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Studying Nature *In Situ*: Immersive Education for Better Integrated Water Management

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Abstract: The term immersive education is currently used in two educational areas – language education, which involves students being totally immersed in a language and its culture; and virtual education, where teachers use computers and simulation games to immerse learners in a virtual, computer-generated environment that mimics a real-world environment and allows learners to interact with it. This paper uses examples from university teaching practices in marine studies and coastal zone management to make a case for a third definition for immersive education in tertiary settings – educating water managers by immersing and guiding them through real-world situations that involve understanding and managing water, biodiversity, catchments, and people, and the interactions between them. Immersive education of this third kind, and traditional tertiary education approaches such as lectures and demonstrations, are compared, and the advantages of immersive education are discussed. The examples from practice and discussion presented show immersive education as being experiential and real, process-driven, trans-disciplinary, collaborative, participatory, and active, encouraging critical thinking and a renegotiation of power in relationships between participants. Such immersive education develops passion and persuasive capacity in students, providing personal experiences that are memorable and potentially life-changing. Challenges to immersive education in tertiary education, including lack of finances, teacher burn-out, safety concerns, and inertia to maintain the status quo of traditional education, are highlighted, as are ways to overcome these.

Keywords: *Immersive education, experiential teaching, trans-disciplinary*

Louis Agassiz (1807-1873) declared, "Study nature, not books," on a sign at the entrance to his summer field course on Penikese Island off Cape Cod, Massachusetts, in the 1870's. Agassiz was a Swiss geologist who had correctly interpreted the impact of continental glaciers in forming the landscapes of northern Europe and North America. Agassiz emigrated to the U.S. and set up a field school that ran for several years on a small remote island until his death in 1873 (Wilder 1898). This course and teaching style were emulated by the Marine Biological Laboratory, set up in nearby Woods Hole in 1888. The Marine Biological Laboratory, the second oldest marine lab in the world, developed immersive summer courses and went on to create one of the world's premier biological libraries, which ironically, is appropriately where the sign now resides (Addante 2009).

Agassiz was renowned for starting his course by placing a whole fish in front of each student and asking them to draw and interpret what they could about the fish. When the students wanted to start dissecting the fish or doing experiments, Agassiz said to just leave the fish intact and observe. He then informed them that this was a half day exercise, and it would take a while for the students to realize that they needed to begin using their eyes and their brain. Agassiz deliberately was teaching them to look, really look at the fish, and begin thinking about how the fish sensed the environment, how it moved through the water, and how it was put together. This exercise got the students to make detailed drawings and sharpen their observational skills (Anon (a) 1879).

What can we learn from Agassiz's adage "Study nature, not books" from the nineteenth century? The progressive era of education (1917-1957) saw educators move away from experiential education to methods that were deemed more efficient such as lectures, text books, and demonstrations (Tolley 1994). With the rapid growth of the natural sciences

literature in the form of scholarly journals and books, and the explosion of sensors that can stream data directly to the laboratory, it may be argued that such "progressive" ideas should still hold sway. Significantly, the study of nature is increasingly linked with the study and management of land, water, and human systems. What can we learn about managing water by immersing ourselves in the real world? Why not just send students to online literature and the computer to download and interpret data or play simulation games? This paper makes a case for immersive education as a way to learn about and better manage water, the things that live in it, and the way that we interact with it and the surrounding landscape. From the management of coastal zones to integrated water management more generally, we need to create real, participatory, collaborative, trans-disciplinary learning experiences in which students study nature, land, water and human systems and the ways we might manage the interactions between them in situ, not from behind a computer screen.

Immersive Education

The term "immersive education" is currently used in two ways. The first is in language education. Language educators have long realized that the most powerful way to teach a second language is to immerse students in situations where that language is the sole communication medium for daily living and learning. The culture associated with that language becomes the dominant culture of the educational process (Cummins 1998).

The second use of "immersive education" relates to the development and use of virtual realities and game-based learning systems for educational purposes (e.g., Immersive Education Initiative 2012).

This paper proposes a third use for the term, arguing that learning about land, water, biodiversity and their management is a task best undertaken *in situ*, immersing the learning process in the setting that is the actual focus of management.

We contend that this conceptualization of immersive education has utility in terms of teaching about water – managing water more sustainably by understanding and managing land, water, the living things that live in and depend upon water for life, human systems, and the interactions between them. In the associated area of environmental education, Lucas (1979) wrote of it having essentially three foci – being about, in, and for the environment. We characterize immersive education as emphasizing the second of these three foci, being immersed in the environment, leading participants to learn more about that particular topic and them also becoming advocates for issues of sustainability relating to that topic. Students and teachers become active participants in real situations. Their learning is experiential. They collaborate. Their learning involves many disciplines. The term "immersion" is metaphorically appealing when we think of learning about water in this way. It may also be a useful educational vehicle in other settings.

In our experience, immersive education can mirror many of the characteristics of popular or participatory education, as described by Paulo Freire (1993). This is particularly true in relation to renegotiation of power relations between teacher and student and the development of a critical consciousness. In this model, students do not accept information at face value, but, like the students examining the fish in Agassiz's laboratory classes, examine what they learn about water more deeply, from diverse points of view, and through a range of disciplinary lenses to detect any factors which may detract from or add to the authenticity of their findings.

The authors have over sixty years of combined experience in water education in formal and nonformal settings. In terms of formal education, this experience ranges from teaching in primary schools, and outdoor and environmental education centers, through to secondary schools and universities. Topics taught have included biology and marine botany, and broader subjects such as marine studies and coastal zone management, through to secondary school environmental education and a post-graduate program in integrated water resource management. Based on this experiential foundation, this paper compares traditional classroom teaching with immersive education, discusses advantages of an immersive approach, and proposes ways to overcome impediments to its implementation. Immersive education is defined based on aspects of the

marine studies and coastal zone management education examples that follow. Finally, the paper proposes that immersive education may have use in many areas of water education from disciplinary-based water topics through to broader, more encompassing areas such as integrated water management, as this field is portrayed in the literature (e.g., Biswas 2004; Ferreyra and Beard 2007; Global Water Partnership 2012; Rahaman and Varis 2005). While immersive education may also have a place in nonformal water education and management settings, this is not the focus of what follows.

Comparing Traditional Classroom Teaching and Immersive Education

The traditional classroom setting has a teacher at the front of the room using a chalkboard for illustrations and the students dutifully taking notes as the teacher imparts knowledge. The chalkboards have been largely replaced with various technologies that serve to bring even more knowledge to the students, who can passively watch the "show." The following comparisons can be made between traditional classroom teaching and immersive education.

Traditional classroom teaching is content-driven. The subject matter is presented in a series of lectures. Immersive education is process-driven. Students learn how to do science. Traditional classroom teaching is broken up into disciplines (e.g., chemistry, biology, physics, geology) and content delivered accordingly. Immersive education is topic-driven and multi-disciplinary, as studying integrated water management inherently involves crossing the disciplinary boundaries. Over the last thirty years, while they may not be labeled as such, examples of immersive education can be found in many areas of higher education, particularly those where solutions to problems are not readily found within a single disciplinary domain and field settings that allow for immersion are accessible to educators. Examples include health, engineering, and environmental science (Ashford 2004; Gilbert 2005; Jacobsen 1990). Looking at what is in front of us in a field setting, rather than content from a single discipline, can turn teaching and learning on its head. In Bill's teaching he would often turn over a piece of coral rubble and ask students to identify which kingdom the encrusting organisms belonged. Sponges, tunicates, and algae can be difficult to distinguish, or which process had formed the rubble itself. Botany, zoology, and geology quickly become inter-twined with epiphytic algal succession and the nutrient sources of coral lagoon eutrophication processes.

Traditional classroom teaching has the teacher at the front of the room as the focal point. Immersive education has the teacher rotating between student groups, and at the end of the course, it is the students in front of the class. Power relationships between teacher and students are re-negotiated. Learning becomes participatory with students sharing responsibility for both teaching and their own learning (Freire 1993). Traditional classroom teaching ultimately is a forgettable experience. Immersive, experiential learning is truly unforgettable. Bill often says, "Put me in front of a classroom, and both the students and I will quickly forget what I said in class, but give me a student for several weeks on a ship or a field station and I will change their lives forever, and enjoy myself in the process."

Immersive education is experiential. Science being conducted by students is "real," not an exercise with predetermined answers. The students are doing science, not studying it. Before Bill's first voyage aboard a tall ship as Chief Scientist as part of the Sea Semester, based in Woods Hole, Massachusetts, he kept badgering the more experienced scientists about how he would be able to recognize the major oceanographic provinces as they transited the North Atlantic Ocean. Bill was worried that they would sail right over Georges Bank, through the Gulf Stream and into the Sargasso Sea before noticing any changes. His colleagues kept saying, "Oh, don't worry. You'll know when you get to the Gulf Stream." He was not satisfied with their answer and they finally relented and said to watch the sea surface temperature for the signal. Well, sure enough, as they sailed up to the Gulf Stream, there was a line of clouds along the boundary between the cooler greenish continental shelf water and the deep blue Gulf Stream, the weather was different, with wind and waves changing, and fish were jumping and birds diving along the oceanographic front of the West Wall of

the Gulf Stream. The Gulf Stream literally smelled different. They then experienced the Gulf Stream for several days, as they hove to under bare poles during a storm, but still were carried along at four knots. In reading the student journals at the end of the six week voyage, it was clear that they were all going to remember the Gulf Stream for the rest of their lives.

Immersive education is an active learning experience. It is more powerful than simply "teaching," and connotes an active, rather than a passive experience. The objective is learning through experience and the subject content that the student absorbs is through these experiences with nature and their surroundings, rather than via lectures. When a student picks up a book or reads primary scientific literature, it is in the context of understanding an observation or interpreting their results, rather than content that is delivered by an instructor for later testing.

Immersive education is participatory and collaborative. Group work is central to the process. Students form small groups or "student research teams" (generally 4-6 students per team) that work together to study an aspect of nature. The teams are given enough time together to formulate hypotheses, design observations or experiments to test their hypotheses, and divide up the tasks between themselves. While the instructors circulate among the groups to ensure they are coming up with doable and interesting questions, the students are encouraged to self-organize and develop allocations of tasks that are equitable and utilize the different skill sets that individual team members possess.

Advantages of Immersive Education

There are several advantages of immersive education over traditional classroom teaching for teachers.

1. Teachers are generally "learning junkies," and immersive education provides them with new data and new ideas which can stimulate further research.
2. The immersive setting provides teachers with insights into the personalities and capabilities of students. It is easier to assess a student project when the student is in front of you and there is more than a faceless name on a piece of paper. Advising or selecting students for future academic or professional development becomes easier as well.
3. Teachers get good feedback on the student's mastery of a subject, and can better appreciate what aspects of their teaching need to be modified. More than correct answers on an exam, the teacher can determine whether the students can apply their learning.
4. The enthusiasm of students being exposed to nature can serve to reinvigorate teachers. Being able to see something through the eyes of students who are seeing or doing something for the first time can inspire a teacher to better teaching.

After teaching in immersive settings for thirty years, we would like to reflect on the life lessons to both teacher and student that transcend the course content or subject matter.

1. The amazing amount of research and learning that can be accomplished by a small team of focused people in a short amount of time is an important illustration of what is possible, given the right conditions. This can promote students and teachers to enable these right conditions for productive collaborations in other endeavors. As Margaret Mead said, "A small group of thoughtful people could change the world. Indeed, it is the only thing that ever has." (Anon (b) 2012).
2. Immersive education provides both student and teacher with memorable events and meaningful experiences. Observing bioluminescence, stars, or sea creatures can be memorable, and pushing one's boundaries physically, mentally, or emotionally by working closely together can be meaningful.
3. Developing personal relationships in an immersive learning setting can lead to life-long relationships. Meeting and getting to know interesting people is facilitated by the immersive nature of the setting. Bill's ground rules on personal relationships for students and instructors during a course are no "special relationships" that serve to disrupt the group dynamic.

4. Both as students and instructors, we have been inspired by experiences in immersive education settings. We feel as though we learned more, and learned more deeply. The enthusiasm generated by group dynamics has fueled our passion for environmental science and for the preservation of ecosystem health so that future generations can experience nature.

There are some biological realities that traditional classroom settings attempt to ignore. One reality is that the attention span of an average adult, particularly young adults, is twenty minutes or less. This means that the typical one hour long class is well over the limit. Simply sitting still for extended periods causes the brain to function at reduced capacity as well. Young adults have a lot of energy and forced inactivity does not promote constructive thinking. Another reality is that different people learn better in different ways, often divided into visual, auditory, and tactile learning modes. The traditional classroom is largely auditory, with varying amounts of visual and little if any tactile learning. An immersive education experience can promote a variety of learning opportunities. Many academics believe that students typically learn more from their classmates than they do from their instructors. This means that the teacher-centric classroom setting where students are admonished to "keep quiet" is working at odds with the learning style of students. Given these realities, why do we persist in delivering most of our teaching through traditional classrooms?

Overcoming Impediments to Immersive Education

There are several impediments to implementing immersive education over traditional classroom teaching in university settings.

1. Financial. The financial efficiency of a single instructor delivering a lecture course to tens or even hundreds of students is contrasted with the need for a teacher and teaching assistants to deliver a course to only two dozen students who need to be housed and fed in remote settings. While this is false economy, the costs of running a field course are often an impediment to students (travel costs and additional fees) and institutions (remuneration based on credits and student numbers).
2. Burn-out. The immersive setting means that teachers are interacting with students intensely. This is challenging emotionally. Leading field trips and trying to keep up with students that are decades younger can be exhausting. Upon returning to campus after an exhausting field course, colleagues typically treat the teacher's time away as vacation.
3. Inertia. The challenge of doing something that is off-campus, uses different testing and assessments, and is difficult to assign credit hours takes extra energy on the part of the teacher and the various university administrators. It is always easier to resort to the tried and true lecture setting.
4. Safety. The opportunity for accidents to occur in remote settings without easy access to medical facilities can be a deterrent for both students (particularly parents of students) and university administrators.

While financial, burn out, inertia, and safety issues do pose very real deterrents to delivering immersive education experiences, various mechanisms have been developed to overcome these concerns. Creative funding models that tap additional resources to underwrite student costs, and/or provide remuneration via a lecture-based course component are examples used to overcome financial barriers. Developing a time-in-lieu policy which allows instructors to recover from field trips can reduce burn-out. Reward systems for teachers and support personnel can encourage them to overcome inertia to create and maintain immersive education programs. A fairly strict code of practice needs to be developed for students, as well as provision of first aid supplies and training for teachers.

Two examples of immersive education follow. They illustrate the teaching effectiveness of this approach and the difficulties in sustaining these programs.

Examples of Immersive Education

Example 1

Sea Semester. This program is operated by a private, non-profit organization, Sea Education Association, based in Woods Hole, Massachusetts. The basic course format is to teach students both nautical science and marine science in a classroom setting for six weeks in a shore component. This is immediately followed by a six week sea component where the students join a tall ship and serve as deck hands and scientists. By the end of the six week sea component, the students are expected to run the ship and the science program, providing a powerful motivator for learning. This program has been running for forty years, has an impressive set of alumni, logged over a million nautical miles with an impressive safety record, yet struggles every year financially. The costs of running seagoing vessels are considerable and prone to inflationary pressures, and the students have an increasing diversity of less expensive (and less challenging) options for a semester abroad or a shorter version (e.g., two week sail vs. a full semester). Class size is limited by ship berths, so approximately twenty-five students per ship can be accommodated. Each student conducts a project aboard the tall ship and presents their findings to the class at the conclusion of the course. Some of the data collected by students are published in scientific journals.

Example 2

Field course in coral reef biology and geology. This course was team-taught at The University of Queensland for over twenty years by academic instructors from zoology, botany, and geology. A full semester course was delivered on the main campus which had enrollments in excess of one hundred students. The top twenty five students from the on-campus course were offered the opportunity for the two week course at the Heron Island Research Station on the southern Great Barrier Reef. The field component included reef walks, snorkeling and diving trips, topical lectures, and projects with written and oral presentations at the end of each week. The number of students who went on to professional careers in marine science was considerable. The course was discontinued when key faculty retired or left the university.

Some Outcomes of Immersive Education

Three important personal traits can be fostered in immersive, experiential learning; knowledge, passion, and persuasive capacity. Knowledge, particularly deep knowledge about an ecosystem, is obtained from extended direct exposure to the ecosystem, supplemented with a strong intellectual framework obtained through academic teaching and research findings. Passion for an ecosystem is also generated from extended direct exposure. In addition, the increased understanding of ecosystem features and threats often creates a conservation ethic that leads to passion. The persuasive capacity to convince other people of the need for appropriate actions to preserve or restore ecosystems is generated from the knowledge and passion, analytical and communication skills gained in experiential learning, and can lead to social change.

There are several key components to immersive education that enhance both individual and group learning. An important component is the written and oral communication of research findings at the end of the research projects. The act of synthesizing and communicating the findings provides an opportunity for insights and improved understanding. Sharing research findings between the different research teams also provides a synergistic opportunity for comparisons and contrasts that can create broader synthesis than could be generated with individual projects. Students also obtain a sense of satisfaction for the completion of their project and can appreciate their accomplishments by finishing in a timely manner. Another component that can result in group learning is a constructive, facilitated critique after the presentations in which the clarity of the science and the communication of the science are discussed by the entire class. In this way, students learn by both direct and indirect critiques, as well as learn how to ask good questions, and how to analyze and interpret scientific results. It is often the first opportunity they may have to develop the skeptical rigor necessary for the proper analysis of scientific results, as well as receive constructive feedback on their work from classmates. Finally, most students need to be dissuaded that they have not collected enough data or done enough analysis for their work to be considered a "real" scientific

study. In fact, peer review publications can be generated from student project results, and the data generated in student projects can stimulate further research proposals and projects.

Defining Immersive Education

The above examples show that immersive education places students directly in the water environment that is home to their interests and uses the experiences they gain as a way to learn about, reflect on, and advocate for, the better understanding and management of this water environment (Lucas 1979). Immersive education echoes the exhortations of Agassiz, refocusing both the student and the teacher on the object of study and the context in which it occurs. The examples presented here highlight many aspects of immersive education. In summary, immersive education:

- Is experiential and real. Students are face-to-face with the object of their study. They are physically and mentally surrounded by and enmeshed in the environment that supports this object.
- Is process-driven. It involves formulating and testing hypotheses, linking and testing relevant content, processes, and personal and social values.
- Is trans-disciplinary. Students view the object of study through many disciplinary windows and seek links between knowledge gained and ways to value that knowledge.
- Encourages critical thinking. Observations are not accepted at face value. All data collected and analyzed are subject to close scrutiny, as are any conclusions derived from this analysis.
- Renegotiates power in relationships between participants. In traditional classroom situations teachers control the pedagogic process. In immersive education students are empowered to guide the learning process.
- Is participatory and active. Where possible, data are gathered directly and students are purposefully involved in gathering, analysis, and synthesis of findings.
- Is collaborative. Students work in groups. All aspects of the immersive process involve students working with and reflecting on their findings with both their peers and teachers.
- Provides personal experiences that are memorable and potentially life-changing. Students may become advocates for a particular viewpoint, based on these experiences.
- Develops passion and persuasive capacity. Advocacy skills may be developed as a part of the process.

In Conclusion

While the above list of characteristics may appear somewhat idealistic, it may be a useful checklist for teachers designing immersive education programs. Many of the characteristics found in the two examples and the discussion in this paper (e.g., process driven; trans-disciplinary; requiring critical thinking and renegotiation of power found in relationships between participants; participatory; collaborative) are also, or ideally should be, characteristic of emerging, complex fields of knowledge such as integrated water management.

Our anecdotal observations of the high rates of career success in graduates of immersive education lead to the supposition that there are lasting positive impacts of learning in this style that transcend the actual course and benefit the students (and instructors) later in their careers. A case could be made for developing some good longitudinal studies in which the career trajectories of students with and without immersive education are compared over many years. The pre-selection of students drawn to this teaching mode is also relevant, as the most enthusiastic and keen students will vie for these opportunities. Another aspect that is not typically valued, but can be quite important to individuals, is the personal realization that students may gain from the intense exposure that a certain subject or career path is, in fact, not what they wanted after all. Young people often need to learn what they do *not* want to do so that they can better decide what they do want.

There are many powerful reasons for developing immersive education to either augment or replace traditional classroom teaching. There are advantages of this mode of delivery for both students and instructors. In addition to giving

students a deep knowledge of the subject matter, there are some good life lessons to be gained. Teaching in a non-traditional mode does present some challenges, but innovative approaches and persistence can overcome the impediments. Examples of immersive education demonstrate both the tremendous capacity that these programs can unleash, but also the fragility of maintaining these programs. The long-lasting impacts of this type of learning can be appreciable, and research as to such impacts is needed. Our conclusion as immersive educators is that Louis Aggasiz's succinct, hand-painted sign, "Study nature, not books," still resonates today.

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