Using Emerging Technologies to Facilitate Science Learning and Civic Engagement

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Abstract
Providing students with meaningful academic experiences in the environmental sciences is challenging in today’s urbanized world. Through a combination of activity-based and experiential learning opportunities, today’s learners can be motivated to connect course content with other classes and with their daily decision-making processes. Combining technological advancements with traditional pedagogical strategies provides an innovative springboard from which to launch a stimulating science experience for general education non-major students. Civic engagement projects enhance the community-minded thinking of the younger generation while simultaneously serving the needs of local environmental education partners. This paper describes the use of emerging technologies in curricula redesigns, innovative student civic engagement projects, and provides associated evidence of student learning. Two environmental sustainability-focused courses were redesigned and a two-semester sequence was established that linked a hierarchical civic engagement structure to an activity-based curriculum. Based on feedback from “Student Assessment of Learning Gains” (SALG) surveys, students demonstrated significant advancements related to their confidence in understanding core course concepts. Students responded favorably to the course redesigns and generated meaningful projects, which are directly meeting the needs of the regional community. Future goals include expanding student-created biodiversity map projects across the region and enhancing science, education, and outreach by creating web-based interactive tools for regional environmental education partners.
An urbanized world with an exponentially-growing human population that has surpassed 7 billion inhabitants creates challenges for educating today’s general education non-science majors about environmental issues, largely due to their lack of connections with the natural world and their common reluctance for science. Additionally, today’s learner expects a different learning environment and has new tools available that can be used to enhance the academic experience, both in and out of the classroom (McGee and Diaz 2007). Connecting coursework to other classes and to daily decision-making processes fosters worthwhile learning opportunities, creates engaging science classes, and stimulates passions to become well-rounded individuals who want to contribute in a meaningful way to our democratic society (Burns 2011, Burns 2012).

Delivering meaningful academic experiences to our students is likely the goal of every educator (Dewey 1997, Kolb 1984, Brophy et al 1983, Orr 1992, Zhao & Kuh 2004; Jonassen & Strobel 2006). Although reaching these students can be challenging, frustrating, and difficult, staying current by using technological gadgets and digital lessons can provide an innovative springboard from which to launch new teaching styles and strategies (McGee and Diaz 2007), which allows for the inclusion of high-quality civic engagement opportunities into the curriculum (Jacoby 2009). By linking Education, Ecological Perspective, and Emerging-technologies (eLearning) (the “5 E’s”, Figure 1), an innovative framework that structures the development and evolution of a learner-centered teaching philosophy was implemented. Emerging technologies that include blogs, Wikis, YouTube, podcasting, social tagging, reusable learning objects (RLOs), and social networking websites (Brown 2010), promote higher-order thinking skills (Bloom 1956) from today’s students since they can now become producers of information rather than passive observers and consumers of information through technology. Harnessing this productive energy through careful curriculum design leads to profound differences in learner interest, enthusiasm, and confidence.

Prensky (2001a,b) defined “digital natives” as the kindergarten through college students who have grown up surrounded by and utilizing computers, video games, cell phones and MP3 players. He stated that due to the, “ubiquitous environment and the sheer volume of their (students) interaction with it (technology), today’s students think and process information differently” (Prensky, 2001a). The immersion in technology-rich environments has impacted the learning preferences of digital natives (Prensky, 2001b). Digital natives prefer quick access to information, multitasking, access to hyperlinked information and choices about the learning process, and synchronous interaction with others (Black et al. 2007, Toledo, 2007), which allows these students to move from content-consumers to creators of information for an audience larger than their classrooms (McGee and Diaz 2007) and use higher-order thinking skills outlined by Bloom (1956). While today’s students have matured in a world surrounded by technological advancements, many of their instructors are “Digital Immigrants” who are from a different generation and are trying to learn the language and ways of the student, (though there is debate about the use of these terms (Prensky 2001a,b, Toledo 2007, Bennett et al. 2008)). This technological divide should be bridged and students ought to be prepared for their upcoming professional lives by using technologies of the future in today’s classroom. As faculty and universities continue to adapt to digital learners, emerging technologies are becoming more integrated into the STEM education learning process (McGee and Diaz 2007, Brill and Park 2008, Brown et al. 2010). The incorporation of emerging technologies into the curriculum provides modern, engaging, and learner-centered opportunities for academic growth.

Digital content and web-based applications complement traditional styles of pedagogy (McGee and Diaz 2007), which not only engages students, but also prepares them for their future professional lives (Black et al. 2007). Students expand their community-minded thinking by producing high-quality projects that directly benefit informal environmental science education centers through civic engagement opportunities. Kolb (1984) defined learning as “the process whereby knowledge is created through the transformation of experience.” Active learning is defined as, “instructional activities involving students in doing things and thinking about what they are doing” (Bonwell & Eison, 1991, p. 1). Students should not just be passive receivers of knowledge, skills and dispositions, but should be in engaged in reading, writing, discussions and problem-solving. Stice (1987, as cited in Stalheim-Smith, 1998) adds that active learners remember more when their learning activities are combined with an action such as teaching others. Active learning includes moving the learning from faculty presentation of materials to students understanding, applying,
analyzing, synthesizing and evaluating the materials. Emerging technologies give the educator the necessary tools to complement active-learning classrooms and improve content delivery, which has the following benefits for curricula redesigns:

1) Engages students in the learning process through the use of interactive web-based techniques;

2) Links innovative pedagogy in the STEM education classroom to student uses of everyday digital entertainment devices;

3) Enhances student retention of course material which translates into improved academic successes.

Two popular pre-existing general education non-science major courses at Florida Gulf Coast University (FGCU) are “Environmental Biology: Ecosystems of Southwest Florida” and “Marine Systems: Introduction to Oceanography”. Both were redesigned to include innovative teaching strategies and to provide course-based civic engagement opportunities. The former is a regional basic ecology course designed to introduce students to ecological concepts, ecosystems structure and function, and the scientific process. The latter is a global-scale course that uses our coastal locations as relevant case study opportunities and investigates major disciplines associated with oceanography, human impacts on the marine world, and the scientific method. Both courses include components designed to relate current topics and environmental sustainability discussions to the daily lives of students. Experiential- and activity-based learning strategies are used to create learner-centered environments that maximize interest, engagement, and content retention. Integrative themes (for example, leading students on visits to local natural areas and relating discussions to water flow from the interior ecosystems to the coastal estuaries during the “Journey Down the Corkscrew Watershed”) and guiding questions weave difficult concepts together over time and facilitate student connections across the curriculum. Both course redesigns incorporate technological learning strategies, which exemplifies key components of the FGCU Mission Statement.

Engaged student citizens have opportunities to connect classroom content to serving the needs of the local community. A student who is more connected to a community is more likely to want to help that community. Institutions of higher education were recently challenged in the Campus Compact’s Presidents’ Declaration on the Civic Responsibility of Higher Education to “become engaged, through actions and teaching, with its communities”. While there are many models for embedding civic engagement projects into a course curriculum (Jacoby 2009), in this case, opportunities were woven into the actual fabric of the course by linking student projects with the various regional environmental organizations and partners who assist with our classes. Students are given the opportunity to create high-quality, technologically-advanced projects that directly serve the educational, ecological, and economic needs of our community partners. These student projects also stay consistent with the integrative themes of the courses.

Environmental education, by nature, is an interdisciplinary subject that relates directly to real-world scenarios and connects across a larger context with other classes. Designing appropriate curricula to enhance learning experiences is a challenge, but with careful consideration, it can be a very rewarding experience for instructor, students, and the surrounding community (Figure 2). The SENCER (Science Education for New Civic Engagements and Responsibilities) approach to pedagogy aims to apply the science of learning to the learning of science while embedding civic engagement into the learning process. Two existing courses were redesigned using the SENCER approach to help students connect their STEM learning to real-world examples and to their other courses by embedding emerging technologies, interactive GIS/mapping exercises, and civic engagement opportunities to help advance the connection between an educated citizenry and a functioning democracy. This paper describes the role of emerging technologies in a learner-centered approach to course delivery, explains the curriculum redesign for a two-course sequence, including a hierarchical civic engagement structure embedded within the multi-semester academic experience, and provides results from “Student Assessment of Learning Gains” (SALG) surveys that demonstrate evidence of student learning.

**Curricula Development and Methodologies**

Most of us spend much of our time pondering how to deliver course content, how to make impacts on the students’ lives, and how to keep it all original. We want to passionately guide our students through their academic journeys, but, we realize that today’s learners are different in that they have been immersed in a technologically-advanced world that influences how they learn. Today’s educators can not only stimulate students in the
classroom but also are able to make their learning experiences technologically-rich and engaging outside of the classroom by using digital content and reusable learning objects (refer to Box 1: “Description of a Teaching Innovation: RLOs”). The creation of activity-based curricula that focus on experiential learning, critical thinking, and integrative themes makes for a rich learning experience and helps foster community-minded individuals (Figure 3).

Evolution of class activities occurs semester-to-semester, but within the core academic experience are active-learning modules and breakout groups that focus on hands-on field collection and science discovery labs, campus nature wetwalks, capstone projects, guest speakers, web-based self-created learning modules, and off-campus field excursions to regional sites. Using the mosaic of interacting inland and coastal ecosystem types across the southwest Florida landscape as our natural backdrop, environmental sustainability is the unifying theme during our class “Journey Down the Corkscrew Watershed.” The teaching philosophy focuses on student learning needs while it also provides a rich, stimulating experience based on personal passions and experiences.

Students leaving this course sequence should be thoughtful, engaged citizens who gained an ecological perspective. A rigorous curriculum keeps students motivated by providing them with the necessary fundamentals and learning opportunities early in the semester, so that they may apply these concepts and think deeper about relevant topics later. Enhancing study skills and critical thinking strategies is an important first step. Interactive discovery field labs provide the opportunity for students to understand the scientific method and appreciate how science is conducted, so that they may understand the difference between sound science and junk science. Research skill development is crucial in these classes and students practice finding and interpreting primary literature from reputable science journals. Improving student communication skills (written, oral, and digital) are important developmental needs, and students achieve these skills early in their academic career during this course sequence. During a typical semester a variety of learning opportunities designed to meet the needs of today’s modern learner are made available to students (Table 1). These learning opportunities not only match the needs and desires of “Digital Natives” but map to common learning outcomes for General Education students. Embedding appropriate emerging technologies and matching them to the proper class exercises maximizes student engagement and caters to varying attention spans. The benchmark for academic success is high and encourages students to reach their maximum potential and productivity. The most talented students are challenged, but nobody is intentionally left behind.

The role of instructor might best be labeled as “academic facilitator” who guides students through their personal academic journey, while helping them refine their personal learning strategies. Classes are generally lively and interactions with small breakout groups of students are essential. These groups are asked leading questions and are dropped “thought bombs” for the group to discuss and consider. This method also allows the instructor to assist students real-time who might need a bit more focused attention. Rather than dumping bullet points of knowledge into a student’s head and hoping it stays, students are expected to think deeply about what they are learning so that they may seek out the necessary tools to help them answer their questions, which should enhance their retention of course material. The use of emerging technologies provides the necessary freedom because formal lectures can be delivered online and accessed in myriad ways before, during, and after class. It is very rewarding to have an engaged, noisy, borderline-chaotic classroom where students are discussing, implementing, and creating!

**eLearning Features**

To enhance student engagement in the learning process outside of the classroom, web-based learning modules, activities, and communication tools are highly effective (McGee and Diaz 2007). Video and audio podcasts allow students to take the instructor with them wherever they go. “Digital Natives” are multi-taskers who enjoy having access to course material at times that suit their schedules, which means providing online lectures, field excursion descriptions, and guest speakers who might engage these students while their earphones are plugged-in (Toledo 2007). Discussions using Twitter, where the class is sent a weekly “tweet” and students respond at their leisure, are incorporated to facilitate discussions based on their tweets, responses, and feedback, which provides for more profound class interactions and gives reluctant students a much-needed voice (Brown 2010). Most recently, a library of digital Reusable Learning Objects (RLOs), unique to the redesigned courses and based on strong pedagogical models (Black et al 2007), were created and are easily accessible by students via online learning management platforms (refer to Box 1: “Description of a Teaching Innovation: RLOs”). A series of
regionally-relevant Geographic Information System (GIS) lab exercises are embedded within the course redesigns to serve as visualization exercises of core academic concepts. It is important that students use and create, so students are encouraged to create webpages, record podcasts, and employ RLOs for their own class projects and service-learning materials (Figure 4).

Civic Engagement Connections
Embedding civic engagement opportunities into the academic experience provides profound learning opportunities for students. Learners take the knowledge they have gained in the classroom, reflect on that learning, and apply it to meaningful projects that directly benefit the local community. Establishing opportunities early in a student’s academic journey will make for a productive experience throughout the process. For this sequence of course retrofits, students are partnered with the same regional environmental site locations that are visited during class field excursions. Multiple student-driven projects linking the “Three E’s” (Education, Ecology, and eLearning) were created that serve the needs of these community partners.

It is important to organize the projects so that students can succeed and not be burdened by complicated tasks. Before the project begins, students must contact their host agency representative and create a project proposal. Students are asked to complete a minimum of 5 hours of outside service-learning time for their entry-level projects and are generally clustered into small groups to maximize effort-per-individual. Following completion of the project preparation and direct interaction with regional partners, students present orally to the class and highlight their group’s effort. The regional partners and host agencies are invited to this important event. As a final deliverable, students submit a high-quality reflective essay that explains how the project helped them connect learning to real-life scenarios.

A structured hierarchy introduces students to the value of service-learning early in their academic careers which assists them by embedding opportunities throughout their entire time as an undergraduate. Because of the hierarchical structure, students add valuable life skills to their service-learning opportunities. Upon completion of both entry-level classes, students can elect to join “The Straw Hat Brigade” and serve as supervisors for the next semester’s student groups. Students are recognized because of the straw hats commonly worn in Florida to keep the sun off of one’s face while doing field-work. Members of this new “brigade” of student leaders furthers their commitment to community projects by working directly with the instructor and serve as communication facilitators between student groups, regional partners, and instructor. They may also lend advice, provide peer-review, and give assistance to specific projects. Motivated students may even create new projects that directly interest them in relation to their academic majors. As students progress through their academic careers, they may advance their service-learning skills by joining university-level programs aimed at providing rich experiences (i.e. the E.A.R.T.H. Program) instead of haphazard completion of required hours for graduation. The E.A.R.T.H Program is a recently-implemented faculty-led interdisciplinary network of mid to high-level students who are combining structured service-learning projects with work-study opportunities and internships. A capstone course, called University Colloquium, is required of all students, where they reflect on their complete environmental education experience and perform 10 hours of service-learning with an environmental organization. Lastly, graduate student assistants play an important role with communication efforts, scheduling, and project facilitation. The hierarchical strategy and its relation to existing university requirements is explained in Figure 5.

A primary objective in this course sequence is for students to make positive contributions to the community based on their knowledge from the course, newly-acquired skills and ecological perspective. Civic engagement projects help students foster a sense of respect and responsibility, help them make connections between course content and real-world scenarios, and directly enhance the surrounding communities. A common theme these student-driven projects share is that they link ecological perspective and community education through the use of emerging technologies (Table 2). Students are producers of educational content rather than merely passive consumers of information. Community-minded individuals leave this two-course sequence and have made positive contributions to the world around them.

Student Assessment and Evidence of Learning
Assessment of student learning is important when redesigning curricula. The SALG (Student Assessment of their Learning Gains) is used to help gather baseline data related to students’ self-assessment of improved academic successes. The SALG tool is an online survey that students take before the semester
begins in the form of a pre-SALG and after the semester is completed as a post-SALG. A wide variety of question types are asked and students rank their personal attitudes and confidence related to each question. Additional free-writing typed responses are also made available to students. This is a valuable feedback opportunity to demonstrate student learning has taken place and to gain student perspective on course content. The SALG surveys provide a synopsis of the course retrofits, by summarizing the “Guiding Question”, primary “Student Objective”, and expected learning outcomes for each course. The teaching philosophy and methodologies are validated when looking at the survey results refer to Box 2: “SALG Surveys”). Figures 7 and 8 are summary graphs that illustrate the results from the pre- and post-SALG surveys. In relation to all major course concepts, students enter the course “somewhat” confident in their abilities and understanding of these core concepts, but leave approaching “a great deal” more confident with their understanding. These results demonstrate that students increased their confidence in the course material during the semester. Specific questions from the SALG that directly relate to the components of the course “Guiding Question” have been chosen, which are important measures of student learning and academic success. This type of feedback improves the overall course delivery and helps refine the curricula based on student perspectives.

An assortment of conventional measures of student feedback are obtained, including pre/post tests, project feedback, traditional SAI (Student Assessment of Instruction surveys), etc. to complement the SALG surveys. Each semester, students are given the opportunity to anonymously state what they most enjoyed about the course and what can make the course even better. Such student responses improve the class every semester as lessons can be fine-tuned and calibrated to match students’ needs. Students are responding positively to the course redesigns and are demonstrating increased confidence in all categories measuring learning gains:

“Project-based learning helped me a great deal, and was refreshing after other classes filled with just reading and tests.” Marine Systems – SALG

“I really enjoyed the teaching method and the way the professor was passionate about the subject and the way he passed it on.” Environmental Biology – SAI

Future Plans and Goals

Students will continue to be recruited into “The Straw Hat Brigade” program, which provides them with meaningful service-learning opportunities, leadership skills, and supervisory roles. A major goal of this initiative is to create highly-advanced projects that help general education students improve their written, oral, and digital communication skills while simultaneously gaining an ecological perspective that relates to their daily decision-making processes. To accomplish these goals, student biodiversity map projects across the region will be expanded to enhance science, education, civic engagement, and outreach by creating web-based interactive maps for regional environmental education locations. Students will also present their projects at different venues to build momentum for the entire program and to gain valuable networking skills in professional settings.

Another goal is to work with environmental educators across the country who teach similar classes. Together, we can develop and publish a SENCER Model Course based on this course sequence redesign that would connect students across the United States via a web-based class structure, where each institution is located near a coastal watershed. A strong interdisciplinary program that is highly collaborative has the potential to expand student awareness of critical environmental issues we face today. Student exchange programs would be included to foster a sense of respect for other locales. Civic engagement strategies, educational technology techniques, and environmental awareness opportunities will be embedded within the proposed model course organization.

Conclusion

Students begin their academic journeys with varying degrees of ecological knowledge and connections to the natural landscape. Coupled with an apprehension toward science, environmental education can be a challenging endeavor for today’s educator in a highly politicized and urbanized society. Finding new ways to stimulate and reward learners is an appropriate response by educators.

Experiential and activity-based learning opportunities enhance the environmental education experience for general education non-major students. Integrative themes woven through the fabric of the course helps students draw natural connections to difficult course content and concepts. This two-course sequence and associated service-learning hierarchical track strategy is improving the overall experience for students. Students demonstrated increased comprehension of all core
course themes related to sustainability, ecosystems structure and function, natural goods and services, the relationship between these concepts, and how studying these subjects helps address real-world issues. Students responded favorably to both the approach and to the civic engagement components by creating community-friendly projects that benefit regional environmental education partners. Students leave this track as educated and engaged citizens who serve the needs of their local communities.

Tomorrow’s classroom will look much different spatially and technologically. In fact, that classroom of the not-too-distant future and the academic tools in it may not even exist yet. As faculty members, we must continue to provide our students with the technological skills they need to succeed professionally, even if we, ourselves, are unsure of that technology. We must challenge ourselves and use innovative teaching methods to reach today’s learners. I caution that simply throwing technology at our students is not sufficient. We need further evaluation and assessment of incorporating emerging technologies in the classroom to ensure that these tools are academically sound and actually facilitate student interest in the learning process (Austin 2009). Choosing the right technology to accompany sound pedagogical methods (McGee & Diaz 2007, Brill & Park 2008) should be carefully done so students can communicate effectively, collaborate during the learning process, and think critically about course topics. A primary goal of this STEM education course sequence redesign was to connect learning to social issues through innovative teaching strategies by matching appropriate emerging technologies with teaching methodologies and with civic engagement projects. Entry-level general education STEM courses, like the track described in this article, provide us with the opportunity of exploring these emerging technologies in our curricula.

The complete academic journey during a semester is significant and a great deal of effort is spent trying to understand the needs of students and what must be done to effectively address those needs. The inclusion of active-learning strategies and emerging technology into the teaching philosophy engages students in and out of the classroom, exemplifies the goals of today’s universities, and provides ongoing and rewarding interactions with students. As educators in a democratic society, we have a serious role and responsibility to prepare the younger generation for their professional lives ahead of them (Burns 2011, 2012). The late Steve Jobs, co-founder of Apple, suggested that our outdated education system could be greatly improved if each student had individually-tailored digital learning resources that included just-in-time assessment of student abilities (Isaacson 2011). The strategies, methodologies, and activities chosen in this course sequence redesign reflect passions for education, ecological research backgrounds, and interests in innovative eLearning methods. By interjecting our passions into the academic journey, we just might have a chance to assist students in drawing meaningful connections with the natural landscape in this highly-urbanized system and help them overcome their apprehensions about learning science.

About the Author

David Patrick James Green is an Instructor in the Department of Marine and Ecological Sciences at Florida Gulf Coast University. His research background has primarily been focused on fish community structure and function along salinity gradients in the Florida Everglades. He is currently retrofitting introductory science courses using the SENCER approach to pedagogy and assessing the effectiveness on student engagement and learning. Through hierarchical civic engagement projects that incorporate emerging technologies for delivery to the general public, his students create and provide high-quality educational materials to regional informal science centers that have an ecological perspective. David recently received the FGCU “Excellence in Teaching Award” and the FGCU “Presidential Award for Best Teaching Practices” as a result of his SENCER-related activities.

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Description of a Teaching Innovation: RLOs

A recent study by the Educause Center for Applied Research reported that nearly 78% of students download music and video during an average of 18 hours per week spent online (Salaway & Caruso 2007). Educators can assist students with exploring the educational benefits behind such entertainment gadgets. As faculty and universities adapt to digitally-based learners and learning environments, web-based technologies are becoming integrated into the learning process (McGee and Diaz 2007). This summary explains an emerging technology called “Reusable Learning Objects” (RLOs) that is currently being implemented and tested in Environmental Biology and Marine Systems classes (Brown et al. 2010).

Since formal lecture time is lost as a result of active-learning practices, including outside lab activities and off-campus site visits, digital RLOs complement the academic experience of a student by providing an enhanced online interactive learning environment (Black et al. 2007). These self-produced, creative presentations provide students with interactive lectures and real-time quiz assessments that can be continually accessed at any time or place (Figure 6). Of the 54 students recently polled, 64% used the RLOs regularly, and of that 64% all of the students stated that the RLOs helped them succeed academically.

Benefits associated with incorporating web-based RLOs include:

- Breathing new life into tired Power Point slides by adding animated figures, text, and illustrations;
- Adding assessment tools and quizzes for student self-checks during real-time studying;
- Making digital educational content available for resource-sharing with other educators;
- Converting to various formats which allows for easy upload to learning management systems and tablet computers;
- Freeing-up classroom time for activities other than lecturing, but still delivering core academic concepts.
- Engaging, technological options provide a fun and interactive academic experience for students. Experimenting with new teaching techniques allows the instructor to maintain an inventive learning environment, while simultaneously providing the students with tools they need to succeed academically. An engaged student is a successful student, so why not let them have access to the course wherever they go?
FIGURE 1. The interconnection of the “3 E’s” (Education, Ecological Perspective, and eLearning) guides the development and evolution of the teaching philosophy, enhances student engagement in the learning process, and facilitates professional growth.

FIGURE 2. From non-science majors to engaged citizens with ecological perspectives. The overall goal of environmental education is enhanced by experiential and activity-based learning opportunities. An integrative theme of the course sequence, environmental sustainability, is introduced by outlining the specific case study involved, which is called “A Journey Down the Corkscrew Watershed.” Next, the incorporation of emerging technologies into the environmental education curriculum prepares today’s learners for tomorrow’s professional world. Lastly, civic engagement projects that include emerging technologies and link regional partner collaborations with students tie everything together, which allows the learner to reflect on the learning process and give back in a meaningful way to the local community.
FIGURE 3. Conceptual Model for Curricula Development The “Curricula Development Conceptual Model” illustrates the linkages between the teaching philosophy and course delivery: Emerging technologies, activity-based, experiential, and project-based learning styles facilitate student engagement and content retention, while civic engagement opportunities are embedded to connect course content to real-life scenarios.

FIGURE 4. The screenshot is an example of a student-created project. This particular endeavor began as a service-learning project where groups of students created nature trails for a regional nature center. Following trail construction, new groups of students mapped them using handheld GPS receivers and cloud-based GIS software. Most recently, groups of students have begun embedding education content (i.e. videos, learning objects, pictures, etc.) into the interactive version of the GIS map, which is made available to the general public using smartphone technology (as seen in the smaller inset image). Such projects relate to the “3 E’s” by educating the public about ecology while using emerging technologies as tools.
FIGURE 5. Civic engagement hierarchical strategy
The hierarchical strategy implemented into the general education course sequence. Students are introduced to course-based service-learning opportunities during their first two semesters. They advance through the hierarchy and can connect future service-learning opportunities with advanced projects and responsibilities as part of “The Straw Hat Brigade”. This sequence feeds into mid-level and higher-tier requirements and establishes a complete “track” of service-learning opportunities for students.

FIGURE 6. A screenshot of a digital reusable learning object (RLO) as seen when accessed from a typical web browser. The navigation pane appears on the left and is where students can move from one component to another. Also evident in this navigation panel is the “quiz” function that allows for real-time feedback to students. The image displayed is actually an interactive image where a cursor has scrolled over a definition (in this case, the definition is related to ecological niches) and a second image appears that helps the student visualize the text they just read. A digital RLO also contains corresponding audio. To interact with an actual RLO, I encourage the reader to visit the following webpage and scroll to the bottom where it reads “Reusable Learning Object Example: Ecosystem-based Management and the Florida Everglades”, http://faculty.fgcu.edu/dgreen/
TABLE 1. Descriptions of learning opportunities and the relationship to “Digital Native” (student) education enhancement and needs. Educational needs (or desires) of modern learners (with abbreviations) include: O: Provides ownership of learning experience; AS: Engages learners with varying attention spans; D: Digital delivery of content. Traditional learning outcomes (with abbreviations) include: C: Enhances Communication Skills (Oral, Written, and/or Digital); CO: Increases Ability for student to collaborate with peers; CT: Critical-thinking exercises embedded; HOTS: Students-as-producers of content (Higher Order Thinking Skills – Bloom’s Taxonomy).

<table>
<thead>
<tr>
<th>Learning Opportunity</th>
<th>Description</th>
<th>Matching Education Needs of “Digital Natives”</th>
<th>Mapping to Traditional Learning Outcomes for “Digital Natives”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presentations (non-traditional lectures, web-based, and interwoven within-class exercises)</td>
<td>These just-in-time presentations use PowerPoint, whiteboards, interactive discussions, and other techniques to engage students.</td>
<td>AS, D</td>
<td>C, CO, CT</td>
</tr>
<tr>
<td>Guest speakers</td>
<td>Regional experts connect students with real-time content. A digital library of recorded guest speaker presentations is now available and used for follow-up projects.</td>
<td>O, D</td>
<td>C, CT, HOTS</td>
</tr>
<tr>
<td>Within-class breakout group projects and presentations</td>
<td>Interactive exercises and breakout group opportunities facilitate discussions, help with comprehension of difficult subject matter, and retain student attention.</td>
<td>O, AS, D</td>
<td>C, CO, CT, HOTS</td>
</tr>
<tr>
<td>Guiding Questions</td>
<td>The semester focuses on a central “Guiding Question” and every class activity addresses this integrative question throughout the term. Each individual class session also begins with a “Guiding Thought of the Day” to help students make connections.</td>
<td>O, AS</td>
<td>CT</td>
</tr>
<tr>
<td>Capstone projects with written, oral, and digital communication elements</td>
<td>Students summarize all major course concepts in a webpage format, which enhances communication and teamwork skills.</td>
<td>O, D</td>
<td>C, CO, CT, HOTS</td>
</tr>
<tr>
<td>Lab exercises</td>
<td>Opportunities to describe the scientific method in action, to provide encounters with the local habitats, and to help explain/visualize key concepts are provided.</td>
<td>O, AS</td>
<td>C, CO, CT, HOTS</td>
</tr>
<tr>
<td>Field excursions</td>
<td>Foundational experiential learning opportunities at local sites (both on and off campus) are explored as a class. There are walk-and-talk sessions, fieldwork opportunities, identification exercises, and more.</td>
<td>AS</td>
<td>CT</td>
</tr>
<tr>
<td>Student presentations</td>
<td>During the semester, a variety of presentation types, including formal typed lab reports, impromptu oral presentations, formal presentations, web-based presentations, etc. are used to enhance student confidence with their presenting skills.</td>
<td>O, D</td>
<td>C, CO, CT, HOTS</td>
</tr>
<tr>
<td>Reflective journal exercises</td>
<td>Students make observations, reflect on those observations, and apply this knowledge to course assignments and tasks.</td>
<td>O, D</td>
<td>C, CT, HOTS</td>
</tr>
<tr>
<td>Online learning modules</td>
<td>These serve as supplementary academic opportunities so that students have access to class outside of the normal meeting times.</td>
<td>AS, D</td>
<td>C, CT</td>
</tr>
<tr>
<td>Civic engagement projects</td>
<td>These projects enhance service-learning for students and directly connect our course content to opportunities that benefit regional environmental organizations.</td>
<td>O, AS, D</td>
<td>C, CO, CT, HOTS</td>
</tr>
</tbody>
</table>
TABLE 2. Civic engagement projects serve the needs of local budget-limited nature centers and informal science education outlets by providing educational content for public use. Students, using higher-order thinking skills, are producers of interactive web-based and smartphone-enabled projects. All projects relate to the “3E’s” described in this paper: Education, Ecological Perspective, and Emerging Technologies, so that “Digital Natives” are given the tools they need to succeed in their future professional lives.

<table>
<thead>
<tr>
<th>Civic Engagement Project</th>
<th>Educational Content Provided</th>
<th>Ecological Perspective Gained by Members of Community</th>
<th>Emerging Technologies Used by Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interactive nature trail maps</td>
<td>Education and outreach related to respective nature centers and trail systems</td>
<td>• Local ecology and ecosystem structure/function</td>
<td>GPS handheld units, Cloud-based GIS map-making software, YouTube Videos, QR Codes, Webpage construction</td>
</tr>
<tr>
<td>Botanical maps</td>
<td>Tree species identification, location, and associated ecological data</td>
<td>• Local ecology and importance of native tree species</td>
<td>GPS handheld units, Cloud-based GIS mapping software</td>
</tr>
<tr>
<td>Interactive campus research projects map</td>
<td>Communication tool for current and past scientific research projects on campus, people involved, project summaries, and associated data</td>
<td>• Scientific method</td>
<td>Cloud-based GIS software, Webpage construction</td>
</tr>
</tbody>
</table>
SALG Surveys

SALG Survey #1: Environmental Biology

“How Guiding Question” for this course:

How can tomorrow’s generations of all southwest Florida inhabitants continue to benefit from the natural goods and services a healthy coastal watershed provides, by better understanding our role as citizens today?

Primary Course Objective:

Students will be able to positively influence southwest Florida and global communities to make evidence-based decisions regarding human use and impacts of coastal watersheds and ecosystems.

To form educated responses to the “Guiding Question”, students must demonstrate an advanced understanding of:

1. The definition of sustainability;
2. The ecology of a coastal watershed and human benefits / influences;
3. The role of civic engagement and the importance of an educated citizenry;
4. The connectedness of these main course concepts with their daily lives and decision-making processes.

SALG Statement Descriptions:

“Presently, I understand the following main concepts that will be (or were) explored in this class:

1.1.1 Sustainability
1.1.2 Ecosystem Structure and Function
1.1.3 Natural Goods and Services
1.2 The relationship between these main concepts
1.5 How studying this subject helps people address real-world issues

1.6 How civic engagement activities help connect course content to real-world scenarios.”

SALG Response Choice Scale of Agreement:

1: N/A 2: Not at all 3: Just a little 4: Somewhat 5: A lot 6: A great deal

SALG Survey #2: Marine Systems

“How Guiding Question” for this course:

Given the current degree of human impacts on the marine world, how can tomorrow’s generations of all inhabitants continue to benefit from the natural goods and services a healthy marine system provides, if we better understand our role as citizens today?

Primary Course Objective:

Students will be able to positively influence southwest Florida and global communities to make evidence-based decisions regarding human use and impacts of coastal and marine areas/resources.

To form educated responses to the “Guiding Question”, students must demonstrate an advanced understanding of:

1. The definition of sustainability;
2. Human impacts and reliance on the marine world;
3. The major disciplines related to marine science;
4. The role of civic engagement and the importance of an educated citizenry;
5. The connectedness of these main course concepts with their daily lives and decision-making processes.

SALG Statement Descriptions:

“Presently, I understand the following main concepts that will be (or were) explored in this class:

1.1.1 Sustainability
1.1.2 Natural Goods and Services
1.1.3 Marine Geology
1.1.4 Marine Chemistry
1.1.5 Physical Oceanography
1.1.6 Chemical Oceanography
1.1.7 Marine Biology / Ecology
1.1.8 Human impacts on the marine environment
1.2 The relationships between those main concepts
1.5 How studying this subject helps people address real world issues
FIGURE 7. SALG results are displayed (pre-SALG and post-SALG; mean values / SE are reported; n = 28) from the Fall 2011 Environmental Biology class. Students responded to the SALG Statements listed below and had a choice of responses ranging from “Not at all” to “A great deal” (also listed below). This subset of SALG statements relate directly to the “Guiding Question” and core concepts for the course. Students clearly leave the class feeling more confident in their understanding and demonstrate significant learning gains.

FIGURE 8. SALG results are displayed (pre-SALG and post-SALG; mean values / SE are reported; n = 58) from the Fall 2011 Marine Systems class. Students responded to the SALG Statements listed below and had a choice of responses ranging from “Not at all” to “A great deal” (also listed below). This subset of SALG statements relate directly to the “Guiding Question” and core concepts for the course. Students clearly leave the class feeling more confident in their understanding and demonstrate significant learning gains.
Green: Using Emerging Technologies to Facilitate Science Learning and Civic Engagement

References


