

**TITLE:** Mentoring Instructors to Teach About Earth for a Sustainable Future

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### **Abstract**

In the past two years we have worked with the El Paso higher education community to increase the number of instructors using InTeGrate (Interdisciplinary Teaching about Earth for a Sustainable Future) materials in their courses. We have documented the steps we have taken to mentor and engage instructors and to collect their reflections on the mentoring process and these materials. Early adopters of the materials tended to be newer instructors and adjunct faculty who we engaged through focused one-on-one meetings. As the number of InTeGrate materials grew, we held workshops in Fall 2015 that helped instructors navigate the materials website, provided model syllabi for courses and offered hands-on experience with different types of pedagogy used in the activities. Over half of the workshop attendees (14 instructors) began to use materials in their Fall 2015 or Spring 2016 courses. Another 15% did not specifically use the materials but reported they had adopted similar activities in their classes. All instructors who used the materials once used them again when repeating a class, with about 60% of these instructors adding more InTeGrate content. Based on the success of the Fall 2015 workshops, we held special workshops for graduate teaching assistants in Spring 2016. Barriers to adoption included: the reporting efforts required by the program, reluctance to try new teaching methods, lack of alignment between the materials and the topics taught in their classes, and lack of time.

### **Introduction**

InTeGrate (Interdisciplinary Teaching about Earth for a Sustainable Future) is an NSF-funded five-year STEM Talent Expansion Program (STEP) Center grant running from 2012 to 2016. The grant focuses on increasing the Earth literacy of all undergraduates so that they can apply their knowledge to key societal issues such as dwindling fresh water, food, mineral and energy resources or the impact of natural hazards (earthquakes, volcanoes, extreme weather) on an increasingly urbanized environment. The two main goals of the program are: 1) to develop curricula to increase Earth literacy of all undergraduate students and 2) to increase the number of majors in the geosciences and related fields to assist other scientists, business people and policy makers in developing solutions to major environmental and resource challenges (InTeGrate, 2016). The program seeks to engage over 150 instructors in creating and testing curricula that will be provided in an on-line repository to reach over 400,000 undergraduate students.

Teaching materials developed by the program are designed to focus on one or more Earth related challenges, encourage interdisciplinary and systems thinking, improve students' understanding of methods used by geoscientists and use authentic geoscience data to learn important concepts. The materials must meet rigorous criteria (InTeGrate, 2013) to ensure they satisfy the goals of the program and involve the use of effective pedagogical techniques. The El Paso higher education community, consisting of El Paso Community College (EPCC), El Paso early college high schools (ECHSs) and the University of Texas at El Paso (UTEP), is encouraging geoscience instructors to increase their use of InTeGrate curricular materials to insure that students taking introductory classes at any institution will be exposed to comparable course content and that geoscience majors will be similarly prepared for advanced courses.

All of our institutions are Hispanic serving institutions with student bodies that are at least 80% Hispanic (El Paso Community College, 2014; University of Texas at El Paso, 2016).

Hispanics are poorly represented in the geoscience community. In 2012 only 5.5% of bachelor's degrees awarded in earth science related fields were awarded to Hispanic students (NSF, 2015) and only 4.1% of professional geoscientists (Bureau of Labor Statistics, 2010) are Hispanic. Therefore one motivation for using InTeGrate curricular materials was to determine if they appeal to Hispanic students and lead them to consider pursuing a professional career in the earth sciences. This paper describes the methods we used to mentor instructors to adopt and adapt InTeGrate materials for use in their classrooms, all of which contained at least 80% Hispanic students.

### **Methods for Developing Mentoring Program**

The first curricular materials became available for general use in Fall 2014 and focused on climate change. We decided to test one unit of these InTeGrate materials in four classes taught by four different instructors (Introduction to Environmental Science, The Blue Planet and two sections of Historical Geology) that already covered the topic of climate change. This allowed us to obtain baseline information on how the materials appealed to students, to assess how much curricular content the students retained based on responses to questions on a follow-up exam, and to determine how difficult it was for instructors to use the materials in their classes. Three other classes (Introduction to Environmental Science and two sections of Physical Geography) taught by one instructor who did not use the materials but also covered topics related to climate change served as a control group. At the end of the semester the control group was given the same general exam questions as the four classes using InTeGrate materials. The instructors involved in the pilot study met as a group in October 2014 to review the unit we planned to teach, decide which assessment questions would be asked on an exam following the activity, insure we obtained consent forms from all students involved in the study, and agreed to keep instructor logs on what happened in the classroom during the activity.

The unit we selected examined how past civilizations adapted (Inca) or failed to adapt (Maya and Viking) to climate change. The students were then asked what they learned from these examples that could help us to better adapt to climate change expected in the future (Shellito, 2014). Students were assigned a brief reading on the topic, either as homework or at the beginning of class, and then asked to complete a gallery walk assignment (Science Education Resource Center, 2004) where they worked in groups to discuss and answer questions that encouraged analysis, synthesis and evaluation of the reading assignment. The questions were posted around the edges of the classroom or on tables, requiring students to move around the classroom.

Based on the initial positive feedback from instructors and students, we had hoped to move forward with the implementation of more curricular materials on other topics in Spring 2015; however no new InTeGrate materials were available until the end of the semester. This was due in part to the need for the materials to score 80% or higher on a rigorous rubric (InTeGrate, 2013) prior to their public release.

In May 2015 we sent an email questionnaire to about thirty instructors who we had identified as having taught earth science related classes at EPCC, UTEP or local ECHSs. We wanted to gauge their general interest in the materials and interest in attending workshops on using the materials. The instructors were asked to return the questionnaires to an email account set up by a UTEP system administrator so that responses would remain anonymous. We received seven responses to the survey with six of the seven respondents indicating they would

be interested in using the materials, although some felt the activities might fit better in a laboratory setting than a lecture setting.

Our first workshop on InTeGrate materials was held during the first week of the Fall 2015 semester. This was our first major gathering as a group and we spent about 10 minutes at the beginning of the workshops and 15 minutes in mid-workshop socializing to open lines of communication between instructors from different institutions. We spent about 45 minutes on an overview of the program including how to navigate the program web pages. We provided examples of how instructors had used materials in their courses in the Fall 2014 and Spring 2015 semesters and documentation on how student outcomes had improved in classes where the materials had been added. This overview was followed by a choice of one of two hands-on sessions that used InTeGrate materials. A subsequent workshop in October 2015 provided hands-on sessions for two additional units.

Fewer UTEP instructors generally teach introductory courses in the spring semester, so we made an effort in Spring 2016 to engage more instructors at EPCC and to encourage the use of InTeGrate materials in upper division classes at UTEP. A workshop that included information on the materials, but did not include a hands-on session using the materials, was held at EPCC in January 2016.

Since most of the graduate teaching assistants at UTEP were unfamiliar with the InTeGrate program, we held a workshop for them in February 2016. The workshop demonstrated the use of a group activity termed a “jigsaw” (Tewksbury, 2009). Following division of a class into separate groups comprised of 3 or 4 students, each student in a group works on a specific piece of a problem individually and then all students from the group come together to synthesize their results and draw conclusions. The activity we used had each student examine photographs of natural and human modified landscapes to determine similarities and differences between the images based on an activity developed by Fortner, Murphy & Scherer (2015). We have found this activity to be especially appealing to visual learners in our classes.

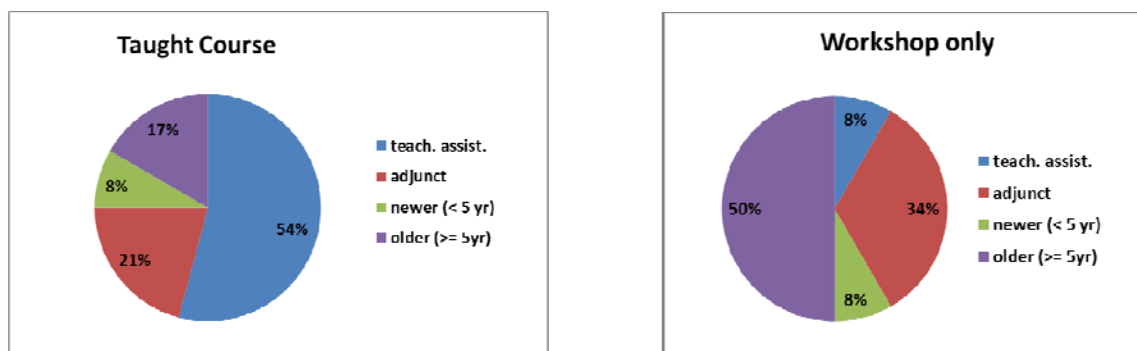
## **Results**

Students and instructors were overwhelming positive about the materials covered in the Fall 2014 climate change unit and the use of the gallery walk technique for enhancing student learning. We found that over 65% of the students correctly answered questions given at the end of the semester on topics that were directly related to the unit. Students exposed to the InTeGrate materials did as well or better on answering more general questions related to climate change than the control group. All instructors who used the unit in Fall 2014 have continued to use it in their classes, adding additional units over time.

Our August 2015 workshop attracted six instructors from EPCC, one from an ECHS and nineteen from UTEP. Instructors from UTEP included five graduate teaching assistants who taught sections of introductory physical geology laboratories. Seven instructors attended the October 2015 workshop. Feedback from the two workshops indicated that instructors appreciated the ability to “test drive” teaching materials that introduced pedagogical techniques that were unfamiliar to many of them. Others felt that the activities would take too long for a fifty-minute class or that the students would need to have pre-class assignments to insure that they had looked over the materials. Several indicated the need to “practice” with the materials multiple times before they felt confident enough to try it alone in the classroom. Five of the instructors subsequently met one-on-one with the workshop leaders to obtain further guidance on

how to use the materials in their classroom. Two instructors also came to observe how InTeGrate materials were used in a large classroom setting.

Following the two workshops and one-on-one consultations, eight instructors and eight graduate teaching assistants used the materials during the Fall 2015 semester (Figure 1) in a variety of classes and laboratories. About 15% of instructors attending the workshops who did not use the materials in their classes indicated they were using other active learning techniques. Note that 29% of the instructors who used the materials (Figure 1) were newer instructors or served in adjunct positions, while only 17% were instructors who had taught for five or more years. Reasons cited for not using the materials included lack of alignment between the materials and the instructors' Fall 2015 course content, lack of time to adopt/adapt the materials, concern that the materials could not be covered in a fifty-minute class period or that they were satisfied with their current materials. Instructors teaching for five or more years (50%) were most unlikely to try new materials and new pedagogies, in spite of evidence presented at the workshops that showed a marked improvement in students' performance and overall grades in courses where the materials had been used over the past two years.



*Figure 1 – Comparison of instructors who adopted/adapted InTeGrate materials for their classes during the Fall 2015 semester (left) to instructors who only attended one of the Fall 2015 informational workshops (right). “Newer” and “older” refer to number of years of teaching experience for tenured or tenure-track faculty.*

The January 2016 workshop at EPCC did not lead to more EPCC instructors adopting InTeGrate materials; however it did lead to a follow-up meeting between EPCC and UTEP instructors in February 2016 to discuss new EPCC curriculum changes mandated by the State of Texas and their expected impact on students planning to transfer to UTEP. The five teaching assistants participating in the February 2016 workshop quickly saw how the hands-on activity would be of interest to their students and noted many benefits of the activity. One teaching assistant even noted how the jigsaw concept could be extended to any topic that has layers/levels of detail and that it would work for all levels of classes.

Six instructors and six graduate teaching assistants used InTeGrate materials in Spring 2016. Two of the instructors (both from UTEP) and five of the graduate teaching assistants used the materials for the first time. One of the first time users was the instructor of an upper division course (Geology for Engineers) at UTEP. He used materials that had been prepared and tested by co-author Doser in the same course during the Spring 2014 and 2015 semesters. This instructor reported that the students were enthusiastic and highly engaged in the materials. He

was so pleased with the student interactions that he began to use similar pedagogical techniques in the other classes he was teaching at UTEP and EPCC. Preliminary analysis of student outcome data from the 2016 Geology for Engineers class indicates the students performed similarly to Doser's 2014 and 2015 courses, suggesting that InTeGrate materials provide high levels of student engagement and learning, regardless of the instructor.

Since active recruiting of instructors began in Fall 2014 we have seen a steady increase in the number of instructors using InTeGrate materials (Figure 2). All instructors who have used these materials once have used them again, and over 60% have added new materials each time they teach an established class. Over 10 instructors per semester are using the materials to teach over 500 students per semester in face-to-face, hybrid and on-line courses at our institutions (Figure 2).

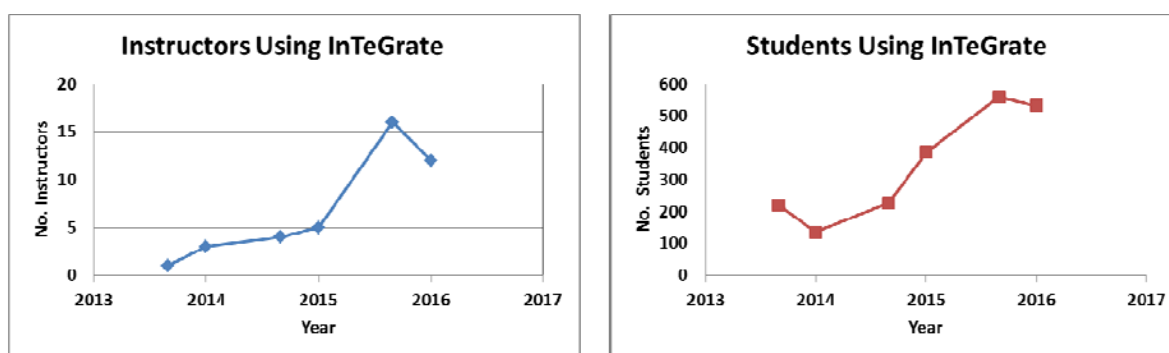


Figure 2 – Number of instructors (left) and students (right) using InTeGrate materials over time.

## Discussion

We have found that the best way to encourage instructors to adopt new curricular materials is to have several instructors first pilot the materials to document student reactions and outcomes as well as the challenges of teaching the materials. Next, we held a series of workshops to introduce other faculty to the new materials and teaching methods. Faculty who were interested in adopting/adapting the new materials could then follow up with one-on-one consultations, visit classrooms to observe how the materials were used and attend supplemental workshops. About 15% of instructors who decided not to use the new materials indicated that they were using other teaching techniques and materials that had similarities to the InTeGrate materials. Instructors who had taught less than five years, adjunct instructors and graduate teaching assistants appeared to be the most open to using new materials and pedagogic techniques. An added benefit of the workshops was that it allowed for interactions between instructors at different institutions. This led to multi-institutional follow-up meetings to discuss other common interests and problems, such as overall curriculum alignment and ways to assist transfer students.

Our mentoring program was not without its challenges. First, it was difficult to persuade EPCC and ECHS instructors to use InTeGrate materials, even when an informational workshop was held on an EPCC campus. The materials website is extensive and difficult for the novice to navigate. Instructors at these institutions also have higher teaching loads that limit the time that can be spent in developing new curriculum. More established instructors (who had taught five or more years) were also not easily persuaded to use the materials. A hands-on experience with

the materials to illustrate their ease of use and appeal to students may be critical to successful adoption by these instructors. It was apparent that once the instructors made the effort to try the material in the classroom and saw the positive student reactions, they continued to use the materials and add more materials over time.

Another challenge was using the materials in a large (100+ students) classroom. Many activities involved group work and more than one instructor was often required to help answer questions and keep the large number of groups on track. However, the extra help may only be necessary for the first week or two of a course until students become more comfortable working together. Large classrooms with fixed seating also did not work well for group interactions. Instructors needed to plan ahead to request classrooms that had adequate seating arrangements for the activities.

Completing activities in a fifty-minute class period sometimes required pre-class assignments or flipping lectures so that the entire period could be devoted to the activity. Other activities required the use of the internet and sufficient bandwidth was not as readily available on EPCC campuses. Instructors that were aware of this problem were able to retrieve the required data from the internet ahead of the class period. To help surmount these instructional problems we compiled a users' guide to all materials that had been tested by our group. The guide highlights the suitability of the materials for large, small and on-line classes, materials that require extensive use of the internet or color figures, the approximate time it will take to complete an activity and the activities that are especially popular with students.

Most instructors who used the materials were too busy to keep teaching logs, but they were willing to be interviewed at the end of the semester about the teaching process and the students' reactions to the material. Instructors were also willing to include multiple-choice and open ended questions on final exams that we could compile to help gauge student reactions to the new material and overall improvement in student learning. Our preliminary results show most (over 60%) students found that the materials were relevant to their courses, increased their understanding of sustainability issues related to their courses and enjoyed the variety of methods used in the classroom.

### *Acknowledgements*

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### REFERENCES:

- Bureau of Labor Statistics (2010). *Occupational Outlook Handbook, 2010-11 Edition*, U.S. Department of Labor, Washington, D.C.
- El Paso Community College (2014). El Paso Community College fact book. Retrieved from <http://www.epcc.edu/InstitutionalResearch/Documents/FactBook2012-2013.pdf>
- Fortner, S., Murphy, M. & Scherer, H. (2015). Unit 1: Impacts of land use. Retrieved from [http://serc.carleton.edu/integrate/teaching\\_materials/sustain\\_agriculture/activity1.html](http://serc.carleton.edu/integrate/teaching_materials/sustain_agriculture/activity1.html)
- Interdisciplinary Teaching about Earth for a Sustainable Future (2016). About the InTeGrate project. Retrieved from <http://serc.carleton.edu/integrate/about/index.html>

Interdisciplinary Teaching about Earth for a Sustainable Future (2013). Guidance: InTeGrate curriculum development and refinement rubric. Retrieved from [http://serc.carleton.edu/integrate/teaching\\_materials/itg\\_materials\\_dev.html](http://serc.carleton.edu/integrate/teaching_materials/itg_materials_dev.html)

National Science Foundation (2015). Bachelor's degrees awarded, by field, citizenship, and race or ethnicity: 2002-2012. Retrieved from <http://www.nsf.gov/statistics/2015/nsf15311/tables/pdf/tab5-3.pdf>

Science Education Research Center (2004). What is a gallery walk? Retrieved from <http://serc.carleton.edu/introgeo/gallerywalk/what.html>

Shellito, C. (2014). Forecasting climate variability and change: A matter of survival. Retrieved from [http://serc.carleton.edu/integrate/teaching\\_materials/climate\\_change/unit1\\_cover.html](http://serc.carleton.edu/integrate/teaching_materials/climate_change/unit1_cover.html)

Tewksbury, B. (2009). Jigsaws. Retrieved from <http://serc.carleton.edu/sp/library/jigsaws/index.html>

University of Texas at El Paso (2016). 2015-2016 facts. Retrieved from <http://universitycommunications.utep.edu/facts/index.html>