Challenges of Globalization and Successful Adaptation Strategies in Implementing a 'Scientific Writing and Authoring' Course in China

Kaidi Yang,[†,§] Cun-Yue Guo,[‡,*] and Rainer E. Glaser[#,†,‡,*]

[#]Department of Chemistry, Missouri University of Science and Technology, Rolla, Missouri 65409, U.S.A.,

[†]Department of Chemistry, University of Missouri, Columbia, Missouri 65211, U.S.A.,

[‡]School of Chemical Sciences, University of Chinese Academy of Sciences, 19A Yuquan Road, Shijingshan District, Beijing 100049, P.R. China, and

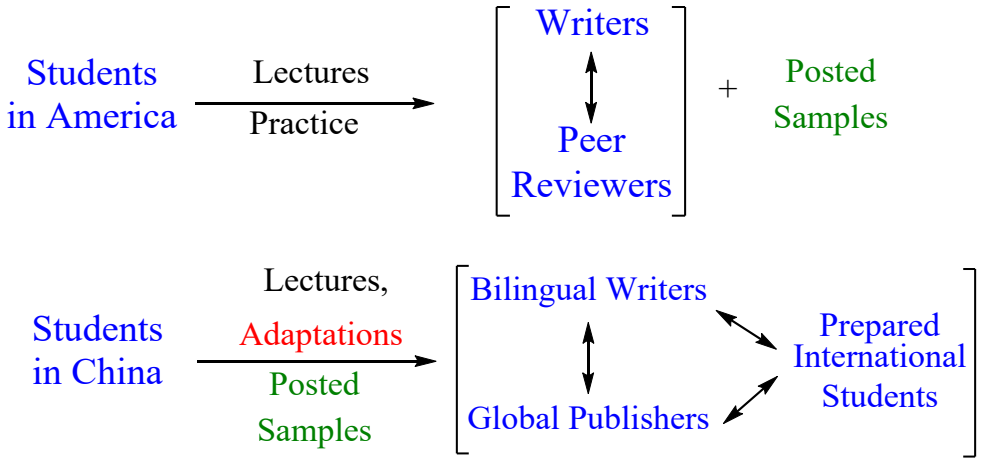
[§]Department of Chemistry, Northwestern Polytechnical University, 127 Youyi West Rd., Beilin District, Xi'an, Shaanxi, P.R. China

Email: glaserr@mst.edu, cyguo@ucas.ac.cn

ABSTRACT

This paper describes the adaptation of an upper-division undergraduate seminar course taught at the University of Missouri in Columbia (MU) to the Summer School Program of the University of Chinese Academy of Sciences in Beijing (UCAS). The course "Scientific Writing in Chemistry" addresses an essential need for science students across the globe to receive experiential education in scientific writing. An assignment-based curriculum was developed to instruct students on best practices in writing a scientific paper and to educate students about the scientific publication process and peer review. The semester-long MU course that included three meetings per week and with low enrollment was adapted to twenty-hour UCAS block courses with much higher enrollments. The drastic differences in scale and mode of delivery posed numerous non-trivial challenges and required modifications of the teaching goals. Because of the short duration of the summer courses, the MU curriculum with its focus on "working on assignments and working with rubrics" was adjusted to a curriculum which is based on "working with posted samples of completed assignments and working with rubrics" at UCAS. Instruction on publication ethics was emphasized and several adjustments were made to address cultural and language differences. Enrollment data and results of evaluations collected over five years (2011 – 2016) are presented to demonstrate the success of the adaptation. It is hoped that this paper will contribute to the wide and open dissemination of this "Scientific Writing" curriculum and, more generally, that the example of our course adaptation might encourage outstanding experts from many science, technology, engineering and mathematics (STEM) fields to contribute in a significant way to international education.

GRAPHICAL ABSTRACT



KEYWORDS

Graduate Education / Research < Audience, Curriculum < Domain, Communication / Writing < Pedagogy, Minorities in Chemistry < Topics, Student-Centered Learning < Topics, Problem Solving / Decision Making < Pedagogy, Constructivism < Topics, Upper-Division Undergraduate < Audience, Learning Theories < Topics, Ethics < Topics

INTRODUCTION

Building on a century of general education policy,[1] the National Science Foundation of the United States[2] recommended that science, technology, engineering and mathematics (STEM) teachers "… model good practices that increase learning; start with the student's experience, but have high expectations within a supportive climate; and build inquiry, a sense of wonder and the excitement of discovery, plus communication and teamwork, critical thinking, and life-long learning skills into learning experiences." We developed *Chemistry is in the News* (*CIITN*) to teach chemistry in the context of real-world issues and to expose students to some aspects of science communication.[3-7] In fact, science communication involves all kinds of interactions among STEM professionals and with the public. The central competence in scientific writing is technical communication in the STEM disciplines.

Table 1. Comparative Enrollment at MU (Spring) and at UCAS (Summer) in 2010 to 2016

Year[a]	Theme	Students Enrolled at MU, *N*	Students Enrolled at UCAS, *N*	
			Course 1	Course 2
2010	Aspirin and other Painkillers	32	289	—
2011	Dyes, Indicators, and Chemical Sensors	25	108	92
2012	Soaps, Detergents, and Ambiphiles	36	118	54
2013	Solar Energy	32	197	84
2014	Nutraceuticals: Sources and Functions	34	168	107
2015	Light-Based Technologies: Photocatalysis	31	—	—
2016	Nutritional & Health Benefits of Pulses	39	313[b]	—

[a]All course websites are publicly accessible; see refs. *12-18*. [b]Since 2016, the course is accompanied by a 10 h MOOC (see the text discussion).

The effective communication of scientific research is vital both to the scientific community and to a scientist's career. Proficient writing skills make collaboration within and across disciplines easier and more efficient. Skillful writing also attracts readers' attention and makes one's work stand out among thousands of other papers and makes the communication between

readers and authors more precise and effective.[8] It is not easy for students, even graduate students, to use their own language to describe chemical diagrams,[9] or to fully understand how to read spectra.[10] Thus, training chemistry students to express their scientific ideas precisely is as important as teaching them chemistry knowledge. And a chemistry teacher is better suited to teach scientific writing than a writing expert because the former understands the scientific underpinnings and knows better how to express the idea precisely.[11]

Fully recognizing and accepting the premise that scientific writing and publishing ethics are important elements in chemistry education, a *framework* was developed for an assignment-based curriculum to instruct students on best practices in writing a scientific paper and about the scientific publication process and peer review. Each implementation is unique because each employs a new curriculum, which is based on an overarching *theme* (Table 1, column 2), and all assignments are original with adapted online resources and rubrics for assessment. The assignments, associated data and sources, peer review devices including assessment rubrics, and samples of completed assignments are available online on the course web sites.[12-18] The curriculum was developed for the writing-intensive, upper-division undergraduate seminar course *Scientific Writing in Chemistry* taught at the University of Missouri in Columbia (MU). The curriculum meets the criteria for writing-intensive courses of MU's Campus Writing Program (CWP 2014),[19] and each implementation was reviewed and approved by an interdisciplinary group of faculty peers. It has been taught every Spring Semester since 2010, and we recently reported on the design of this curriculum and on results of evaluation[20,21] that demonstrated student interest in and acceptance of this curriculum.

Here, we report on the adaptation of the seminar course taught at MU to the Summer School Program of the University of Chinese Academy of Sciences in Beijing (UCAS). The MU

curriculum was developed for a semester-long (14 weeks) course with three one-hour meetings per week and with limited enrollment, and its adaptation to two one-week, twenty-hour, large lecture UCAS block courses taught in English posed numerous critical challenges because of the drastic differences in scale and mode of delivery (Table 1). Moreover, teaching a course in another culture adds a myriad of additional demands and difficulties. Clearly, some adaptations are necessary to ensure student learning and success in their own environment. Most importantly, the teaching goals needed to be adjusted. We will show how these challenges can be met, in part, by shifting from a curriculum based on "working on assignments and working with rubrics" at MU to a curriculum based on "working with posted samples of completed assignments and working with rubrics" at UCAS and the synergistic connection of the courses at MU and UCAS. Furthermore, in the lecture component, more emphasis was placed on instruction about publication ethics and responsible conduct of research (vide infra). Moreover, curricula with these goals are innovative in China and if one wanted to achieve systemic change, then it must be a teaching goal to achieve high student acceptance to ensure the establishment of a sustainable program. Results of evaluations collected over six years (2011–16) are presented to demonstrate the success of the adaptation. It is hoped that this paper will contribute to the wide and open dissemination of this *Scientific Writing* curriculum. More generally, the example of our course adaptation might encourage foreign experts from many STEM fields to contribute in a significant way to international education. Education globalization is a large and growing field with opportunities for students and faculty alike.

PUBLICATION ETHICS AND EDUCATION GLOBALIZATION

Ethics education is important for all parties involved in the science process, and it needs to become an integral part of science education. With the advent of globalization of scientific

publishing, the professional societies recognized the need for the formulation of professional ethics.[22] Courses on scientific writing are the obvious venue to teach students about ethics in writing and publishing. Hence, we are beginning this article with a description of educational materials available for instruction on scientific writing and publication ethics. In parallel with the globalization of scientific publishing, and perhaps less well known, education globalization has become a large and growing field with opportunities for students and faculty alike, and we are describing such efforts to spotlight the magnitude of international education.

Resources for Scientific Writing and Publication Ethics Education

Several resources on scientific writing and communication are available to address scientific publications. Some books are comprehensive and aimed at working professionals,[23] some address specific STEM disciplines,[24] and a few offer instructions for beginners.[25] The American Chemical Society (ACS) has published the *ACS Style Guide*[26] since 1986, and each ACS publication has its own *Guidelines to Authors*.[27] More recently ACS has curated a video series on scientific authoring.[28] However, to learn how to be a good scientific writer, it is not enough for individuals to just read these books. Professional guidance and copious amounts of practice are crucial to develop scientific writing skills.

In 2007, competency in science communication across all levels of the STEM community was elevated from a desirable goal to a required mandate. Since 2007, the National Science Foundation (NSF) requires every institution of higher education to ensure that all students and postdoctoral researchers complete *Responsible Conduct of Research* (RCR) training before they enter any NSF funded project.[29] The *America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science* (COMPETES) Act[30] states: "(Sec. 7009) Instructs the Director to require that each institution that applies for financial assistance from NSF

for science and engineering research or education describe in its grant proposal a plan to provide appropriate training and oversight in the responsible and ethical conduct of research to participating undergraduate students, graduate students, and postdoctoral researchers." NSF provided guidelines to set up training programs,[31] and RCR educational materials were developed including, for example, the case studies from Columbia University[32] and from the HHS's Office of Research Integrity.[33] Yet, ten years after the initial request, half of all institutions do not require students to complete the RCR training despite of the NSF mandate,[34] and many respond to the mandate merely with a short online tutorial. This situation obviously does not meet the spirit of NSF's requirement, and we have been using the *Ethical Guidelines to Authors*[35] of the American Chemical Society for RCR instruction.

Another consideration concerns the composition of the committees that author ethical standards. While such committees usually seek international representation, cultural differences are not usually addressed in the ethical standards in significant way. However, such cultural differences manifest themselves markedly, for example, in the peer review process.[36,37] In writing a peer review, one may state criticism rather directly or opt for a more indirect approach. Likewise, the interpretation of comments by international peer reviewers is influenced by the authors' diverse cultural backgrounds and so are their approaches to revision.

Extent of Education Globalization

Globalization in education has become a trend. In China, there are currently 930 joint undergraduate programs and 220 joint graduate programs, and among them, US institutions are involved with 206 joint undergraduate programs and 56 joint graduate programs.[38,39] These programs allow students to start their studies in China and complete their degrees in foreign countries. In 2017, America hosted more than one million international students.[40] Therefore, it

is necessary for the professors in America to know as much as possible about their international students to become mindful of cultural differences, to help them acclimate to the American classroom, and to ensure their potential to achieve success.

Not only are there large numbers of international students in America, but more and more opportunities arise for American professors to go overseas. In China alone, there are 70 undergraduate foreign-Chinese universities and 39 graduate foreign-Chinese universities[38,39] and these include 5 American-Chinese joint graduate schools and 15 American-Chinese undergraduate schools. In addition, there are uncounted summer schools, summer camps, and series of lectures taught by foreign professors. Those universities and programs require many foreign professors to teach in China, and they all need to know how to adapt the courses they have been teaching in their own countries to Chinese students in China.

RECOGNIZING THE CHALLENGES

Cultural and Language Barriers

In China, due to the high student-professor ratios, most of the courses in all schools are teacher-centered, that is, students get used to listening to the lectures and taking notes. In-class discussion rarely happens, and students do not have many opportunities to get involved. Thus, Chinese students are frequently described as "quiet learners".[41] Compared to American students, Chinese students are less verbally active in class and tend to give no indication of understanding.[42] So it is not easy to obtain in-class feedback. Extra encouragement is needed if one wants students to interact in class. Teaching in English only adds to the challenge because some students are not confident in their oral English and, like any young student, they are afraid of making mistakes in front of their classmates. Moreover, most students have not had any experience of learning

chemistry in English. Thus, their chemistry vocabulary is often poor, even if their basic English skills are quite good.

Audience Description

Students in top institutions also need training on scientific writing. UCAS is a top university domestically and globally, but students still face challenges writing in English. In 2018, its chemistry field ranks 15 in the world according to *Nature Index*.[43] The UCAS institutes are highly selective and attract talented graduate students from all areas of China. They have more research experience than typical MU undergraduate students. However, the English requirement to be admitted to UCAS is only at the average level of the Chinese Graduate School Entrance Examination. Due to this admission selection criterion, the English level of students admitted to UCAS is not necessarily better than the English proficiency of students attending lower-ranked universities. Thus, it is necessary to consider the English levels of the general Chinese student population in graduate school before teaching a course in English to UCAS students.

In general, writing scientific papers in English is a major challenge because Chinese students' English classes that are mostly test-oriented.[44] Writing is not emphasized and counts for only10-16% of most English exams.[44] English writing courses aim to teach students to write grammatically correct and short (no more than 120 words) formulaic essays, and the topics are rarely about science, and the topic, the content, and the structure of a scientific paper are totally different. In addition, Chinese universities provide little in terms of professional training about scientific writing, and thus scientific writing skills of Chinese students are not satisfactory even by the standards of Chinese faculty.[45] When Chinese students go abroad for further education, the frequent writing assignments present one of their most serious challenges. Chinese students' average scores of the writing parts in TOEFL and GRE are both below average.[46,47]

MEETING THE CHALLENGES

Adjusting Teaching Goals

We pointed out above that there is no significant history of scientific writing courses in Chinese universities. Therefore, one has good reasons to be concerned about the very acceptance of such a course by students, faculty and administrators. The large enrollments clearly show that students were very interested, but it is an entirely different matter to ensure high retention rates and high scores on student teaching evaluations (STEs). Thus, student acceptance becomes the *sine qua non* for any chance at establishing a sustainable program, and one must do as much as possible to achieve this teaching goal.

Students in the writing course at MU are expected to learn how to write and submit scientific papers by practicing the entire process. For students at UCAS, it is not realistic to pursue the same goals due to the time limit. Thus, the teaching goal was adjusted from letting students learn from practice to giving students guidance as to how to write and submit papers. Most importantly, the course aims to teach the students about the importance of continuously improving their writing skills and to gradually build their confidence about writing scientific papers in English.

There are more than 70,000 doctoral degree recipients and 500,000 master's degree recipients per year in China, and they contribute substantially to the overall body of scientific publications. However, Zhang and Zhu recently wrote that "plagiarism, duplicate submission and republication in translation are the three ~~most~~ common misconducts by Chinese student authors".[48] One reason for this situation is that non-native speakers of English have a higher rate of repeating the text from the source.[49] Another reason is that student authors do not really understand what academic misconduct is. It has been argued that plagiarism is a disciplinary issue, and it is a professional need to teach students about giving recognition, using appropriate citation formatting, and

performing related acts in writing.[50] Most of the time, students do not even realize that these behaviors are inappropriate and are not aware of the severity of the consequences. Thus, it has been an important goal at UCAS to teach about the ethics of scientific writing and authoring.

With a view to faculty development, we note that high retention rates and high STE scores may remind the leadership of the chemistry department, and even the greater campus community, of the importance of offering scientific writing education across the disciplines. In fact, the demonstration that such an innovative course can succeed might provide inspiration for Chinese faculty to emulate the contents and delivery of such a course.

Partitioning of the MU Curriculum into Two Block Courses at UCAS

The course *Scientific Writing in Chemistry* was first offered in the summer of 2010 as *one* 20-hour block course at UCAS with an astounding enrollment of 289 students! The high enrollment certainly was not expected because UCAS summer courses usually have enrollments of less than 50 students, and the enrollment at UCAS was *a magnitude higher* compared to MU (Table 1). This large number of students required the use of two lecture halls with the lecture in one hall being simultaneously broadcast to an adjacent hall. In light of this overwhelming interest, it was quickly decided to offer *two* 20-hour block courses in subsequent summer programs, one course on *Scientific Writing in Chemistry* and an advanced course on *Scientific Authoring in Chemistry*.

The pair of courses was offered in successive weeks in 2011. In that year, a total of 200 students enrolled in the two courses and we noticed that the great majority of these students took just one of the two courses. This observation suggested that the two courses could be taught in parallel and, in 2012 and 2013, both courses were taught in the same week, one in the morning and one in the afternoon. Yet, as word about the courses spread among UCAS students, more and

more students expressed a keen interest in taking both courses in the same summer and these students greatly prefer to take the courses sequentially. Responding to this demand, we returned in 2014 to deliver the two courses in successive weeks. The focus on one course per week also is beneficial in that the teacher and the teaching assistants have more time to attend to student questions outside of class.

The partitioning of the MU course materials between the two UCAS courses evolved over the years. Initially, there was some overlap of the content of the two courses. The UCAS courses differed in that one course was aimed at beginning students while the other course was for advanced students. Over the years, however, the overlap between the two courses was minimized and, instead, the two UCAS courses now are taught essentially as parts 1 and 2 of the MU course. The content of the MU course includes the *Skill Development for Scientific Writing* (A01 - A07) and the *Near-Authentic Exercise in Scientific Writing and Authoring* (A08 - A11). The various skills developed in working on the assignments are listed in Table S1, and this table helps to illustrate the reasons for the distinction of these two parts of the curriculum and explain the partitioning of the content between two courses.

Most recently, in 2016, we taught one course which was accompanied by a professionally produced 10-hour massively open online course (MOOC). Much of the teaching on writing and authoring skills, and a good portion of the instruction on publication ethics, are well suited for online delivery in the MOOC, which is now available across campuses of the Chinese Academy of Sciences (CAS). The MOOC videos come with complete transcripts in Chinese and in English (*vide infra*). Lecture time can then be used effectively for more conversational instruction.

From Semester Course to Block Delivery: The Role of Posted "Samples"

The MU curriculum was developed for a semester course with three one-hour meetings per week. The schedule of the meetings was described in details in our previous paper.[20,21] Students submit one assignment every week and every assignment is reviewed and graded by their classmates. One or more exemplary submissions by some of the students are posted on the assignment page of the course web site after all students have completed the assignment. The selection of a submission as a posted "sample" recognizes exemplary work and raises the grades of the authors by one notch (e.g., A- to A). The posted samples of *previous cohorts of students* play a significant role for *the students of subsequent MU courses*. The samples from earlier courses exemplify assignments of the same types but in a different theme area and, hence, they serve to define reasonable expectations and to set standards without concerns about plagiarism.[51]

The contact time of the semester-long MU course (total of 35 hours in 42 class meetings of 50 minutes each) aligns well with the overall contact time of the two one-week UCAS courses (20 hours per course). However, major adjustments are required to address two challenges: (1) the compression of the curriculum into five days with four hours of consecutive class meetings and (2) the change of the mode of delivery from small seminar to large lecture (Table 1). Thus, UCAS course #1 essentially covers the first seven weeks of the MU course (A01 – A06), and UCAS course #2 covers the last five weeks of the MU course (A08 – A11). Roughly speaking, each day of instruction at UCAS deals with one assignment. In course #1, assignments A05 and A06 are combined. Assignment A06, the formal oral presentation of A05, is not practical at the present time in the large lecture setting and under the time constraints. But it is still possible to instruct on good practices for the preparation of oral presentations. In course #2, the four assignments are

covered in four days. One day is used for both instruction on publication ethics and discussion of case studies on responsible conduct of research and scientific misconduct.

Of course, at UCAS the students do not have enough time to work and complete a complete set of assignments with its own unique theme in a stand-alone block course. There is, however, the opportunity for an adaptation based on the idea of moving from a curriculum based on "working assignments and working with rubrics" at MU to a curriculum based on "worked assignments and working with rubrics" at UCAS. Many chemists actually learn how to write proper chemistry papers by reading and analyzing other chemists' papers.[24b] The adaptation is made possible by the direct and synergistic connection of the UCAS courses with the MU courses, and the posted samples—assignments worked by MU students—are providing the essential link.

A typical day of instruction at UCAS includes about two hours of lecture on the topic of the day, one hour about the topic related assignment(s) and the associated rubrics(s), and another hour in which samples are presented and discussed with reference to the respective rubric. The samples are employed to illustrate with specific examples the concepts and principles taught in the lectures. For every type of assignment, samples are available from seven implementations at MU with seven different themes (Table 1). For a given type of assignment, one or two samples are presented in class, and the students are encouraged to study additional samples outside of class. The existing pool of samples enables the UCAS students to work with rubrics. While the posted samples are exemplary submissions, the samples show the work of students as they progress through the MU course, and there remains room for improvement. Hence, selected samples are discussed in class with reference to the respective rubric and the appropriate balance of praise and criticism. The UCAS students exercise their peer reviewer competency by scoring some of the posted samples.

The connection between the MU and UCAS courses truly is synergistic and *both courses have benefited from each other*. The process of adapting the MU course to the UCAS format contributed to the evolution of the MU course. For example, the idea of using the existing pool of samples to instruct UCAS students on working with rubrics led to a module to prepare MU students for rubric-based peer review. More generally, the teaching materials have been improved continuously and the content and the delivery have become increasingly more mindful of the global audience.

Table 2. Schedule of the Scientific Writing Course at UCAS in 2016[a]

Day	Topic Areas	Sessions Each Afternoon[b]					
		1:30–2:20	2:30–3:20	3:30–4:20	4:30–5:20	5:20–5:50	6:00–7:00
Monday	Standard Science Sequence	Introduction: "Science"	Introduction: "Course Web Site"	Publication Types: What to Read?	Construction of a Paper	Office Hours	Dinner
Tuesday	Writing a Paper: Planning, Preparation & Submission	*JOC* Guidelines for Authors	Mind-Maps & Outlining, Elements of a Paper	Peer Review Example & Cover Letter	A8/R8,[c] A9 MMA & Paper	Office Hours	Dinner
Wednesday	Understanding Peer Review: Reviewing & Being Reviewed	Professional Ethics	ACS Ethics Guidelines, 1/2	Peer Review Example & Peer Review	A10[d] Peer Review	Office Hours	Dinner
Thursday	Dealing with Peer Review: Revision & Rebuttal	ACS Ethics Guidelines, 2/2	Summarize & Paraphrase without Plagiarism	Peer Review Example & Rebuttal Letter	A11/R11[e] Revision	Office Hours	Dinner
Friday	Responsible Authorship	Ethics Case Studies, Yale	Ethics Case Studies, Columbia	Test	Office of Research Integrity Cases	Office Hours	Dinner

[a]Adapted from ref. 52. [b]Sessions were held in the same lecture hall, Room T2 101. [c]A8/R8 and A9 MMA focus on writing and submitting a paper. [d]A10 focuses on the scientific peer review process. [e]A11/R11 focuses on the process of revision and rebuttal.

Table 2 exemplifies a specific and representative schedule of the scientific writing course at UCAS in 2016, including contact hours, location, topics and outlines. The course was constructed based on the overarching theme of 2016 (Table 1).[52] We selected the five most important and

suitable topic areas from our semester-long MU course for each day. On the first day, we talked about pre-writing activities and we introduce the "course web site" to students and teach them how to learn from all the resources, which include scientific topic resources, assignments, and posted samples in the website. On the following days, we teach the students about the fundamental concepts and elements of scientific writing and of the scientific publication process. Each day, one or more assignments together with the posted samples were shown and discussed with students. The skill training exercises A01 – A06 were discussed within the lectures as examples. As can be seen, the majority of the classroom time is used to teach publication ethics and focuses on the writing of a paper and its submission (A08 & A09), the scientific peer review (A10), and the process of revision and rebuttal (A11). Students not only learn the basic scientific writing knowledge from the lectures, but also how to review their posted assignments with the help of the rubrics. This provides practical training for students who want to practice their writing skills and work some of the assignments after the course.

Overcoming Cultural and Language Differences

As we attempt to understand cultural and language differences, we address differences with a positive attitude and seek common ground. Chinese students are less used to engaging in conversation in class (*vide supra*). As icebreakers at the beginning of the course, simple questions were asked in order to elicit one-word or two-word answers. This simple strategy provides an effective means for students to understand that it is not difficult to get involved in the class. The students' answers were welcomed with compliments to further encourage them to speak English in class and to gradually build some level of confidence.

We found that the students become more active in class if they get to know the instructional team. Thus, more chances were created for students to communicate with the lecturer and his

group of teaching assistants before or after class so that students have opportunities to become familiar with the instructors. As shown in Table 2, there are office hours after lecture every day to make the lecturer more approachable. Dinner or lunch is listed in the course schedule because it is made clear that any student is welcome to join the dinner or lunch with the lecturer. These out-of-class faculty-student interactions help the lecturer and his TAs to better understand the students' backgrounds and educational levels and to apply this knowledge to improve the instruction.

As for the language barrier, it is important to use simple and short sentences when teaching non-native speakers. More time was spent to ensure that students were able follow the lectures. When talking about chemistry, molecular structures were also shown together with the names of the compounds so that students have a better idea of what was discussed in case they are not familiar with the English names of those chemical compounds. The addition of the English-language MOOC component presented a huge step forward in this context for two reasons. Obviously, students can follow each video at their own pace and, secondly, the MOOC comes with complete transcripts in English and Chinese.

The co-evolution of the MU and UCAS courses in and of itself contributes to international education.[53] More recently we have taken the international education component to a new level through the involvement of some students in the courses in the U.S. and in China.[54] Kaidi Yang was invited to MU in the spring of 2014 to participate in the MU course after she took the block course in the summer of 2013 in China. Likewise, MU students Cory Camasta and Ethan Zars traveled to China in the summer of 2014 to assist with the teaching of the UCAS courses, and Kaidi Yang, now a MU graduate student, served as TA at UCAS in 2016. The presence of American teaching assistants enabled access to the instructional team on a peer-to-peer level and

made it easier for students to get help, which in turn contributed to more effective student learning in the course. Studies showed that a pure English environment can help students with their English. On the other hand, the chance for the students to communicate in their own language can help them to learn chemistry better.[55] Therefore, we have always valued to work with a group of Chinese and American TAs. Having Chinese TAs on the instructional team definitely increases student involvement and results in better learning outcomes. It appears that the Chinese TAs can grasp the meaning of the instructor's intents well because of their advanced standing, and they can communicate these intents more clearly in Chinese than the instructor could possibly communicate these goals directly in English. The Chinese TAs also are effective because they can share their own experiences with the novice students and thereby provide credible guidance to adapt to the English classroom environment. In fact, we believe that instruction in Chinese should be part of such courses, and we have started to integrate Chinese-led exercise sessions into English-language summer courses.

RESULTS OF TEACHING EVALUATIONS

Evaluation Device Employed at UCAS

The evaluation of the scientific writing course at MU was published and serves as reference.[21] The course evaluations at UCAS were performed with a comparable questionnaire and this device contains two parts. The students rate the teacher on the twelve criteria listed in Table 3 (entries 1 – ~~12~~11) using a five-level Likert scale ("excellent", "good", "medium", "qualified", "unqualified"; 4 – 0, 4 is high). In analogy to MU's "overall rating", we determined an "overall rating" (Table 3, "Comprehensive Evaluation") by averaging the numerical scores of the eleven questions (Table 3, entries 1 – 11).

The second part of the UCAS questionnaire requests the students to respond in writing to the following three questions:

1. Virtues and characteristics of this course.

2. Suggestions for improvements.

3. Comments on the evaluated items.

Table 3. Comparative Teaching Evaluation Results from UCAS Students Enrolled in the Summer Scientific Writing Programs, 2011–2016

Evaluation Categories		Evaluation Criteria by Item Number	Mean,[a] N = 592	SD
Teaching Attitudes	1	Rigorous manner, well-prepared content, careful impartation of knowledge	3.96	0.03
	2	Sufficient grasp and understanding of the course	3.94	0.03
	3	No adverse effects of suspended classes and adjustments on the lecture	3.95	0.04
Teaching Content	4	Conformation to the syllabus	3.93	0.04
	5	Proper emphases, details, and omissions	3.92	0.05
	6	Introduction of frontier and hot issues in this discipline	3.90	0.05
Teaching Methods	7	Enlightening, individualized, vivid in speech, inspiring in students' initiative	3.92	0.04
	8	Attentive to the combination of knowledge impartation and ability (skill) training	3.92	0.05
	9	Rational arrangement of homework or extracurricular reading	3.92	0.05
Teaching Outcomes	10	Realization of teaching goal and enhancement in students' learning capacity	3.92	0.03
	11	Gains and improvement through this course	3.92	0.04
Comprehensive Evaluation[b]			3.94	0.04

Note: Evaluation criteria translated from Chinese to English by the author, KY. [a]Students rated the teacher using a five-level Likert scale ("excellent", "good", "medium", "qualified", "unqualified"; 4–0, 4 is high). [b]Comprehensive evaluation score was determined by averaging the overall scores given by the students over all courses.

The complete sets of student evaluation data and of student comments for the nine courses taught at UCAS are provided as Supporting Information in English translation, and the verbatim Chinese comments are available on request. One file is provided for each course, and each file of the supporting information contains four tables containing the following information. The first table lists the counts for the five possible responses to the twelve questions (Table 3, entries 1 – ~~12~~11) and this data resulted in the average values listed in Table 3. The other three tables list the

verbatim responses by the students to the three questions and results of our analysis of these data are summarized in Table 4.

We searched for common themes in the students' answers to the questions concerning "Teaching Attitudes", "Teaching Contents", "Teaching Methods" and "Teaching Outcomes", and the common themes identified (CTI) are listed in the second column of Table 4. The numbers in columns 3 show how many students ~~of each course~~ commented on the CTI of column 2 across all nine courses. The common themes identified are listed in the order of descending total counts. The numbers of evaluations returned for each of the courses are listed in the last row of Table 4 together with the total count of student evaluations (N = 592). The values in column 4 are the percentages for the appearance of a given theme with respect to the entire pool of student evaluations.

While the selection of the CTI items is unique, one might consider pooling items that appear in slightly different form. One could combine the CTI items "topics explained in detail" and "topics explained meticulously", for example. One might argue that the CTI items "course is well prepared" and "teacher has sufficient grasp and understanding of the course" are correlated and that these items therefore could be pooled. Similarly, one might consider pooling the responses to "teacher is captivating", "teacher lectures in a witty manner", and "teacher is enthusiastic". However, we decided to refrain from any such pooling and to respect the precise choice of words by the students.

Table 4. Frequency Analysis Results of Student Comments on Teaching Evaluations for UCAS Students Enrolled in the Summer Scientific Writing Programs, 2011–2016

Comment Categories	Evaluation Comment Topics	Count, Total *N* = 592	Component of Total, %
Teaching Attitudes	Teacher is humorous	57	9.63
	Course is well prepared	40	6.76
	Teacher has sufficient grasp and understanding of the course	24	4.05
	Teacher is captivating	15	2.53
	Teacher lectures in a witty manner	11	1.86
	Teacher is enthusiastic	6	1.01
Teaching Content	The knowledge is practical	36	6.08
	Rich in content	35	5.91
	Provides a good overview with sufficient detail	28	4.73
	The knowledge is useful	25	4.22
	Course covers a broad range	19	3.21
	Frontier and hot issues discussed in class	10	1.69
	The course is interesting	9	1.52
Teaching Methods	Vivid in speech	91	15.37
	Individualized teaching and learning methods	70	11.82
	Topics explained in detail	37	6.25
	Nice class climate	34	5.74
	Topics explained meticulously	22	3.72
	Examples and cases used in the course	21	3.55
	Rigorous manner	20	3.38
	Scrupulous manner	19	3.21
	Good pronunciation	16	2.70
	Inspires students to think deeper	15	2.53
	Positive faculty–student communication	3	0.51
Teaching Outcomes	Improvement and gain of knowledge	54	9.12
	Beneficial for our future	49	8.28
	Course reaches the teaching goals	25	4.22
	Ability/skill training	24	4.05
	Improve English listening ability/comprehension	22	3.72
	Improve our understanding of prior knowledge	20	3.38
	Improve English ability	18	3.04
	Hope more courses like this would be held	3	0.51
Evaluation Totals[b]		592	100.00

Note: Comment topics translated from Chinese to English by the author (KY).

According to the students' evaluations, students are satisfied with the writing course. In Table 4, the most frequent comments are that "the teacher is very humorous", "the knowledge is

practical", "the teacher is vivid in speech", and the students attest that they have achieved "improvement and gain of knowledge".

In the "Teaching Attitudes" category, many students noted that the lecturer was trying to engage students and to promote active learning by being humorous. Students also thought that the course is well-prepared and competent. For the "Teaching Contents", many students believed that they have learned a lot of practical knowledge, which means that the course exposed the students to content they had never learned before and that the students felt that they can use the new knowledge directly in their research. For the "Teaching Methods", students thought the teacher is vivid in speech. This outcome reflects the continuing efforts to explain content repeatedly and with different words so that the Chinese students can construct the meaning in various ways. Also, students noticed the "discriminative teaching and learning methods". This is a very positive outcome because it means that the students with different levels of English and from different fields of chemistry all were able to learn from the lectures. At last, as shown in the "Teaching Outcomes", students thought they have learned knowledge that is beneficial for their future. The high scores on the latter criterion are especially encouraging to us, because the students clearly understood that science writing, science communication, and science ethics will be important in their careers. Overall, the evaluations over many years confirm the success of the adaptation of the *Scientific Writing in Chemistry* course to UCAS.

CONCLUSION

It has been the goal of the seminar course *Scientific Writing in Chemistry* to educate students at the University of Missouri in Columbia (MU) on best practices in writing a scientific paper and about the scientific publication process and peer review. Each implementation of the course presents a *new* curriculum because it fuses the *framework* of the assignment-based curriculum with

a new overarching *theme*. The course *Scientific Writing in Chemistry* integrates content, context, collaboration and science communication in a unique fashion, and it addresses an essential need for science students across the globe. The course was taught at several universities in China. We have described its adaptation for *Scientific Writing and Authoring* instruction in the summer school program at the University of Chinese Academy of Sciences (UCAS), and we described adjustments made to the content, delivery and teaching goals.

At MU, exemplary submissions are posted as "samples" on the assignment page. The posting of samples recognizes exemplary work and serves to define reasonable expectations. In particular, these samples play a key role for the adaption strategy of the MU course to UCAS. The adaption for the UCAS courses presented two major challenges because of the block format and the large lecture delivery. These challenges were met in part by shifting from a curriculum based on "working on assignments and working with rubrics" at MU to a curriculum based on "working with posted samples of completed assignments and working with rubrics" at UCAS. The adaptation is successful because of the direct and synergistic connection of the courses at UCAS and at MU, and the posted samples—assignments worked by MU students—are providing the essential link. In addition, more emphasis was placed on instruction about responsible conduct of research, the publication process, and the justification of the need for commonly accepted standards. Several adjustments were described to build a good rapport with the students to ensure high student acceptance as one requirement to building a sustainable program. The addition of the English-language MOOC component also helps to address the challenges in a significant way because the students can study the video at their own pace and refer to transcripts in English and Chinese.

It is hoped that the summer course leads the students to work assignments and to peer review each other with the help of our lecture materials and all the online resources. But we believe that the peer review process works best when conducted anonymously. Hence, we are exploring practical ways for the short-term summer school students to practice peer review. It is one exciting possibility to have UCAS summer students participate in the peer review of the submissions created in the following implementation in the US.

ASSOCIATED CONTENT

Supporting Information

The Supporting Information is available on the ACS Publications website at DOI: --.----/acs.jchemed.-------.

The complete sets of student evaluation data and of student comments for the 9 courses taught at UCAS are provided as supplemental online material in English translation (9 files, PDF). The verbatim Chinese comments are available on request. This information also is available directly from the authors upon request.

AUTHOR INFORMATION

Corresponding Authors

*E-mail: glaserr@mst.edu, cyguo@ucas.ac.cn

ORCID:

Rainer Glaser: 0000-0003-3673-3858

Cun-Yue Guo: 0000-0002-4000-8141

Kaidi Yang: 0000-0001-8957-3726

Notes

The authors declare no competing financial interest.

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REFERENCES

(1) Boyer, E. L.; Levine, A. A quest for common learning—The aims of general education. Washington, D.C.: The Carnegie Foundation for the Advancement of Teaching, 1981.

(2) National Science Foundation (NSF), Division of Undergraduate Education. Shaping the Future: New Expectations for Undergraduate Education in Science, Mathematics, Engineering, and Technology. Arlington, VA: National Science Foundation. 1996. http://www.nsf.gov/pubs/stis1996/nsf96139/nsf96139.txt (accessed Feb. 7, 2018)

(3) Glaser, R. E.; Poole, M. J. Organic chemistry online: Building collaborative learning communities through electronic communication tools. *J. Chem. Educ.* **1999**, *76*, 699-703.

(4) Carson, K. M.; Hodgen, B.; Glaser, R. E. Teaching dissent and persuasion. *Educ. Res. Rev.* **2006**, *1*, 115-120.

(5) Glaser, R. E.; Carson, K. M. Chemistry is in the news: Taxonomy of authentic news media based learning activities. *Int. J. Sci. Educ.* **2005**, *27*, 1083-1098.

(6) Wu, Z.; Glaser, R. E. Software for the synergistic integration of science with ICT education. *J. Inform. Tech. Educ.: Research* **2004**, *3*, 325-339.

(7) Carson, K. M.; Glaser, R. E. Chemistry Is in the News: Assessing Intra-Group Peer Review. *Assessment and Evaluation in Higher Education* **2009**, *34*, 69-81.

(8) Harmon, J. E.; Gross, A. G. The Craft of Scientific Communication. University of Chicago Press, Chicago, 2010; pp VII.

(9) Bhattacharyya, G.; Harris, M. S. Compromised Structures: Verbal Descriptions of Mechanism Diagrams. *J. Chem. Educ.* **2018**, *95*, 366-375.

(10) Muelleman, A.; Rainer Glaser, R. Learning to Read Spectra: Teaching Decomposition with Excel in a Scientific Writing Course. *J. Chem. Educ.* **2018**, *95*, 476-481.

(11) Wingate, U. Discipline-Specific Approaches to Academic Literacy Instruction Academic Literacy and Student Diversity. United Kingdom. The Case for Inclusive Practice, 2015.

(12) Course website for spring semester 2010: https://faculty.missouri.edu/~glaserr/RG_T_SS10.html (accessed Sept. 25, 2018).

(13) Course website for spring semester 2011: https://faculty.missouri.edu/~glaserr/RG_T_SP11.html (accessed Sept. 25, 2018).

(14) Course website for spring semester 2012: https://faculty.missouri.edu/~glaserr/RG_T_SP12.html (accessed Sept. 25, 2018).

(15) Course website for spring semester 2013: https://faculty.missouri.edu/~glaserr/RG_T_SP13.html (accessed Sept. 25, 2018).

(16) Course website for spring semester 2014: https://faculty.missouri.edu/~glaserr/RG_T_SP14.html (accessed Sept. 25, 2018).

(17) Course website for spring semester 2015: https://faculty.missouri.edu/~glaserr/RG_T_SP15.html (accessed Sept. 25, 2018).

(18) Course website for spring semester 2016: https://faculty.missouri.edu/~glaserr/RG_T_SP16.html (accessed Sept. 25, 2018).

(19) Campus Writing Program, University of Missouri. Online at http://cwp.missouri.edu (accessed Feb. 7, 2018).

(20) Glaser, R. E. Teaching content, context, collaboration, and communication in college chemistry. *Chemistry in Action!* **2014**, *101*, 10-19.

(21) Glaser, R. E. Design and assessment of an assignment-based curriculum to teach scientific writing and scientific peer review. *Journal of Learning Design*. **2014**, *7*, 85-104.

(22) Davis, M. Eighteen rules for writing a code of professional ethics. *Sci. Eng. Ethics.* **2007**, *13*, 171–189.

(23) Hofmann, A. Scientific Writing and Communication: Papers, Proposals, and Presentations. Oxford University Press: Oxford, 2016.

(24) (a) Robinson, M. S.; Stoller, F. L.; Costanza-Robinson, M. S.; Jones, J. K. Write Like A Chemist: A Guide and Resources. Oxford University Press, 2008. (b) See, p. 7 in ref. (a).

(25) Irish, R.; Poe, M.; Deans, T. Writing in Engineering: A Brief Guide. Oxford University Press: Oxford, U.K., 2016.

(26) Coghill, A. M.; Garson, L. R. The ACS Style Guide: Effective Communication of Scientific Information. American Chemical Society: Washington, D.C., 2006.

(27) For example, guidelines to authors of *J. Org. Chem*. articles can be found at http://pubs.acs.org/paragonplus/submission/joceah/joceah_authguide.pdf (accessed Feb. 7, 2018).

(28) Publishing Your Research 101 Video Series. American Chemical Society. http://pubs.acs.org/page/publish-research/index.html (accessed Feb. 7, 2018).

(29) Responsible Conduct of Research (RCR). National Science Foundation. https://www.nsf.gov/bfa/dias/policy/rcr.jsp (accessed Feb. 7, 2018).

(30) H.R.2272 - America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science Act 110th Congress (2007-2008). https://www.congress.gov/bill/110th-congress/house-bill/2272 (accessed Feb. 7, 2018).

(31) National Academies of Sciences, Engineering, and Medicine. *Fostering Integrity in Research*. Washington, D.C.: The National Academies Press, 2017. https://doi.org/10.17226/21896 (accessed Feb. 7, 2018).

(32) RCR Responsible Authorship and peer review. Columbia University, New York, NY. http://ccnmtl.columbia.edu/projects/rcr/rcr_authorship/case/index.html (accessed Feb. 7, 2018).

(33) The Office of Research Integrity. Research Integrity: Case Studies. Online at https://ori.hhs.gov/videos/case-study (accessed Feb. 7, 2018).

(34) Mervis, J. NSF reiterates policy on teaching good research habits despite its limitations. Posted online at doi:10.1126/science.aao7114 on Aug. 17, 2017. http://www.sciencemag.org/news/2017/08/despite-its-weaknesses-nsf-reiterate-policy-teaching-good-research-habits (accessed Feb. 7, 2018).

(35) Ethical Guidelines to Publication of Chemical Research. ACS Publications, 2015. http://pubs.acs.org/userimages/ContentEditor/1218054468605/ethics.pdf (accessed Feb. 7, 2018).

(36) Burrough-Boenisch, J. NS and NNS scientists' amendments of Dutch scientific English and their impact on hedging. *English for Specific Purposes* **2005**, *24*, 25-39. Online at http://authors.elsevier.com/sd/article/S0889490603000632 (accessed Feb. 7, 2018).

(37) Yang, Y. Exploring linguistic and cultural variations in the use of hedges in English and Chinese scientific discourse. *J. Pragmat.* **2013**, *50*, 23-36.

(38) Chinese-Foreign Cooperation in Running Schools. Ministry of Education of the People's Republic of China. Online at http://www.crs.jsj.edu.cn/aproval/orglists/1 (accessed Sept. 25, 2018).

(39) Chinese-Foreign Cooperation in Running Schools. Ministry of Education of the People's Republic of China. Online at http://www.crs.jsj.edu.cn/aproval/orglists/2 (accessed .Sept. 25, 2018).

(40) US: International Students Top 1.18 Million, The Pie News. 2017. Online at https://thepienews.com/news/usa-international-students-1-18-million-sevis-by-the-numbers-2017/ (accessed April 24, 2018).

(41) Olaussen, B. S. Students' use of strategies for self-regulated learning: Crosscultural perspectives. *Scand. J. Educ. Res.* **1999**, *43*, 409–422.

(42) Cheng, H. Y.; Guan, S. Y. The Role of Learning Approaches in Explaining the Distinct Learning Behaviors Presented by American and Chinese Undergraduates in the Classroom. *Learn. Individ. Differ.* **2012**, *22*, 414–418.

(43) Nature Index. Online at https://www.natureindex.com/institution-outputs/generate/Chemistry/global/All/weighted_score (accessed April 24, 2018)

(44) Fu, D.; Matoush, M. Teacher's Perceptions of English Language Writing Instruction in China. *In* International Advances in Writing Research: Cultures, Places, Measures. Bazerman, C.; Dean, C.; Early, J.; Lunsford, K.; Null, S.; Rogers, P.; and Stansell, A. (eds.) The WAC Clearinghouse: Fort Collins, Colorado, p. 23, 2012. Online at https://wac.colostate.edu/books/wrab2011/chapter2.pdf (accessed Feb. 7, 2018).

(45) Wu, D. Introducing Writing Across the Curriculum into China: Feasibility and Adaptation. Springer: Lexington, KY, 2015, 108-110.

(46) Test and Score Data Summary for TOEFL iBT Tests, January 2016–December 2016 Test Data. Online at https://www.ets.org/s/toefl/pdf/94227_unlweb.pdf (accessed Feb. 7, 2018).

(47) A Snapshot of the Individuals Who Took the GRE revised General Test, July 2015- June 2016. https://www.ets.org/s/gre/pdf/snapshot_test_taker_data_2016.pdf. (accessed Feb. 7, 2018).

(48) Zhang, C. J.; Zhu, Y. China's graduate students need better education in scientific writing and publishing. *J. Zhejiang Univ. Sci. B*. **2016**, *17*, 409-412.

(49) Pecorari, D. Academic Writing and Plagiarism: A Linguistic Analysis. Bloomsbury. New York, 2010.

(50) Fish, S. Plagiarism Is Not a Big Moral Deal. The New York Times. August 9, 2010. Online at https://opinionator.blogs.nytimes.com/2010/08/09/plagiarism-is-not-a-big-moral-deal/ (accessed May 1st, 2018)

(51) Myers, S. Questioning author(ity): ESL/EFL, science, and teaching about plagiarism. *The Electronic Journal for English as a Second Language* **1998**, *3*, 1-21. Online at http://www.tesl-ej.org/wordpress/issues/volume3/ej10/ej10a2/ (accessed Feb. 7, 2018).

(52) Online course schedule for UCAS 2016 summer course: https://faculty.missouri.edu/~glaserr/CHINA2016/UCAS2016_contact_hours.html (accessed Sept. 30, 2018).

(53) Soria, K. M.; Troisi, J. Internationalization at Home Alternatives to Study Abroad: Implications for Students' Development of Global, International, and Intercultural Competencies. *Journal of Studies in International Education* **2014**, *18*, 261-280.

(54) Urban, E. L.; Bierlein Palmer, L. International Students as a Resource for Internationalization of Higher Education. *Journal of Studies in International Education,* **2014**, *18*, 305–324.

(55) Flores, A.; Smith, K. C. Spanish-Speaking English Language Learners' Experiences in High School Chemistry Education. *J. Chem. Educ.* **2013**, *90*, 152−158.