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Science Diplomacy: Results From a Three-Year Pilot

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Abstract

An entirely novel course was developed to teach science, technology, engineering, art, and math (STEAM) diplomacy to engineering students. The course uses blended delivery, a flipped format, and modified mastery learning with a buffet approach to assign final grades. The course has been piloted for three semesters to a total of 35 dual-level (seniors and first year graduate) students pursuing a baccalaureate degree in environmental or civil engineering or a graduate degree in environmental or civil engineering. The course introduces the three pillars of "science diplomacy" as described in the New Frontiers in Science Diplomacy report published in 2010 by the Royal Society and the American Association for the Advancement of Science, including: 1) science-in-diplomacy; 2) diplomacy-for-science; and 3) science-for-diplomacy. During the semester, students conduct policy analyses of case studies including: 1) the Lower Mekong River Initiative of the United States; 2) the Antarctic Treaty as described by the Royal Geographical Society; 3) the Make the Planet Great Again campaign of France; and 4) HIV/AIDS treatment in South Africa as described by Harvard Law School. Each policy analysis follows Bardach's eightfold path, including: 1) problem definition; 2) collecting evidence; 3) brainstorming alternatives; 4) identifying criteria; 5) future-casting outcomes; 6) considering trade-offs; 7) committing to a decision; and 8) telling a story to secure support and buy-in. Two unique aspects of this course include the performance of a model United Nations debate, and the completion of a personal application for a fellowship in policy or diplomacy. The purpose of this article is to share: 1) the course content and format; 2) an analysis of the results of student evaluations from three complete offerings of the pilot course; and 3) personal experience gained by the instructor teaching policy (in this case, science diplomacy) to engineers.

Introduction

Teaching science diplomacy is simultaneously a challenging undertaking and a rewarding frontier for engineering educators. By its very nature, diplomacy includes skills and attitudes – including history and social sciences such as linguistics, anthropology, and psychology – different from applications of science in engineering practice. For example, diplomats may employ "constructive ambiguity", or the deliberate use of unclear language to advance a political purpose [1]. In contrast, engineers most often employ "science communication", or filling the gap between what people know and need to know to make informed decisions [2]. Securing an advantage for one party by intentionally confusing the other party in a negotiation may seem the polar opposite of objectively sharing facts for the purpose of elevating the understanding of all parties; this is an example of both the challenge and the reward for teaching science diplomacy. And yet

engineers are not entirely excluded from practicing a form of subterfuge in negotiation as exemplified through the process of entering a low bid to win a construction project and relying upon cost overruns to turn a profit [3]. It is within this dynamic tension, between practices shared by engineers and diplomats and practices shared by engineers and scientists, where a pilot course entitled, "Science, Technology, Engineering, Art, and Math (STEAM) Diplomacy" was initially proposed in 2017 [4].

As defined in 2010, in a report co-published by the Royal Society and the American Association for the Advancement of Science (AAAS), science diplomacy includes three pillars, namely: 1) science in diplomacy (i.e., represented by a scientist – typically a natural scientist – serving as a diplomat); 2) diplomacy for science (i.e., represented by diplomatic effort empowering scientific discovery – including natural as well as social sciences); and 3 science for diplomacy (i.e., represented by interpersonal relationships shared by scientists from different countries; a form of cultural diplomacy facilitated by scientific exchange that may include arts and humanities) [5]. Over the past decade, the AAAS has facilitated the growth of resources to study about and to teach science diplomacy including the creation of the, "AAAS Center for Science Diplomacy," as well as the quarterly publication of *Science & Diplomacy*, an online open-access journal for "rigorous thought, analysis, and insight to serve stakeholders who develop, implement, or teach all aspects of science and diplomacy."

In 2013, the United States Department of State launched, "Diplomacy Lab", as a public-private partnership where foreign policy challenges are "course-sourced" to teams of faculty and student experts. Diplomacy Lab provides content suitable for term-length group projects on science diplomacy [6]. And in 2017, Springer Publishing Company introduced a monograph suitable for use as an introductory text entitled, "Science and Diplomacy: A New Dimension of International Relations," [7]. Equipped with these materials, a pilot course entitled, "STEAM Diplomacy," was offered in the Spring 2018 semester, and the preliminary results were previously presented to the audience of the American Society for Engineering Education [4].

As described previously, and therefore not repeated in detail in this manuscript, the importance of science diplomacy in the modern era originated in 2009 with, "A New Beginning", a speech delivered by United States President Barack Obama at Cairo University [4], [5]. The U.S. announced investments to support technological development in Muslim-majority countries, to support the establishment of centers of scientific excellence in Africa, the Middle East, and Southeast Asia, and to appoint scientific envoys serving as cultural ambassadors to bring U.S. scientific experts to countries around the world. During the past decade, a limited number of institutions have begun to offer courses on science diplomacy, including Tufts, Columbia, and New York University, among others [4]. The creation and initial piloting of a new term-length course in the Spring of 2018 leveraged the unique personal experience of the author as a scientific advisor at the U.S. Department of State [4].

Building upon the initial pilot offering, in the Spring of 2019 and again in the Spring of 2020, two additional offerings of this novel course were provided to a total cohort of 26

undergraduate (n=13) and graduate (n=13) students. The purpose of this article is to share: 1) updates to the course format (as compared to the prior publication, [4]); 2) an analysis of the results of student evaluations from three complete offerings of the pilot course; and 3) personal experience gained by the instructor teaching policy (in this case, science diplomacy) to engineers. The course uses blended delivery, a flipped classroom, and modified mastery learning with a buffet approach to assess final grades. Demographic information as well as results from an online Jung Typology test (available online at: http://www.humanmetrics.com/cgi-win/jtypes2.asp) and an online Learning Styles Inventory (available online at: http://www.educationplanner.org/students/self-assessments/learning-styles-quiz.shtml) were collected from students, and student satisfaction was assessed using an existing anonymous, online course evaluation administered using a campus-wide system after the fifteenth week of the course.

Methods

Course Catalog Description. The special topics course number is designed to give the Department of Civil, Architectural, and Environmental Engineering at the Missouri University of Science and Technology an opportunity to test a new course (in this case, STEAM Diplomacy). Prerequisite: Junior standing (note: no prior experience with environmental science/engineering necessary and no prior experience with political science/international relations necessary).

Science, Technology, Engineering, Art, and Mathematic (STEAM) Diplomacy aims to excite interdisciplinary students to consider diplomatic craft and foreign policy to further professional business interests as well as to contribute to creating a more secure, democratic, and prosperous world for the benefit of the American people and the international community. While STEAM Diplomacy is inherently global, to facilitate the introductory nature of this course, the materials will be discussed with an emphasis on American foreign policy approaches.

Course Delivery. As described in detail previously, this course includes: a blended format; a flipped classroom; mastery learning; and a buffet of optional summative assessments used to assign a final grade [8]. Briefly, the 'blended format' includes delivery of course content via both online digital media and via face-to-face lecture. This approach improves student satisfaction by supporting diverse learning styles (i.e., listening or reading) [9], [10]. A 'flipped classroom', where students are exposed to course content before participating in a formal lecture with the instructors enhances the opportunity for the use of inductive learning strategies (i.e., think-pair-share) [11]. Mastery learning allows students to self-pace as they struggle individually, and collectively, to obtain the knowledge, skills, and attitudes described in the learning objectives. And finally, a buffet approach to summative assessments – after minimum mastery has been achieved – provides an alternative approach to grade contracting where students select specific activities to complete successful as demonstrations of their understanding of the course content.

Course Content. The course includes a total of ten modules. Seven required modules that must be completed by all students to earn a passing grade, include: 1) course introduction; 2) science diplomacy introduction; 3) answering the question, "what is science diplomacy?"; 4) science diplomacy as a national issue; 5) diversity of national approaches to science diplomacy; 6) science in the vanguard of diplomacy; and 7) multilateral science diplomacy. Three additional optional modules that may be completed by students to earn a grade of a "B" or an "A", include: 8) participation in a model United Nations debate; 9) identifying, drafting, and submitting an application for an individual fellowship in some aspect of policy; and 10) conducting a policy analysis on topic selected by the student. These final three optional modules are described as "term projects", while the prior seven required modules represent the regular "day-to-day" course content throughout the semester.

Course Assessment. Details about students, such as demographics as well as personality traits (i.e., via an online Jung Typology test available at: http://www.humanmetrics.com/cgi-win/jtypes2.asp) and predominant learning styles (i.e., via an online Learning Styles Inventory available at: http://www.educationplanner.org/students/self-assessments/learning-styles-quiz.shtml), were collected from students. The views of the students about the effectiveness of the instructor, course format, and course content were collected using an existing anonymous, online course evaluations administered through a campus-wide system after the fifteenth week of the course. The course format includes modified mastery learning, and students were required to complete a variety of instruments to demonstrate mastery, including multi-choice vocabulary quizzes, true/false statements from the online, required lectures, and true/false statements from the required readings. Students who demonstrated full mastery before the deadlines stated in the syllabus received a grade of 'C' for the course. A buffet of optional assessments were used to assign grades to students above a "C". These optional assessments included the performance of portions of policy analysis on case studies, and reporting the results using the Pechu Kucha format (i.e., available online at: https://www.pechakucha.com). The optional case studies for policy analysis, included: 1) the Lower Mekong River Initiative of the United States; 2) the Antarctic Treaty as described by the Royal Geographical Society; 3) the Make the Planet Great Again campaign of France; and 4) HIV/AIDS treatment in South Africa as described by Harvard Law School. Each policy analysis followed the eightfold path, including: 1) problem definition; 2) collecting evidence; 3) brainstorming alternatives; 4) identifying criteria; 5) future-casting outcomes; 6) considering trade-offs; 7) committing to a decision; and 8) telling a story to secure support and buy-in [12]. Rubrics were used to assess the additional unique aspects of the course including the model United Nations and the fellowship application. As discussed previously [8] the use of a modified, mastery learning approach allows the instructor to identify knowledge that 'must be learned', and to separate this required knowledge from the optional knowledge that 'can be learned'.

Human subjects. Exemption for this education activity was provided by the Institutional Review Board (IRB) at the Missouri University of Science and Technology.

Results

Details of Course Content. While a complete recapitulation of the entire content of "STEAM Diplomacy" is beyond the scope of this paper (please contact the author for full course content), three critical elements of the course content are discussed below, in detail.

First, as described previously [8], students' lack of familiarity with a blended format, a flipped classroom, mastery learning, and a buffet of optional summative assessments to assign a final grade is overcome through the use of a "Happy Saint Syllabus Day" as the title for the inaugural course meeting. A didactic lecture is used to go over the content of a hard copy of the syllabus distributed to each student. This is the one-and-only "traditional" lecture delivered during the entire semester. Before meeting for the second lecture, students are required to complete a series of online activities using Canvas (a Learning Management System, or LMS). The full instructions provided to students for this introductory unit are provided as Appendix 1, and Appendix 2 includes representative questions included in the online student assessment of mastery learning – students may take the online quiz as many times as needed to earn a score of 100% before the class meeting (i.e., to demonstrate complete mastery).

Second, to provide a "real-world" experience of multilateral diplomacy the students are invited to participate in an optional model United Nations exercise (i.e, https://www.un.org/en/mun). Individually students propose a list of three potential topics to their classmates. From the comprehensive brainstormed list, each student selects a single topic and presents a Pechu Kucha arguing "why" this topic should be selected. Collectively, students vote on the topic of choice. Then students begin the process of preparation for the model UN. This includes the selection of a country and the preparation of a background description of the country as well as a draft position paper for the country based upon the selected topic. The draft paper is graded by the instructor, and returned to the student to use as part of the oral debate. Student grades are based upon their written documents as well as their performance in the model UN debate. Collectively, the students must come to a consensuses position on the issue at hand. Resources for the model UN are available online, and include: 1) Model United Nations (https://www.nmun.org); 2) Model Diplomacy from the Council on Foreign Relations (https://modeldiplomacy.cfr.org/pop-up-cases); and 3) Using Science for/in Diplomacy for Addressing Global Challenges (https://www.s4d4c.eu/s4d4c-cases/).

Third, to provide a personalized "real-world" experience of policy/diplomacy, the students are invited to participate in an optional fellowship application process. Individually students propose a list of three potential fellowships to their classmates. From the comprehensive brainstormed list, each student selects a single topic and presents a Pechu Kucha describing "why" they are qualified for this opportunity and should be selected for a fellowship. Then students begin the process of completing a draft version of an application. The draft paper is graded by a peer, and returned to the student to use as part of the final submission for a fellowship. Because some fellowship

opportunities fall outside of the cycle of the class meeting, the instructor allows some "flexibility" to assign a grade based upon the "intention" of the student to submit an application. Examples of fellowship considered by students, include: 1) Fulbright Scholarships from the United States Department of State (https://eca.state.gov/fulbright); 2) Peace Corps (https://www.peacecorps.gov); and 3) Science and Technology Policy Fellowships from the American Association for the Advancement of Science (https://www.aaas.org/programs/science-technology-policy-fellowships).

Incorporation of Liberal Arts into Course. As described in the pilot course offered in the Spring of 2018 [4], the liberal arts – including history and social sciences such as linguistics, anthropology, and psychology – are incorporated into "STEAM Diplomacy". For example, students are introduced to and invited to reflect on the 13 dimensions of Foreign Service Officers as described by the U.S. Department of State (https://careers.state.gov/work/foreign-service/officer/13-dimensions/). These dimensions include: cultural adaptability (i.e., "to work and communicate effectively and harmoniously with persons of other cultures, value systems, political beliefs, and economic circumstances; to recognize and respect differences in new and different cultural environments"); oral communication (i.e., "by speaking fluently in a concise, grammatically correct, organized, precise, and persuasive manner; to convey nuances of meaning accurately; to use appropriate styles of communication to fit the audience and purpose"); working with others (i.e., "to interact in a constructive, cooperative, and harmonious manner; to work effectively as a team player; to establish positive relationships and gain the confidence of others; to use humor as appropriate"); and written community (i.e., "to write concise, well organized, grammatically correct, effective and persuasive English in a limited amount of time").

Skills of cultural adaptability and working with others are specifically highlighted in the model UN exercise where each student assumes the identity of a representative from a different country, while the skills of oral presentation are incorporated in the Pechu Kucha presentations that accompany each course module. Written communication is an essential part of the optional fellowship application process. Through these various required and optional exercises throughout the semester, students gain practical hands-on experience in the application of skills from a liberal arts education.

Details of Pilot Results. A new course, "STEAM Diplomacy" was offered in the Spring of 2018, 2019, and 2020 to a total of 35 students. Table 1 presents a summary of course demographics. As part of the Required, online lecture for Unit 0, students were directed to complete an online Learning Styles Inventory and a Myers-Briggs Personality Test. The results of these assessments were captured in questions included in the Unit 0 Required lecture quiz (see Appendix 1, below). Additional student demographics including gender and enrollment status (i.e., distance student or face to face student; Graduate student, Senior, or Junior standing; and degree program) were collected from information provided by each student and cross referenced with the database maintained by the Registrar.

Of the 35 total students who participated in the three course offerings, the classes varied significantly with 9 in the first offering, 17 in the second offering, and 9 students in the third offering. Each class was between 0 and 40% female. Visual and Auditory were the preferred, single strongest Learning Styles, but the overall most preferred learning style was a combination of two or more styles. Among the results of the Myers-Briggs Personality Test, the Jung Typology for "source of energy" indicates a near equal balance for Introversion and Extroversion, which may be considered somewhat surprising for a class predominantly of engineering students who are often stereotyped as "shy". In sharp contrast, the overall cumulative results for how students "gather information", "make decisions", and "process information" showed strong bias in the overall data. For example, there was a preference for Intuition over Sensing (i.e., "gut feelings" over "tradition"); Thinking over Feeling (i.e., "logic" and "rules" over "values"); and Judging over Perceiving (i.e., "order" and "instructions" over spontaneity). A description of trends in Myers-Briggs test results have been reported previously for students in our department [8], and based upon these trends in Jung Personality Type, the use of clear instructions (i.e., For Your Information, FYI.doc file) has been included as part of each course unit (i.e., Exhibit 1, above).

In the Spring 2018 and 2019 offerings, no students were enrolled via distance. In Spring 2020, 1 student was enrolled via distance. During the Spring 2020 semester, all instruction was modified to distance in response to COVID-19 [13]. It is unclear why this course has not attracted a greater number of distance students.

Nearly half of the students in the class held Graduate status, and all of the remaining students were Seniors, typically in their final semester. Given the maturity of the student population, it was somewhat surprising and disappointing that the results from course evaluations, discussed below, represented limited participation.

And finally, the majority of the students were enrolled in the Environmental Engineering degree programs, and a smaller number were enrolled in the Civil Engineering degree programs. Therefore, the student responses to course evaluations conducted at the end of the semester should be interpreted cautiously as they are focused primarily in two related engineering disciplines.

A summary of final grades for "STEAM Diplomacy," is presented in Table 2. In the first two offerings of the course, approximately half of the students elected to complete optional assignments to earn a grade of "A". In the Spring 2020 offering, all of the students participating in the face to face delivery of the course elected to earn a grade of "A". As with prior courses offered using the buffet approach to mastery learning, the instructor noted that class attendance was lower on optional days, and fewer students opted to complete the optional homework assignments. There is no immediate explanation for why students would elect not to do the work necessary to earn a grade of "A". Future studies should attempt to ascertain if there is a "reason" for students electing to ignore or not-complete optional assignments to earn a higher grade.

Table 1. Demographics of a total of 35 students enrolled in three course offerings of "STEAM Diplomacy" in the Spring semester of 2018, 2019, and 2020.

	Spring 2018	Spring 2019	Spring 2020
	N = 9	N = 17	N = 9
Gender			
Male	6	10	9
Female	3	7	0
Learning Styles Inventory			
Visual	1	4	2
Auditory	4	3	2
Kinesthetic	1	1	1
V, A, K all equal	2	1	1
Two higher than third	1	8	3
Jung Typology			
Extrovert (E)	2	9	5
Introvert (I)	7	8	4
Sensing (S)	1	7	4
Intuition (N)	8	10	5
Thinking (T)	4	12	8
Feeling (F)	5	5	1
Judging (J)	7	15	5
Perceiving (P)	2	2	4
Enrollment status			
Distance	0	0	1
Face to face	9	17	8
Graduate student	3	6	7
Senior standing	6	11	2
Junior standing	0	0	0
Civil Engineering	2	3	1
Environmental Engineering	7	14	8
Other	0	0	0

Figure 1 presents a summary of student satisfaction for Spring 2018, Spring 2019, and Spring 2020 collected using an anonymous, online course evaluation administered by the institution during the fifteenth week of the course. For Spring 2018, the rate of response (N=4) was less than half of the full course enrollment (N=9). This result – a lack of students completing the online, anonymous course evaluation – is consistent with the overall low level of participation in most end-of-semester evaluations conducted at our campus – and calls into question the value of these data for interpreting teaching effectiveness. Five questions were included in the assessments. The first three questions – assessing the quality of the course independent of the instructor; the instructor's concern for students; and the overall teaching effectiveness of the instructor – are required by the institution. The fourth and fifth questions – tell other students about the instructor's communication skills; and recommends the instructor to other students – are required by State law.

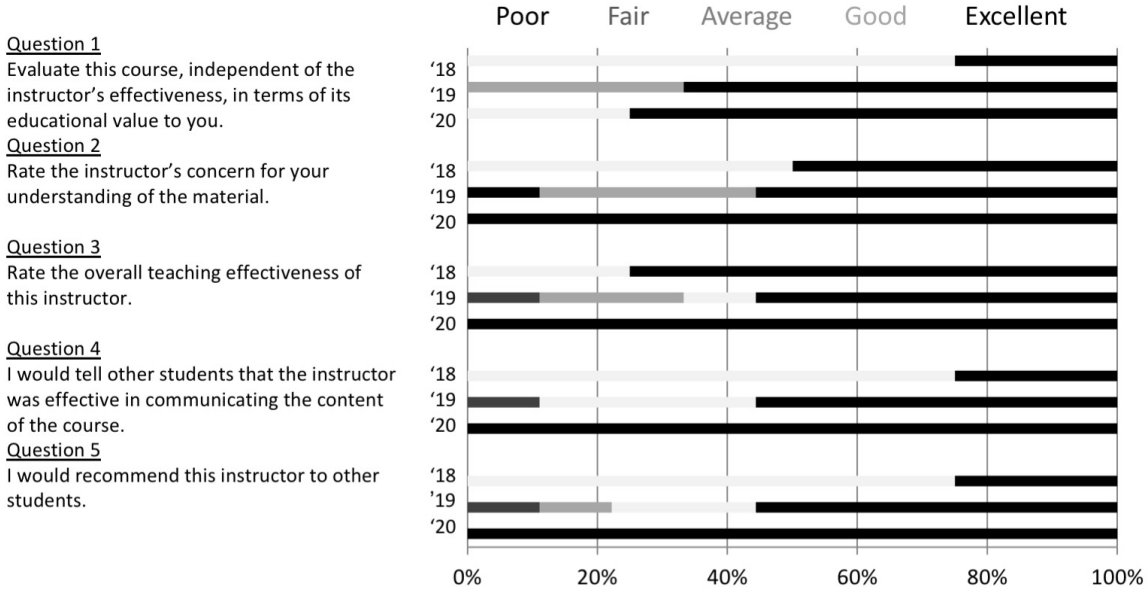
Table 2. Summary of final course grades for "STEAM Diplomacy" for the Spring 2018, 2019, and 2020 semesters.

Final grade	Spring 2018 (N=9)	Spring 2019 (N=17)	Spring 2020 (N=9)
A	5	9	8
B	2	6	0
C	2	2	1
F	0	0	0

For the fifteenth week of Spring 2018, the results for all five questions demonstrate a strong positive response with "good" as the most common answer on the five-point Likert-scale. Although a limited sample size, the results from the first offering of this course indicate that many of the students were satisfied – perhaps even a majority when considering the final course grades (Table 2, above).

For Spring 2019, the same five questions were administered during the fifteenth week of the course. The response rate (N=9) was slightly greater than one-half of the full course enrollment (N=17), and again reflects the poor rate of response typically observed on our campus. The majority of responses were either "excellent" or "good". While the overall response was generally positive, it is interesting to note that at least one student expressed significant concerns – an assessment of "poor" or "fair" in the second offering of the course (see discussion of open-ended responses, below). For Spring 2020, again the same five questions were administered during the fifteenth week of the course, and the response rate (N=4) represented a minority of the enrollment (N=9).

Figure 1. Results of student assessments conducted after the fifteenth week of the semester in Spring 2018, Spring 2019, and Spring 2020. Responses are reported normalized to one hundred percent.



To supplement the numeric scores reported in Figure 2, representative "additional comments", edited to increase readability, have been provided in Appendix 3 for all three semesters. These comments are provided as representative of the "free responses" received from students. To aid in evaluation of the comments, the similar comments have been grouped into three categories, namely: 1) about the instructor; 2) about the course format; and 3) about the course content.

Comments A and B reflect a strongly favorable reaction by the students to the practical experience the instructor brings to this highly unique course; while comments C and D reflect almost the exact opposite opinion regarding the quality of the instructor. These comments serve to show that a broad diversity of opinions was possible even from similar students in the same classroom covering identical course materials.

Comments E and F reflect a strongly favorable reaction by the students to the course format, specifically the approach to mastery grading with a buffet of options to assign a grade. Comment G is useful advice for the practical operation of the course highlighting the value students placed on the model UN exercise. Comment H is typical of the response of some students when exposed to mastery learning (Oerther, 2017b), and Comment I is an additional example of the type of comment that reflects the diversity of views held by students on the role of faculty as both teachers and simultaneously as researchers.

Comments J, K, and L are examples of the type of specific recommendations provided by students on course content. As reflected in Comments J and K, the model UN exercise is highly valued by students. Interestingly, Comment I reflects the view held by some students that discussion of diplomacy describing the UN or regional organizations was preferred to discussion of diplomacy focusing on the United States

Discussion

Recently, there has re-emerged an emphasis on the importance of "science diplomacy" as a way for nations to interact. To address this need, a new course was created entitled, "STEAM Diplomacy." This article summarizes the course description, delivery, and content. The results of assessment of three offerings to a total of 35 students are presented. The course included a blended format, a flipped classroom, mastery learning, and a buffet of optional summative assessments used to assign a final grade.

While teaching this course, the instructor learned: (1) it is easier to create a new course using blended, flipped, and mastery pedagogy when an instructor has prior experience with these pedagogical approaches (i.e., [8]); (2) students both "enjoy" and are "challenged" by summative assessments using a buffet approach; and (3) hands-on learning, such as the model UN, is highly valued by students. As described previously [14], the author benefitted from an extended period working as a science advisor at the U.S. Department of State, which was described as, "a once-in-a-lifetime opportunity to

learn science-in-diplomacy firsthand." Furthermore, the author leveraged prior experience as a cultural ambassador through a Fulbright Distinguished Chair Award [15], and the author was part of an effort to recruit diplomats to promote science [16]. Because the author enjoys prior experience with all three pillars of science diplomacy – namely science-in-diplomacy (i.e., serving as a science advisor), diplomacy-for-science (i.e., recruiting diplomats to promote science), and science-for-diplomacy (i.e., cultural exchange) – the author has the privilege of sharing first-hand practical stories with students to provide an authentic context for learning. Based upon this experience of the author, a recommendation to faculty who wish to offer a similar course is to gain at least some first-hand experience in science diplomacy through programs such as Fulbright or perhaps through extensive international, cross-cultural engagement as an active member (or perhaps officer) of an international scientific society.

Reflecting on the three-year experience of this pilot project, recommendations for future work, include: 1) re-connecting with former students to evaluate if the course content proved useful in their careers (i.e., was science diplomacy a skill that was utilized by engineers after graduation); 2) assessing changes in student attitudes and beliefs from before and after the course (i.e., measurements of affective domain learning, or gains in attitudes before and after the course); and 3) promote the replication of both the pedagogical approach as well as the course content at additional institutions to evaluate the effectiveness of the approach and the material independent of the instructor and with a variety of student types. This third suggestion for future work may be undertaken by comparing results observed in similar semester-long courses such as those offered at Tufts, Columbia, and New York University, among others.

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Appendix 1. The instructions provided to students to complete their first, online, blended, flipped, mastery exercise in "STEAM Diplomacy."

Course: STEAM Diplomacy
Unit: 0 Introduction to Blended, Flipped, Mastery Learning
Document: FYI

The objective of this unit is to familiarize students with the technologies used in this course, to aid students in creating a personal plan for success in this course, and to begin to establish peer-peer interaction among students.

By the end of this module, students should:

1) be able to access Canvas for course materials
2) be familiar with the vocabulary and concepts that differentiate classroom and online education
3) understand the concepts of 'adult learning' and 'mastery learning'
4) have, in mind, a plan for successfully completing this course
5) complete at least one discussion board assignment
6) OPTIONAL complete a discussion board assignment to evaluate the pro's and con's of MOOCs

Detailed instructions of REQUIRED exercises (NOTE: All required exercises must be completed before the deadline stated in the syllabus. The completion of all required exercises is necessary to earn a grade of 'C'. If you do not complete all required exercises before the deadline stated in the syllabus, you earn a grade of 'F' for the entire course.)

1) download the file entitled, 'vocabulary.doc'
2) read the following blog entries making notes about the vocabulary terms:
   a. Making the transition from classroom to online education
   b. The difference between online and on campus courses
   c. How to ace your online class
   d. NOTE: these three blog entries are available for download as PDF files from the folder entitled, 'copies of blog entries'
3) using your notes, complete the online vocabulary quiz entitled, 'Unit 0 REQUIRED vocab quiz' (NOTE: You may retake this quiz as many times as you wish before the deadline stated in the syllabus. You must achieve a 100% to complete the quiz and to earn a grade of 'C' for this exercise. If you do not achieve a 100% before the deadline stated in the syllabus, you earn a grade of 'F' for the entire course.)
7) open the folder entitled, 'REQUIRED lecture'
8) listen to the MP3 files and review the accompanying Power Point slides available in PDF format. Each MP3 file is approximately 15 minutes in length. (NOTE: you may wish to listen to the audio at an accelerated speed. ALSO NOTE: URLs are provided in the accompanying Power Point slides for you to access online tools to complete your Learning Styles Inventory and your Myers-Briggs Personality Test)
9) complete the online quiz for the required lecture entitled, 'Unit 0 REQUIRED lecture quiz' (note: You should take this quiz ONE time. You will need to complete the required lecture BEFORE you take this quiz so that you have the information necessary to document your Learning Styles Inventory and your Myers-Briggs Personality Test.)
10) complete the required discussion board activity entitled, 'Unit 0 REQUIRED online introductions'
    a. you are required to complete TWO separate posts, which include the following:
    b. Post One: a brief introduction of yourself suitable for reading by the entire class that includes:
       i. (1 pt) your complete name and what you liked to be called;
       ii. (1 pt) your student status (i.e., full/part time, and field/major);

iii. (1 pt) brief expectations for the course (i.e., I'd like to learn a lot, I'd like to earn an 'A', I'm taking this course because it's a requirement, etc);
iv. (1 pt) what you'd like to learn from the course (i.e., the practice of environmental health, environmental regulations, etc);
v. (1 pt) your plans for how to tackle a course that uses a blended format, a flipped classroom, and mastery learning plus a buffet of summative assessment opportunities for assigning a final grade; and
vi. (1 pt) how you like to communicate online (i.e., email, Twitter, etc).

c. Post Two: (1 point) at least one professional and encouraging comment in response to an introduction posted by someone else in the class.

Detailed instructions of OPTIONAL exercise:

1) complete the optional discussion board exercise entitled, 'Unit 0 optional MOOC article'

a. search the popular press (The Chronicle of Higher Education is one good source) for a news story discussing the 'pros' and 'cons' associated with MOOCs (i.e., read about edX or Coursera or Udacity or others).
b. You need to make TWO separate posts, which include the following:
c. Post One: (10 points total) a brief summary of the article that includes:
   i. (1 point) article citation (publication name, article name, author, date of publication, page numbers, URL, etc)
   ii. (1 point) what is a MOOC
   iii. (1 point) what is one 'pro' of a MOOC
   iv. (1 point) what is one 'con' of a MOOC
   v. (6 points) a concluding statement that supports or refutes the statement, "I believe (or do not believe) that MOOCs will revolutionize learning in higher education because…" Cite specific examples from the story and reference any external citations employed in your summary (your statement should be less than 250 words).
d. Post Two: (10 points total) at least one professional and thought provoking criticism of someone else's concluding statement (i.e., While I agree with your assessment, I believe you missed this important point… etc)

Appendix 2. Representative questions used in the online assessment of student mastery learning. Note, students were required to repeat a quiz until a score of 100% was obtained.

Online instructions for the quiz, "You may retake this quiz as many times as you wish before the deadline. You must achieve a 100% to complete the quiz and earn a grade of 'C' for this exercise. If you do not achieve a 100% before the deadline, you earn a grade of 'F' for the entire course."

Select the correct answer:

1) course content is:
a) information relayed by the professor
b) the online equivalent to "class participation"
c) an important means of opening up the lines of communication between a student and the professor
d) designed by instructors to allow students to work at their own pace
e) a student in an online course
f) other students enrolled in the course

2) message board is:
a) the online equivalent to "class participation"
b) an important means of opening up the lines of communication between a student and the professor
c) designed by instructors to allow students to work at their own pace
d) a student in an online course
e) other students enrolled in the course
f) information relayed by the professor

3) email is:
a) an important means of opening up the lines of communication between a student and the professor
b) designed by instructors to allow students to work at their own pace
c) a student in an online course
d) other students enrolled in the course
e) information relayed by the professor
f) the online equivalent to "class participation"

4) according to lecture, a scientist climbs a mountain to:
a) because its there
b) I don't know why
c) to test a new piece of equipment
d) to place a weather station

5) according to the reading, "science is the systematized knowledge derived from and tested by observing nature without the need to perform experiments such as the empirical studies of engineers."
a) false
b) true

6) the "oldest" cycle question is, "which came first, the chicken or the egg?" What's the correct answer:
a) we don't know
b) the chicken
c) the egg

Appendix 3. Representative student's comments provided during assessment in all three offerings.

About the instructor:

A. Great communicator who is highly knowledgeable on a very practical subject.
B. Very knowledgeable of subject matter well outside the normal experience of most academics; brings valuable real world experience to the classroom.
C. The professor was too flexible and unprofessional occasionally wearing a hoodie or flip flops in the classroom.
D. Seems more interested in his diplomacy than being an instructor.

About the course format:

E. I had to actually invest time in my assignments that made the different for my grade, and that was something I really enjoyed and what I came to school for.
F. I loved the buffet approach to earning a grade.
G. Increase emphasis on UN, and require all students to participate in this optional exercise.
H. The mastery approach puts the responsibility for learning on the student, and I don't think we are ready for that.
I. While it was helpful to bring travel experience into the classroom, it was a distraction to have the professor gone for extended periods.

About the course content:

J. Consider model United Nations exercise as a capstone that we complete near the end of the semester.
K. Use the model UN as an early exercise to teach us how to think like diplomats.
L. Spend less time talking about examples of the United States military winning hearts and minds.