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Ocean Research College Academy by Ardi Kveven and Josh Searle

Just as oceanographic research has always been the stepchild to space research, marine science education is typically relegated to elective course status in public high schools. And, though the recent emphasis on ocean literacy brings core principles to the forefront, the changes are most evident in informal education settings. In traditional 9-12 settings, marine science education is increasingly threatened by the current era of federally mandated testing, standardized curricula, scarce resources, and lack of time for field experiences. For the founders of the Ocean Research College Academy (ORCA), however, the limited status of marine education does not make sense. After all, marine science is inherently interdisciplinary, and Puget Sound is intrinsically relevant to the daily lives of students and faculty in the region. The following question was therefore posed: can the local marine environment be the interdisciplinary theme for a new public school utilizing best practices from education reform initiatives? The answer is yes, through a new early college.

Now in its fifth year of operation, ORCA at Everett Community College has experienced unparalleled degree attainment and university matriculation rates, and marine science has remained the heart of the program. Over these five years, ORCA has built its reputation as a serious school for learning first and marine science second, illustrated by 50% of the students pursuing non-science majors after graduation. In fact, many students enroll less for the science and more for the learning experience they expect at ORCA. In other words, ORCA appears to have created a small learning community of 80 students based around marine science that is attractive to a cross section of students with varied interests.

A common misconception is that ORCA is a magnet school for top students, but faculty work with a range of learners. More than 10% of the student body is derived from home school consortia, and fewer than 10% leave their advanced placement programs in their sponsoring high schools. The faculty has tried diligently to attract underserved students in math and science, specifically women, low income, first generation college graduates, and minority students. In fact, each cohort is typically comprised of 65% female and a combined 40% from minority, first generation college graduates and low income demographics.

ORCA's successes today, (including 95% of graduates attending universities), are the product of a process that continues to evolve. Just as ORCA has made the transition from a pilot program to a fully developed early college program rivaling private college preparatory schools, faculty now focus on the sustainability of ORCA. Thus, it is an opportune time to share our study on the evolution of a marine science themed early college.

Early College

The first challenge in designing a school from the ground up required an institution with instructional flexibility. Clearly, moving marine science from elective status in high schools to the core of a high school's pedagogical approach would not be easy in any of the existing institutional designs. School districts and state legislators have increasingly added graduation requirements, and educational reform efforts targeted at breaking large comprehensive high schools into smaller learning communities continue to face insurmountable challenges and much resistance despite the millions of dollars invested. Fortunately, the existence of early college models in select states around the nation provided founding ORCA faculty with an attractive alternative to the current options available to Washington State high school students and faculty. In addition, Everett Community College's willingness to take a risk on a new program idea, the

availability of Washington State's Running Start program as a funding mechanism, and a generous "start up" grant from the Bill and Melinda Gates Foundation gave founding faculty the time to navigate the competing interests of high school graduation requirements, Associate Degree requirements, and ORCA program goals.

The early college concept is not new; the recent interest in and targeted funding for different early college models represent responses to research concerning the disconnect and breakdown between high school and college degree completion rates coupled with the skyrocketing costs of higher education (The Early College High School Initiative, 2008). Current college degree completion rates are alarming. Of the 70% of students who graduate with a high school diploma, only 50% of those graduates will enroll in a postsecondary education, and fewer than 30% of those students will complete a Bachelor's Degree in ten years (Kazis, 2004). The degree completion rate is even lower for low income and minority students.

There are different versions of the early college model, but central to each early college is the goal of providing students with the opportunity of earning college credit for college-level work while still in high school. At ORCA, high school juniors and seniors take a full schedule of dual credit college courses, earning high school and tuition-free college credit at the same time.

ORCA's early college design gave its faculty new curricular flexibility. However, unanswered was whether students would find success in and admission to university programs in an increasingly competitive university admissions process. Thus far, 80 students have graduated from ORCA with an Associate's Degree; 100% earned the high school diploma and 95% entered university within one quarter of graduating. These graduates have earned over $500,000 in scholarships and financial assistance, with the most financial support awarded to students pursuing science, technology, engineering, and math (STEM) fields. These students have used

their place-based research at ORCA to further their education utilizing field research in an ecosystem approach. One student received a paid, summer internship with the Department of Energy, conducting eel grass research and a National Science Foundation-Research Experience for Undergraduates (NSF REU) grant. Another student is co-authoring a paper that stemmed from her research at ORCA on bioluminescent system responses in jellyfish. A third presented his research at the international Environmental Monitoring and Assessment Network (EMAN) conference on his adaptation of EMAN sampling protocols to measure benthic macroinvertebrates in lakes. Students not majoring in STEM fields have not received the same level of financial aid, but they are successfully pursuing degrees ranging from political science and comparative religion to English literature and business at local and national universities.

Marine Science Theme and Integration

Based on our success in preparing students for continuing diverse fields of study, the key is ORCA's overall pedagogical approach. During ORCA's first year, faculty focused on each quarter as a separate experience. Most published models used thematic units as tools for integrating and unifying content (Small Schools Project, 2008). Since each quarter was new for both ORCA faculty and students, it was easier to integrate disciplines in the same manner. Each quarter was designed around a core scientific discipline, and all other disciplines forged connections through specific capstone projects. There were select, long-term goals defined in ORCA's student outcomes, but students and faculty conceived each quarter as a separate experience. As students in their first quarter took an introductory Oceanography class combined with basic English composition, nineteenth century American history, and a two-credit introduction to college algebra, the faculty considered two projects as shared efforts, i.e., a mock

hearing on ballast water and an experiential week in which students were asked to explore any topic and present their results. The next two quarters followed a similar format, i.e., the winter project focused on a topic from cellular biology and the spring project focused on zoology. On their own, each of these quarterly "shared" projects provided students with significant learning opportunities. However, the necessary rigor of the projects proved to be too intense for students and faculty to accomplish in each 10-week quarter while also delivering content required in each discipline.

Unfortunately, students perceived they were "pulled" in too many directions each quarter, and capstone presentations did not meet faculty expectations. Additionally, faculty believed the ocean was losing its place as the focus of the ORCA model. Interestingly, faculty often discovered some of the strongest content integration occurred serendipitously, with the best connections often voiced by students. A number of changes were made to the second year to respond to these issues. One solution was to create a new humanities course designed specifically for ORCA students in their first quarter. Entitled, "Negotiating Nature," this course focused on the relationship over time between and among humans and nature. The intent of the course is to encourage students to view the environment around them, including the water, through different cultural lenses. In addition, the course focuses on increasing students' critical thinking skills, giving them needed time to adjust to college-level thinking. In terms of content, the humanities course provides a forum for conversation on the environment.

Second, to avoid forced content integration, faculty were encouraged to make connections outside science. For example, twentieth century American literature and history were fully integrated with shared texts in ways that were not linked to marine science. Students

enrolled in introduction to American politics and statistics were asked to analyze statistical information directly related to politics.

Perhaps the largest change, however, was the creation of a long-term research project designed to link each quarter, each year, and each cohort. Further, the research project was designed to link students directly to the marine environment. The project, called State of Possession Sound (SOPS), continues to evolve, but it has developed into a central feature of ORCA. The project is loosely modeled after actual research conducted by various Washington State agencies and published biennially as the State of the Sound Report (Puget Sound Partnership, 2007). The state publication seeks to determine long term trends for multiple indicators, using the trendlines to influence policy makers as well as to inform the public. The SOPS project seeks to create similar long-term monitoring to determine trends in our local estuary as students collect and analyze long-term temperature, conductivity, dissolved oxygen, nitrates, phosphates, pH, plankton presence and abundance, marine bird and marine mammal presence and abundance, and tide and current data. Students participate in vessel-based research cruises each month and present their work at the end of every quarter. The goal is to ultimately incorporate real-time data in much the same way the state of Washington uses its data for the whole of Puget Sound. The SOPS project has become the centerpiece of ORCA's integration, but not in the way it was originally designed. With feedback from students (see appendix A) and deliberate conversation as a faculty, SOPS has been scaffolded into a two year project.

In the beginning, it was assumed the first group conducting real-time, vessel-based data gathering would create and revise protocols that future students would repeat, thereby building a reliable data set over time. Experience by the ORCA faculty with the first group of students designing the various protocols, however, slowly changed the pedagogical focus to one that

celebrated students learning the trials and tribulations of forming and revising research questions, data gathering techniques, analyses of these data, and presenting conclusions. Faculty realized the value of allowing each new cohort of students to find its own way in this process, even if it meant that some of the data would be unreliable. Additionally, faculty mentors have tried to work in a more gradual process so students can focus more time on different elements of the scientific writing. While the obvious ORCA focus in the first quarter is on asking testable questions and creating clear, concise protocols, by the third quarter students are expected to be able to conduct insightful and critical analyses of data, as well as pose future questions stimulated by the discussion. Over the course of three years of SOPS research, ORCA faculty members have determined their use of the local marine environment solidifies student interest in and understanding of the local ecosystem.

The SOPS project has accomplished more than placing marine science at the center of ORCA. In fact, SOPS has also provided a common language for intellectual investigation, described by students as the "ORCA way of questioning." Because SOPS emphasizes experiential learning, students get to fully experience the spectrum of scientific trial and error. Students are given the opportunity to observe and be involved in research questions that fail, to experience protocols that don't work, and to wrestle with data incongruous with their expectations and growing knowledge. This process of investigation, of thinking critically about the world, and then seeking the significance of potential conclusions is clearly a hallmark not only of science, but of other disciplines as well. In other words, the scientific process in which students engage during SOPS has become the foundational metaphor for discussions on learning in the other disciplines. This process has perhaps become the greatest example of interdisciplinary work at ORCA.

The SOPS project has inspired a transformation in ORCA's pedagogical approach, not only in science, but to learning in general. SOPS continues to provide evidence that marine science can in fact serve as the center of a well-rounded academic experience, not because of its content but because of its process. The ORCA students experience extensive integration of traditional subject areas such as building core content knowledge in the humanities, social sciences, and natural sciences. Students evaluate evidence, apply conceptual understandings via internships and research experiences, reflect on thought provoking environmental issues, and communicate their understanding to a variety of audiences. These experiences encourage students to make informed decisions while in a supportive environment where they are asked to continually question. This process cultivates life-long learners who mature into literate citizens capable of making responsible environmental decisions, a laudable goal for any academic program.

Biographies:
Ardi Kveven, is the founder and executive director of the Ocean Research College Academy at Everett Community College.

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Appendix A

Just as we expect our students to learn by doing, so too have we. By applying the same critical lens to our practice, we have succeeded in developing, refining, and improving the learning community at ORCA. The following represents a sample survey administered at the end of every quarter, with samples of students' written feedback.

1. SOPS Evaluation Averaged student responses in bold:

Directions for Part 1: Mark the answer that most closely represents your thoughts. Mark:
1 for strongly disagree 2 for disagree 3 for neutral 4 for agree 5 for strongly agree

1. I liked experiencing real world science in the field.	1	2	3	4	**5**
2. I liked the boat trips.	1	2	3	4	**5**
3. The instructor provided clear expectations for grading.	1	2	**3**	4	5
4. We worked effectively with our partners as a SOPS group.	1	2	3	**4**	5
5. We had enough time to work with the instructor on SOPS.	1	2	**3**	4	5
6. My understanding of the complexities of interrelationships in Possession Sound has increased.	1	2	3	**4**	5

Rate your level of confidence for the following: Use the scale 1 low confidence 3 average 5 high

7. Ability to understand the purpose of SOPS and articulate that purpose concisely in an introduction	1	2	3	**4**	5
8. Ability to represent data visually	1	2	3	**4**	5
9. Make connections to data from other SOPS groups/stations	1	2	**3**	4	5
10. Construct a testable hypothesis	1	2	3	**4**	5

Sample student free responses:

11. What did you like best about this quarter and why?

- SOPS cruises allowed us to get out and experience the things we were learning about in Oceanography and helped our cohort obtain a closer relationship.
- What I liked best about ORCA this quarter was Oceanography and SOPS. I liked them because I was never interested in the ocean before and now that I have done these I am much more interested.
- I really liked doing SOPS this year. I have learned that there is more to the bottom of the ocean and it has almost everything to do with what else we are studying.
- I like that I have begun to look at science more analytically, rather than just as facts. I think more deeply about things inside and outside of school.
- SOPS trips because field work is an important part of science.
- I liked the SOPS cruises and the feed back on the papers, I learned a lot from my mistakes.

12. What suggestions do you have for improving SOPS?

- A night for parents to come and have us present our SOPS work to them so they can get a better idea of what we are doing.
- More time with pods together for SOPS.
- Let SOPS' groups focus on one aspect, don't rotate to different stations.
- More SOPS cruises.