mathematics	9 (25.7%)	6 (20%)
Did not specify	1 (2.8%)	4 (13.3%)
Total responses	**35**	**30**

The university-administered feedback questionnaire mainly surveyed two aspects of students' perceptions of the course, namely course effectiveness and instructor effectiveness. In both semesters, the course and the instructor were both very well received. More than 95% of the RPGs responding to the questionnaire agreed that the course effectiveness was good or very good while 100% agreed that the instructor was effective or very effective. In relation to the measurement of course effectiveness, RPGs evaluated the relevance of course contents to their learning needs, the overall organization of content, the extent to which the course had helped improve their language/communication skills, and had helped evaluate their own learning progress. Apart from rating the instructor's overall effectiveness on their learning, RPGs also

evaluated the extent to which the instructor helped create a positive learning environment in class, explained the learning points clearly, provided useful feedback and guidance, and encouraged class participation. A summary of the evaluation scores is shown in Table 3.

Results from the two rounds of questionnaires are similar for all ten items, which suggest that RPGs in general were satisfied with the course and the instructor. One point to note is the increase in agreement percentage from 84.65% in fall 2012 to 93.75% in fall 2013 for item 4, i.e., more RPGs felt that the assessments they did in fall 2013 were helpful to evaluate what they had learned in the course. It might be due to the fact that more time and formative feedback were given to review their work before submission. Moreover, the consultations done in fall 2013 involved returning RPGs' assignments and giving brief oral feedback so that they could plan ahead for their next assignments. In order to further understand the factors that contributed to the success of the course, students' open-ended comments should be examined closely. The following comment illustrates the relevance and importance for RPGs to take this science ESP course:

"This course teaches me how to start reading a scientific paper, as well as how to write up a summary or critique. I do think that this course has helped me a lot as I am a new research student with not much experience in reading scientific journal articles. Now I feel more confident in reading them…[the teacher] is very enthusiastic in teaching us and has been very helpful." (RPG correspondent A, fall 2013)

Table 3.

Results of the University-Administered Evaluation Scores in Fall 2012 and 2013

Question	Rating – Fall 2012 (N = 33)	Rating – Fall 2013 (N = 32)
1. The course is relevant to my learning needs.	Strongly agree & agree: 96.9%	Strongly agree & agree: 96.88%
2. The course content has been well-organized.	Strongly agree & agree: 96.9%	Strongly agree & agree: 96.65%
3. The course has helped me improve my language / communication skills.	Strongly agree & agree: 87.9%	Strongly agree & agree: 87.4%
4. The assessment has helped me evaluate what I have learned in the course.	Strongly agree & agree: 84.65%	Strongly agree & agree: 93.75%
5. The instructor has helped create a positive learning atmosphere.	Strongly agree & agree: 100%	Strongly agree & agree: 96.65%
6. The instructor has explained the learning points clearly.	Strongly agree & agree: 97.05%	Strongly agree & agree: 90%
7. I have received useful feedback and guidance from the instructor.	Strongly agree & agree: 93.95%	Strongly agree & agree: 96.65%
8. The instructor encouraged me to participate in the learning activities.	Strongly agree & agree: 97.05%	Strongly agree & agree: 96.7%
9. Please rate the course overall:	Very good & good: 96.9%	Very good & good: 96.65%
10. Please rate the instructor overall:	Very good & good: 100%	Very good & good: 100%

The note about how to read or understand a scientific paper was brought up by numerous RPGs in both sets of questionnaires. This is not surprising as science RPGs in general focus more on the facts and figures and the research results of the paper rather than the linguistic or organizational aspects (North, 2005). Language teachers should then design activities that can help RPGs understand the linguistic and organizational features of articles in different disciplines. In the past, academic papers or dissertations followed the traditional Introduction-Methods-Results-Discussion (IMRD) model but researchers realized that the moves in research articles have been changing and have been studied more in the last three decades (Lin & Evans, 2012). The models of writing are evolving and teachers should not only introduce the traditional standard IMRD writing model to a class of RPGs with different academic backgrounds. In this course, writing samples from different disciplines were provided in class so as to raise their awareness. This led to a higher satisfaction index in the course questionnaires.

Course Objectives Evaluations

In both years, RPGs were asked to rank the extent to which the course objectives met their learning needs. A Likert-scale of four, with four being *strongly agree* and one being *strongly disagree*, was used to indicate one's agreement to the objective statement listed in the questionnaire. In the self-administered questionnaires, both batches of RPGs responded very positively (over 70% of agreement) to the course objectives, including the ability to write science articles, summarize key points and write a summary, critically review papers, and to present on a science topic using appropriate visual illustrations. However, in fall 2012, 97.1% of the RPGs agreed that they were able to write a critique of a research paper while in fall 2013, 63.3% of the respondents agreed that they learned how to write a literature review. Despite the fact that the nature of a critique resembles the literature review, RPGs who took the course in 2013 appeared to wrestle more with review writing. Some reasons recorded in the open-ended section of the self-administered questionnaire may explain this:

"[It is] a little difficult for me to write a review since I have not start[ed] my research." (RPG respondent B, Fall 2013)

"I do not know what it is, how it looks and what others expect to see in the literature review. It does not look like a summary that has a similar

74

format that we can follow…all I know about the literature review is there will be loads of references but still the requirement/contents are quite vague." (RPG respondent C, 2013)

To understand the problems encountered by the RPGs, excerpts from a mathematics student's and a chemistry student's literature review are included below respectively.

I am mainly talking about three papers with respect to Lie algebras and Lie groups. They are "The Dynkin index and -subalgebras of simple Lie algebras", "An atavistic Lie algebra", "Automorphisms of real 4 dimensional Lie algebras and the invariant characterization of homogeneous 4-spaces"respectively. In mathematics, Lie algebras are algebraic structures which were introduced to study the concept of infinitesimal transformations. And Lie algebra is a very important branch in mathematics. What's more, it is widely used in many parts of mathematics and physics. (Excerpt of the review from a math RPG)

Firstly, Tofighy et al. (2010) succeeded in synthesizing the CNT sheets and then oxidizing them with concentrated nitric acid (65%) to form an oxidized CNT sheet, and they used these two kinds of CNT sheets to detect the adsorption process of different metal ions of different concentrations. They found that the preferred order of metals adsorption on the oxidized CNT is $Pb^{2+}>Cd^{2+}>Co^{2+}>Zn^{2+}>Cu^{2+}$. Unfortunately, we are not told what kind of CNTs are used in the experiment, for example, single-wall carbon nanotubes or multi-wall carbon nanotubes. Different kinds of CNTs have different surface and physicochemical properties, and these diversities may lead to different adsorptions of metals. On the other hand, after nitric acid oxidation, there will be different functional groups developed on the CNTs, such as carboxyl, lactones, and phenols[4], but Tofighy et al. (2010) did not carry out the functional groups content analysis of their production, so we do not understand the effect of the heterogeneity of CNTs. (Excerpt of the review from a chemistry RPG)

The aforementioned comments and examples highlight two major issues pertinent to the literature review assignment: lack of knowledge about what to read for their own research and assignments, and lack of familiarity with the language features, format and content of a literature review. The writing excerpts reflect what most RPGs suffer from in their

writing, including the use of informal expressions and words such as *I'm mainly talking about, What's more*, and the lack of vocabulary to critique the literature. Current RPG respondents' data are in line with research findings on literature review writing. Melles (2009) found that PGs who use English as a Second Language (ESL) wrestled with the critical review of the literature due to the lack of academic vocabulary. Recently, a guide to energy science article writing also reported scientists' problems with structuring arguments, a key writing technique in the literature review and the discussion section (Weiss & Newman, 2011). The data here implies that curriculum developers should allow more time teaching the language features, organization and contents of the literature review section. Sample writings of different disciplines should be shown and discussed in class, though it should be noted that some disciplines do not have a lengthy review section as do the social sciences and humanities and thus may not follow the standard, traditional writing model (Lin & Evans, 2012). For instance, the outcome of pure mathematics is not "dependent on the interpretation of data and is essentially limited to a binary true or false" (McGrath & Kuteeva, 2012, p. 162), and the ultimate goal of pure mathematics research is to achieve simplicity, i.e., how to reduce the complex proving steps of a theorem. One student suggested that "it would be better if more time can be spent on how to write/what to be included in the literature review" (RPG respondent D, 2013). All in all, how much time the developer gives and the types of activities offered in class do have an impact on science RPGs' learning.

Another reason that science RPGs might find the literature review challenging ties with the different values they have regarding academic writing. North (2005) revealed that arts students tend to focus on the interpretation of the data, and they believe that extensive revision of an essay is essential while science students concentrate on reporting facts in their writings, and getting the "right answers" in their research is of crucial importance. From the interview data, the author suggested that science students did not appear to see the significant value of discussing any data or prior studies; rather they might perceive that as "waffl[ing]"or "padding" (North, 2005, p. 529).

As for spoken language training, RPGs in general agree that speaking about science should be taught in this course. Two comments found in the open-ended section of the university-administered questionnaire outline how the RPGs perceive the integration of the oral

presentation component in this course:

"…[this] course provides useful information about presentation skills which is of great help [to] us to conduct presentations in future." (Fall, 2012)

"It helped me with academic writing and presentation, which is very useful to my PhD program."(Fall, 2013)

Class Activities Evaluations

As for specific class activities that RPGs perceived as conducive to their learning, the results of the fall 2012 questionnaires are summarized in Figure 1.

In the self-administered questionnaires, RPGs were asked in the open-ended section what other activities helped them learn. Some activities such as online resources for autonomous learning, peer evaluation of writings, in-class writing practice and guidance from the instructor were named. One respondent in fall 2012 even stated that "theses in the math disciplines are structured quite differently [from] other science theses. I would strongly believe that my thesis will not follow the structures described in class". In light of these comments, the following activities were implemented in fall 2013 while planning for class activities. Figure 2 below shows the evaluations of the course activities that helped RPGs learn in fall 2013.
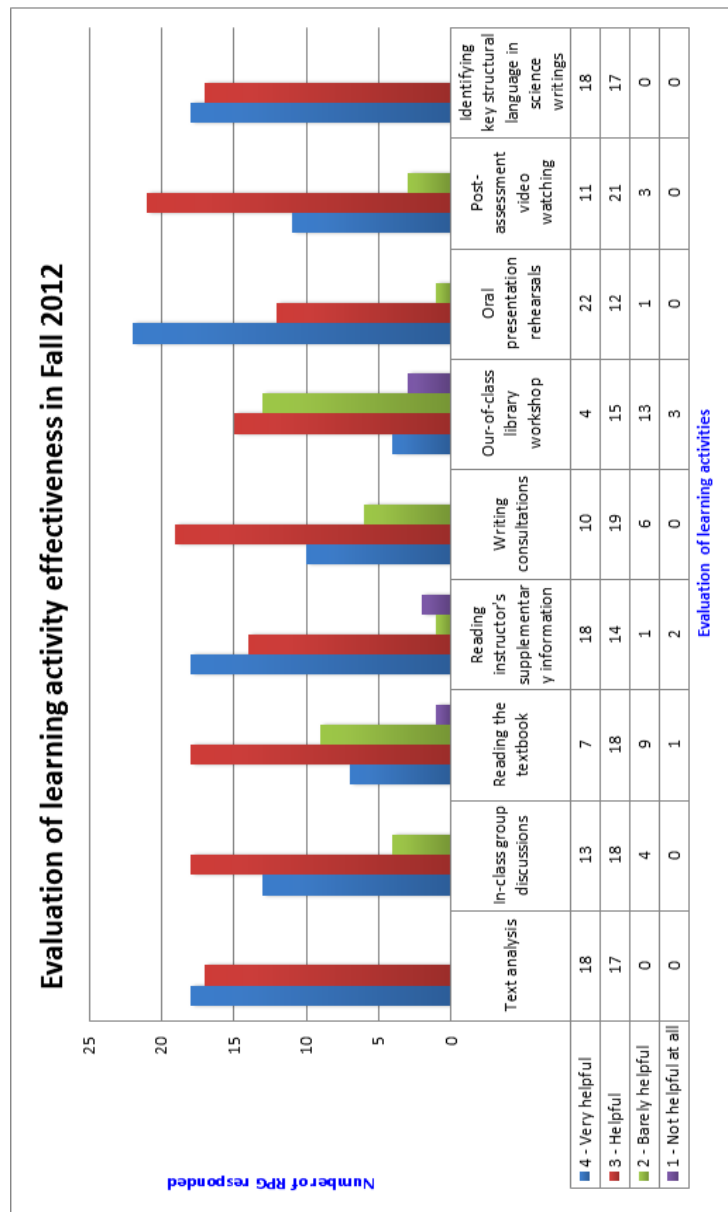
Evaluation of learning activity effectiveness in Fall 2012

	Text analysis	In-class group discussions	Reading the textbook	Reading instructor's supplementary information	Writing consultations	Our-of-class library workshop	Oral presentation rehearsals	Post-assessment video watching	Identifying key structural language in science writings
4 - Very helpful	18	13	7	18	10	4	22	11	18
3 - Helpful	17	18	18	14	19	15	12	21	17
2 - Barely helpful	0	4	9	1	6	13	1	3	0
1 - Not helpful at all	0	0	1	2	0	3	0	0	0

Number of RPG responded

Evaluation of learning activities

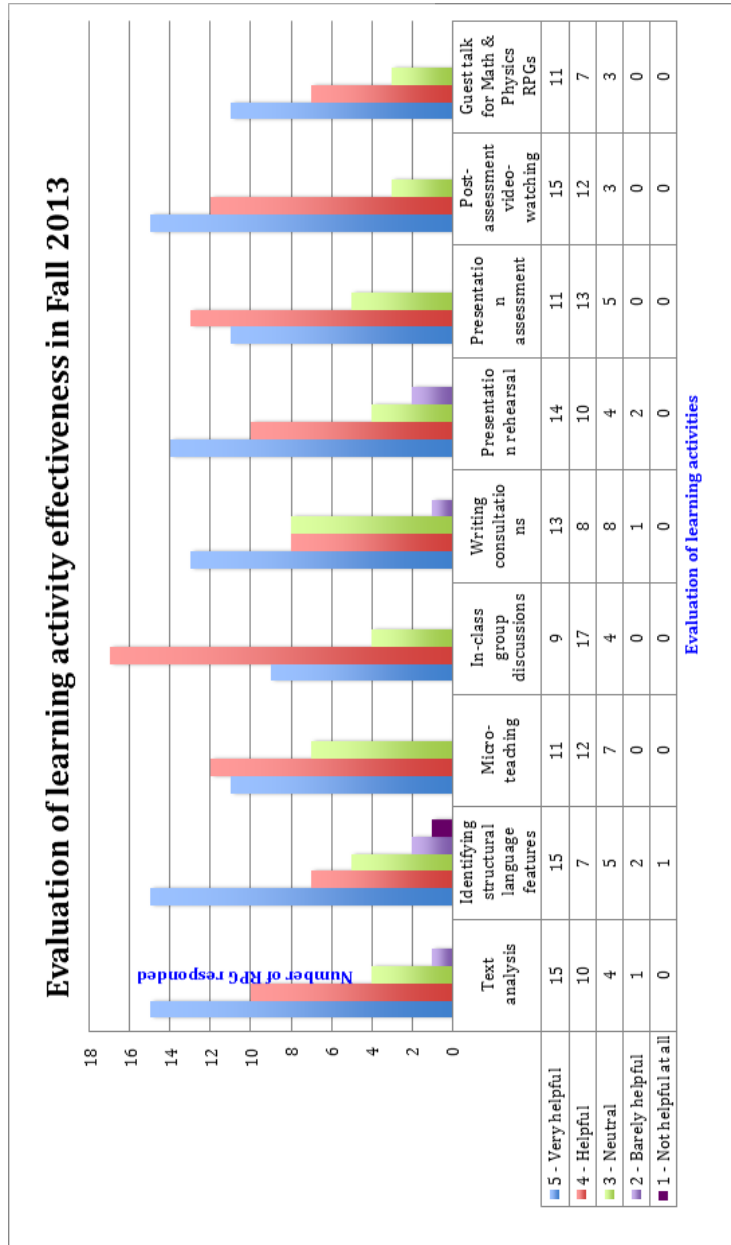*Figure 1.* Evaluation of learning activity effectiveness in fall 2012 – p.31

Figure 2. Evaluation of learning activity effectiveness in fall 2013 – p.32

It can be noted that in 2012, RPGs had to read the course textbook and to attend an outside-of-class library workshop while these two activities were removed in fall 2013. It was mainly because these two activities were not particularly popular among the students. The library workshop was about the use of Endnote, a referencing tool in academic writing, but most of the students had signed up on their own before the course started. Therefore, it was not necessary to be included as part of the course activities. In fall 2013, a guest speaker who holds a doctorate degree in mathematics was invited to give an informal talk to the math and physics RPGs on the importance of language learning in the science research field. This was organized in response to the comments that they made in the questionnaires that the writing requirements in math and physics are different from other disciplines, such as chemistry and life sciences, and it was very well received.

Class activities designed for these two years of teaching seem to have matched the course objectives, which have also brought a positive impact to science RPGs' learning. For instance, sample writing analysis, guided instructions on the structural language features in science writings, in-class group discussions and the writing consultations are all conducive to RPGs' learning of academic writing. Presentation rehearsals, assessment and post-assessment video-watching allow RPGs to be more aware of their own issues in speaking so that they can work on them in future. RPGs in particular embraced the video-watching activity (90% of the respondents found it useful) since they could reflect upon their own performance in the assessments and set a plan for further learning. Micro-teaching of science writing is beneficial to both writing and speaking training. On one hand, RPGs have to understand the language and organizational features of writing a particular section in an article in order to teach their classmates how to write it in the assessment. On the other hand, they are trained to manage their limited time for material delivery, their language use and the tasks designed for their classmates through this exercise. These skills are all transferrable when they become teaching assistants (TA) in their departments. The course objectives and class activities designed and realized in this course appear to be matching science RPGs' needs. The following respondent comment may conclude this section:

"Summary, pair presentation and micro-teaching are all good exercises to practice the 'output skills' (to express our views, to communicate with others) needed in our PG study. The presentation

rehearsal [was] excellent! I personally think that it would be better if more time could be spent on how to write/what to be included in the literature review." (RPG respondent E, 2013)

Pedagogical Implications

In the last section, RPGs' responses to the course design and the class activities have been discussed. This section will focus on the pedagogical implications of this study. Language teachers and faculty members might consider the following when developing or revamping a science ESP course in future.

Type of language support for science RPGs

From the two sets of questionnaire results and the open-ended comments, curriculum developers should include topics such as manuscript and dissertation writing and academic presentations in an ESP course at the postgraduate level. In particular, teachers should spend time discussing and working on the more advanced aspects in academic writing, such as the organizational differences between manuscripts and dissertations, language features in the respective sections in science writings, including tense uses and use of active and passive voice in different sections. Since many RPGs are novices to writing research summaries and literature reviews (Switzer and Perdue, 2011), a considerable amount of time, for example a few weeks, should be spent on teaching these two topics. One topic that can be added to the course is about title writing in science articles and dissertations. Soler (2007) analyzed titles in review papers and research papers and found that there are in fact different patterns of titles in different disciplines and paper formats. Findings from this paper definitely have pedagogical implications for language teachers and curriculum developers. As for speaking training, RPGs should not only be trained on basic presentation skills which they should have received in their undergraduate years. Language teachers should introduce the use of analogy in science presentations. Rule and Furletti (2004) stated that analogies are "valuable in science teaching" as they "help students make connections between new learning and previous knowledge of the real world, thereby conditionalizing the new world (p. 157). Yet, how to select the analogies to explain abstract scientific concepts remains a topic to be further investigated. All in all, language teachers should emphasize the

importance of analogies in scientific presentations in an RPG course.

Delivery of materials at the PG level

In this study, three major modes of delivery were very well received by science RPGs: learning about writing features through text analysis, getting feedback in individual consultations, and building confidence in presentation rehearsals. Language teachers are strongly recommended to look for authentic writing samples from different disciplines and publishers and guide the students through them in class. Xerri (2012) studied a small group of university students through action research on the use of authentic materials in a 12-week writing course. He found that students' confidence in writing as well as motivation in learning was augmented and students' writing fluency generally improved. This suggests that the use of authentic materials in class does have a positive impact on students' writing learning. Science students need special help in highlighting the organization and stylistic writing features in each section. Research studies have reported that writing seminars or courses do have a positive impact on students' writing, for example to develop a positive writing process and to understand their own writing weaknesses (Delyser, 2003; Maros et al., 2012). In the consultations and rehearsals, formative feedback that provides students a sense of direction for revising their work up to the expected standard should be offered (Kumar and Stracke, 2011). RPGs' higher satisfaction toward the statement "the assessment has helped me evaluate what I have learnt in the course" in fall 2013 might be related to the more in-depth formative feedback given. Apart from getting feedback from the instructor, presentation rehearsals allow RPGs to gain confidence and learn from their peers. Tomazou and Powell (2007) showed that RPGs' communication skills could be developed through organizing and presenting at student-led conferences. Docan-Morgan and Schimdt (2012) indicated that public speaking anxiety could be reduced by attending workshops for both native and non-native English speakers. My recommendation though, is to keep the number of students to a smaller size in the rehearsal, so that RPGs can build up their confidence gradually.

Roles of language teachers in an ESP PG course

In the university-administered survey, the instructor's effectiveness was also evaluated. This reflects that successful learning requires both a good curriculum and an effective teacher to facilitate learning in class. Language teachers who do not have a science background may have concerns or even reservations about teaching a science ESP course at the postgraduate level. In this study, three different roles were recognized in designing and teaching the course: manager, facilitator and collaborator. Brown (2007) discusses teachers' roles in an interactive classroom and the concepts of "manager" and "facilitator" are particularly relevant to the current study. When a teacher acts as a manager, s/he is in charge of lesson planning, maintaining students' learning motivation and monitoring their progress towards the goals while allowing flexibility and creativity in class. In this study, the instructor has accomplished this role by setting the course schedule for the class, designing different types of class activities that boost motivation and monitoring their progress in consultations. Students, on the other hand, can exercise their creativity and flexibility in their assignments, e.g., presentations and micro-teaching. This pedagogy is slightly different from content-based instruction as the focus of instruction in this ESP course still remains largely on language instead of its content (Brinton, 2003).

How can a teacher act as a facilitator in a science ESP course? According to Brown (2007), a facilitator encourages students to learn language through a discovery approach. In other words, teachers should raise students' awareness on certain language issues instead of explicitly instructing them on how to write using certain words and tenses. The following task created for the lesson "Introduction writing" exemplifies how a teacher can be a facilitator in class.

Task 2 –Language features of an introduction

Re-read the introduction of the two papers again. Pay attention to the language use. Answer the following questions:
- *What tense(s) is/are being used? Why?*
- *Is there any use of personal pronouns? Why/why not?*
- *What words are used to connect different sentences or ideas together?*

After the students completed the task, sufficient time was given to discuss their answers with their classmates and to share them with the whole class later. The purpose was to ensure that they have time to read, examine and think about the rationale behind the use of words and tenses

in writing the introduction in a science article. This type of task has worked well in the researched classes and is highly recommended to teachers who are teaching adult ESP courses at intermediate or advanced levels.

Finally, language teachers should act as collaborators in promoting collaboration and communication with faculty members. As Cargill et al. (2012) proposed, language teachers should set an "equal footing with science and technology colleagues" (p. 67) when collaborating on the contents of such an ESP course. This is especially important at the postgraduate level as RPGs take their supervisors' advice seriously. If the faculty members recognize the work language teachers do and put forward the message that language learning is important for scientists, RPGs will be more motivated in class and appreciative of what the language teachers have done. This is conducive to both teaching and learning in the long run. As a final remark, ESP course coordinators can consider offering coaching service to novice language teachers who have little or no experience teaching such courses. For example, the more experienced staff can go through the materials with the novice staff and underscore the rationale of the curriculum design and the diverse needs of the students as well as the similarities and differences between teaching an ESP course and an ESL course. Novice teachers on the other hand, can try to work on the tasks designed for the students and revise them accordingly under the supervision of more experienced staff. Regular meetings with faculty members will also be mutually beneficial. Language teachers will learn more about the needs of the students whereas the faculty members can better understand the roles and duties of the ESP teachers.

CONCLUSION

This study has reported the evolution of a science ESP course for RPGs and examined the impact of curriculum design and class activities on their learning. In addition, the rationale behind the course schedule, curriculum design, as well as the implementation of class activities, have also been illustrated. Giving sufficient time to learn and reflect on what has been covered in class is key to successful learning. Writing consultations and small-group presentation rehearsals will help RPGs build up their confidence and understand their weaknesses better. RPGs' positive responses to the course and the teaching as reflected in the

questionnaires have also been shown. To conclude, both teachers and RPGs should work together in order to promote language education in the science field. As more and more science RPGs are taking jobs in the industry instead of staying in academia, equipping them with good communication skills has become imperative for institutions. In future, investigation should be conducted on the learning effectiveness of offering one science ESP course or two courses that can have different focuses on different groups of RPGs. For example, life science and chemistry RPGs tend to follow the traditional writing model in dissertations and journal articles while mathematics and theoretical physics RPGs have different requirements in science writing. It is worth examining the needs of the math and physics students as they have received less attention in research on language learning.

Wei-Wah Claudia Wong

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CORRESPONDENCE

Wei-Wah Claudia Wong, Center for Language Education, The Hong Kong University of Science and Technology, Hong Kong
Email address: lcclaudia@ust.hk

科學專業英語科的一個演變:香港科技大學之個案研究

黃惠華
香港科技大學

近幾年,很多科學家與研究生都面對著發表學術文章和公開演講的壓力(Cargill, O'Connor & Li, 2012)。所以,關於這方面的培育需求也相應提高。有鑑於此,香港科技大學所有在2012年後入學的一年級科學研究生都必須修讀一個科學專業英語科(Postgraduate English for Science Studies),目的是在於提供科學學術英語寫作與演講方面的技巧訓練。本研究旨在演示這個課程的開發過程,重點是研究教材和教學方法對學生的影響。經過兩個學期的資料(包括期末問卷和教材)搜集,結果表示:研究生最能受惠於原著分析、個別輔導和演講彩排。在學術英語科中,英語老師擔當的角色應包括課堂管理者,協調員與合作者。

關鍵詞:科學學術英語科、學術寫作、學術演示、研究生、
　　　　　課程發展