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# Powerful Learning at SEA
## Connecting to complexity and systemic design

*Abstract*

*The Sea Education Association (SEA) has an international reputation for creating powerful learning experiences in semester-long programs that involve conducting scientific research while sailing tall ships. How, why and to what extent these experiences occur were studied through interviews, extant data analysis and participant observation of the SEA Semester program Marine Biodiversity and Conservation. Consistent with past studies of powerful learning, certain themes emerged, for example, authenticity, openness, relationships with others and intense engagement, while the outcomes were highly individual. Greater insight was afforded by connecting themes and the relationships among them to constructivism and complexity, and a promising direction emerged in connecting to systemic design.*

*Keywords:* powerful learning, transformative learning, complexity, systemic design, experiential education, sail training

## Introduction

'We know that it works; we don't know why it works.' That was the challenge presented by an SEA faculty member. For the next 18 months, we sought answers through interviews, extant data analysis and participant observation. A set of key themes emerged, and while they were consistent with past studies of powerful learning and experiential education, they pointed us in a new direction, toward complexity. In this article, we will describe the case and themes and then connect those themes to learning theories, to complexity and to systemic design.

Graduate students and I (first author) have been studying powerful learning experiences for the past seventeen years, attempting to understand their nature and, eventually, to offer guidance for their creation (Bolger, Codner, Reuning-Hummel, & Rowland, 2011; Raabe & Rowland, 2013; Reuning-Hummel, Meyer, & Rowland, 2016; Rivera & Rowland, 2008; Rowland & DiVasto, 2001; Rowland, Hetherington, & Raasch, 2002; Rowland, Lederhouse, & Satterfield, 2004). We have studied this phenomenon with adults in various contexts and, as general conclusions proved elusive, searched for fundamental principles in groups and circumstances that were increasingly similar. We have found a tendency for experiences to be authentic, to involve close relationships with others such as mentors/expert teachers and to offer opportunities for reflection in and on action. More significantly, however, we have found experiences that are highly individual and closely tied to specific circumstances.

## Powerful Learning Experience

We define a powerful learning experience (PLE) as one that stands out in memory because of its high quality, its impact on one's thoughts and actions over time and its transferability to a wide range of contexts and circumstances. It can be a positive experience or a negative experience that leads to significant learning. A PLE can happen quickly or over an extended period of time. Sometimes, it is not recognized as powerful until much later. It can also occur in a formal or informal context.

The notion of 'powerful' learning suggests something that leads to important change,

for example, in one's beliefs, views and/or actions (Brandt, 1998; McPhee, 1996). It is similar to 'meaningful learning' (e.g., Kember, 1991) and to 'deep understanding', although those phrases tend to connote just high-level learning goals (e.g., Gardner, 1999; Perkins & Unger, 1999). Perhaps closer in meaning are what Perry (2002) describes as 'pivotal, memorable' experiences and what Mezirow (1991), Wilson and Parrish (2011) and others describe as 'transformative learning'.

A recent study (Raabe & Rowland, 2013) suggested that PLEs are common in college study abroad programs, and from faculty and former students we learned that this was consistently perceived to be the case with SEA Semester voyages. Thus, examining a SEA Semester voyage presented a rare opportunity to explore potential PLEs as they occurred. Our previous studies involved only retrospective reports.



Figure 1. SSV Corwith Cramer. Photo: Edward Quanstrom.

**Context**

The Sea Education Association offers unique, interdisciplinary programs called SEA Semester on shore at its campus in Woods Hole, Massachusetts, and aboard two tall ships: SSV Corwith Cramer in the Atlantic Ocean (Figure 1) and SSV Robert C. Seamans in the Pacific Ocean. These programs are designed to 'create environmentally literate leaders who are prepared to address the defining issue of the twenty-first century: the human impact on the environment' (Sea Education Association 2018), although faculty and staff acknowledge that the unstated goal of character development is of primary importance.

One program, Marine Biodiversity and Conservation (MBC), is taught each spring and involves a four to five week on-shore component, a five-week cruise, and a second two to three

week on-shore component. The program ends with a symposium, at which students present their research to science and policy experts. MBC attempts a real-world integration of science and policy studies and involves a full set of upper-level college courses. The program was being offered for the second time in 2013.

**Methods**

The study was designed to holistically explore the nature of the MBC program, for example, who is involved, how it is experienced by students and with what outcomes and, if powerful learning occurs, what appears to contribute to such learning. Our research questions and our approach of gathering data before, during and after the program thus approximated the conceptual model of input, process and outcome that is used in some experiential education studies (e.g., Sibthorp, 2003).

I (first author) began collecting data through semi-structured interviews of all five faculty members and eighteen students and by observing classes in the first days of the program in Woods Hole. Six weeks later, I met the students, faculty and crew in St. Croix and sailed as a fellow crewmember to Bermuda. There, I interviewed nearly all of the professional crewmembers before returning home. After a week of activities in Bermuda, including visits to aquaria and research stations and conversations with local researchers, the students continued sailing to New York City and then on to Woods Hole. I returned to Woods Hole for the final days of the program, interviewed all faculty members and students and attended the final symposium. I interviewed fifteen of the eighteen students again six months after the program ended. In addition, I was given access to relevant documents, including an NSF evaluation report from the previous year and student course evaluations.

With the participants' permission, I audiotaped the interviews, and then I began transcribing and coding. I first categorized based on timing—before, during and after the program—and then by emergent theme. I started with an *in vivo* coding method, staying as close as I could to the participants' own words, and then I identified and labelled larger patterns. Essentially, this involved condensing data by becoming aware of similarities, assigning a tentative label and verifying, refining or abandoning categories as necessitated by further data (Miles, Huberman, & Saldaña, 2013).

To enhance trustworthiness, I followed a number of steps recommended for naturalistic inquiry (Lincoln & Guba, 1985). I kept a reflective journal throughout, particularly as an on-board crewmember. I gathered data from multiple sources, including interviews, observations and document analyses. I conducted a member check by providing a draft report to faculty and students, from which I received valuable feedback. As agreed at the outset, prior to sharing this draft all quotations were approved by those who were quoted. I also conducted a peer debrief with the second author, who independently coded the data from all the interviews and inferred thematic categories. We compared our results and refined our coding and categories prior to co-authoring the findings. One weakness to acknowledge is that my background in natural sciences is limited. This constrained my participation and observation of some aspects of the program.

**SEA semester: Marine biodiversity and conservation**

Arriving April 8th, I found an excited group of students and faculty, all of whom were deeply interested in scientific exploration and stimulated by the challenge. The eighteen students represented sixteen institutions in Canada, Grenada, Mexico and the US. Most were majoring in fields directly related to the program content, for example, marine biology or environmental science. I introduced the study, and all students and faculty members agreed to participate and signed consent forms approved by my college's Institutional Review Board.

I observed the orientations and lectures. From the interviews, I learned that the students

had a wide range of past educational experiences that they considered significant, including study abroad programs and internships. Most related their excitement for the challenge, high expectations for intellectual and personal growth as well as uncertainty regarding what they would experience. Few students had previous sailing experience, and none had been aboard a tall ship for an extended period of time, although some described a clear preference for such active learning opportunities. Half indicated that they saw MBC as a test of their future career path, and a third hoped to develop their professional network for future opportunities. Perhaps the strongest themes that emerged were a search for guidance and an openness to change at a transitional point of their lives.

The faculty confirmed these impressions, describing the students as varied in backgrounds and personalities, smart, motivated and self-selected for the academic challenge. They stressed that the program would be intense but highly rewarding. I learned that several faculty members were SEA alumni, and all shared a deep commitment to the SEA mission as well as a firm belief in learning by doing, which one faculty member called 'living your learning'.

Members of the faculty articulated specific, ambitious goals. They hoped that students would learn about career opportunities and gain technical skills in conducting research and sailing tall ships. These were portrayed as important but secondary to personal development, such as gaining greater confidence and new perspectives, and developing independence and teamwork skills. More than other programs, MBC challenged the students to effectively bridge science and policy. As one faculty member observed, 'We just don't have experts that are biodiversity experts *and* policy experts. These people don't exist. We are cultivating them'. This challenge clearly excited the faculty and the students.

**On shore and at sea**
The students prepared for the voyage by developing their conceptual understanding and practical skills for conducting research. They began eighteen course credits in Ocean Science and Public Policy, Nautical Science, Biodiversity, Advanced Ocean Policy Research, and Directed Ocean Research. They were assigned to research groups on biodiversity and policy. In addition, they learned to live together, for example, to share the responsibility for cooking and cleaning their campus houses. Over these five weeks, I monitored classes from a distance through the online course management system.

Arriving in St. Croix on May 13, I learned from the two faculty members who were able to sail with the class that the students were highly engaged—some had apparently done three all-nighters to finish up the first component. The staff met the next morning as part of crew turnover, and the captain reviewed policies and practices. In particular, he reinforced aspects of the SEA approach to teaching and learning, for example, 'As soon as a student can do it, make him or her responsible' and 'the end goal is someone who can solve problems'. The students arrived that afternoon, and berths and watches were assigned. All requests to be with or separated from other individuals were ignored. Emergency briefings, an emergency drill and rounds of orientations on parts of the ship and their functions were conducted.

We set sail for Bermuda the following afternoon and immediately engaged in the many tasks necessary to simultaneously sail a tall ship and conduct research. Over the next two weeks, I rotated among the three watches, contributing where I could (sailing the ship; Figure 2) and stepping aside where I could not (science labs; Figure 3). I shared in the highs, such as the beauty of the sea, the excitement and laughter, the sense of accomplishment and the camaraderie we developed as we became a competent crew. I also shared in the lows, such as the frustration of making the same error a second time and the growing fatigue from little sleep. We followed a modified Swedish watch system, rotating work hours on a 72- rather than 24-hour pattern.

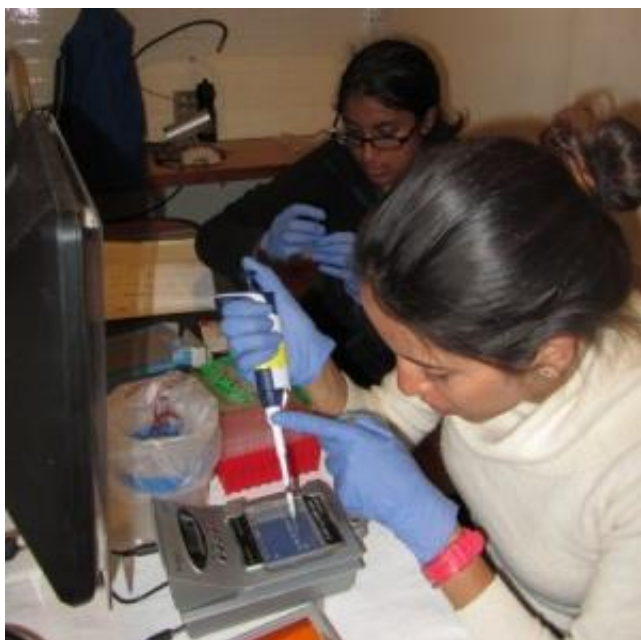*Figure 2.* Furling the jib. From SSV Corwith Cramer Blog.



*Figure 3.* Loading gels for DNA analysis. From SSV Corwith Cramer Blog.

I paid particular attention to the teaching/learning processes, which were sophisticated, multi-levelled and individualized. Individualization was enhanced by the very low student–faculty ratio of eighteen students to eleven professional scientists and crewmembers, all of whom acted as educators. Teaching and learning occurred 24/7, with the exceptions of sleep and an unwritten rule to just enjoy each other's company during meals. Expectations of understanding and competence continually rose, and the students consistently met the challenge.

After arrival in Bermuda, I was able to interview nine of the eleven mates and assistant scientists; two had extensive port-stop duties and were unavailable. They described their personal histories and reasons for working at SEA, their high level of mutual respect and their passions for tall ship sailing and experiential education. They shared their pride in associating with SEA as well as their philosophical alignment with SEA's approach to teaching/learning. They echoed the faculty members' statements that while science and sailing are attractive, the primary goal is character development. They also agreed that each student would have a different experience and take away something unique.

On June 4, the ship set sail for New York City, where the students would meet representatives of the Wildlife Conservation Society. This longer leg of the cruise brought new experiences and challenges, including high seas as they skirted a tropical storm. The students took shifts as Junior Watch Officers (JWOs), becoming fully responsible for supervising their watch and sailing the ship. Coupled with increased demands in their coursework, the intensity and stress on the students grew very high. They arrived in Woods Hole on June 17 with two weeks left to finish their courses and prepare to present their research.

In the interviews at the end of the program, nearly all of the students described MBC as an amazing experience. They said that they loved the ocean and sailing the ship, and that they had learned a great deal about science, sailing, themselves and working with and depending on others in a close-knit learning community. However, nine students stated that they were very tired and stressed from the heavy workload, and three shared frustrations related to interpersonal relationships. Regardless, and without being prompted, seven students talked about gaining confidence, learning to adapt to quickly changing demands and accepting being out of control and not knowing something. They described their sense of accomplishment from stepping outside of their comfort zones and overcoming challenges. Fifteen said that the experience had informed their future career and life paths.

I asked the students about the teaching/learning process, and they differentiated between on-shore and on-board components: traditional lectures on-shore, although more interactive due to the instructors' openness and the low student–faculty ratio; and hands-on active learning aboard ship—figuring things out for themselves, asking questions and imitating the actions taken by those with more experience. They described the latter as a pattern across hierarchical levels, which could be seen as traditional master–apprentice relationships: mates and assistant scientists learned from the captain and chief scientist while students learned from the mates and assistant scientists. The students indicated that success sometimes depended on matching personalities, for example, to which watch officer one was assigned.

Course content came up in eight interviews, and, when asked, seven of these students felt that the program had effectively integrated science and policy and led them to appreciate the complexity of policy issues. Overall, fifteen students indicated that MBC had enhanced their understanding of conservation challenges, which five framed in terms of personal actions such as water conservation. While all students felt that the program had been worthwhile, some said that it would take time to fully appreciate what they had accomplished.

The faculty said the intensity was greater due to the upper-level coursework in MBC (although typical of SEA Semester programmes), and that the stress would indeed fade from the students' memories as they gained a fuller appreciation of their accomplishments. The high intensity was thus intentional and thought to prepare students for work in the field. As one faculty member observed, 'part of what they are learning is dealing with more than they can possibly do, and working as a team to prioritize and ... not to get caught up in the details that sometimes can fritter away a couple of hours that you don't have to spare.' Other faculty members agreed, saying that working through discomfort was important and helped students to gain confidence and trust in one another and to discover that they are capable of more than they believed at the outset.

**Six months later**

Approximately six months after the program ended, I was able to interview fifteen of the eighteen students by telephone; multiple attempts to arrange interviews with three were unsuccessful. I asked them about their strongest memories and any lasting impact from the program. To explore changes in their impressions, I shared answers they gave to questions that I asked at the beginning and end of the program.

Their strongest recollections were of their time aboard, for example, sailing the ship and working together in watches and teams. Nearly all cited something specific that they experienced alone or with a shipmate, such as a conversation that resulted in a new way of thinking, a special event such as interacting with an expert or a situation in which they averted danger by quick thinking. Reflecting on the program's difficulty, several students described a feeling akin to reverse culture shock. They had difficulty returning to the lower academic expectations of their home institutions and said they would seek out higher bars in the future.

Asked about lasting impact, all but one student indicated that MBC had influenced their career or life direction, for example, increasing their interest in an area or expanding their horizons. In fact, three said they had gained specific opportunities from connections they had made. Many felt that the program had changed their perceptions and attitudes, including what some described as a shift in their sense of priorities regarding work. One student stated, 'My work ethic has changed. I used to get bent out of shape about every little thing. Now [I'm] not beating myself up about it. I can try my hardest and I may fail and that's okay…'. Another said, '[I'm now] more relaxed about schoolwork. I used to be uptight about getting everything done on time, and worried about my grades... I think I have a healthier relationship with work now'. Others felt more confident and capable of doing more than they had previously believed.

In our first interviews, I asked the students to describe the most powerful learning experiences of their lives. I portrayed this as mere curiosity so as to not reveal the focus of my study, which I referred to as experiential learning. I repeated these descriptions back to them here and told them to consider those experiences a 10 on a 0–10 scale. I asked how they thought MBC compared. Twelve rated MBC as 8 or above. Several rated it as 10 or above. A large majority of the students thus felt that MBC had been a powerful learning experience. Their answers to this question and others led us to conclude that, by our definition, PLEs had indeed occurred. A few students distinguished this rating from positive experience, saying that powerful learning resulted from getting past the intensity and other negative aspects.

Similarly, I repeated statements from interviews at the end of the program and asked the students if their impressions had changed. While strong impressions remained, many students indicated that negative aspects had begun to fade. As one student put it, 'Retrospection will eventually eliminate the sour'. Most had also gained an appreciation for the extreme challenge. One stated, 'It was a trade-off. In order to achieve the things we did you have to be physically, mentally, intellectually pushed for that much… We might have been miserable doing it, but that was what doing everything we accomplished... that was the price'. Another said, 'When I think of that time period I remember it being overwhelming and exhausting, really draining but I can look back on it and I wouldn't want to have missed anything that we had done. I guess it's good for some periods of your life to pack as much in as you can'. Overall, the students indicated they were very glad that they had participated in the program.

To conclude the interview, I revealed the specific nature of my research, and I asked the students directly, based on MBC and all other previous learning experiences, what they felt led an educational experience to be powerful. Their responses were varied, but several themes stood out. First, they spoke of a need to be challenged and to move outside of one's comfort zone, or as several students put it, to 'stretch your horizons'. Most, but not all, thought that it was important that this move was chosen rather than imposed, and that the participants entered with open minds. One student described this as allowing oneself to be vulnerable; another described it as surrendering to the experience. Other themes were the uniqueness of the setting, the authenticity of the experience and supportive relationships with others.

**Themes**

The themes above along with others repeatedly appeared across the three interviews with students, two interviews with faculty, interviews with mates and assistant scientists and in my

observations and journal notes. They stood out not only in terms of positive instances contributing to learning but also in negative instances in which their absence or opposite appeared to diminish learning. Below we describe each theme, and then we consider their interactions and links to theory. For the former, we use a simple scheme of setting, people, processes and outcomes (see Table 1).

Table 1. Themes emerging from analysis.

| Category | Theme |
|---|---|
| Setting | Uniqueness<br>Authenticity<br>Strength of culture |
| People | Shared fascination<br>Openness<br>Helping relationships |
| Processes | Sustained focus on learning<br>Intense engagement |
| Outcomes | Individual outcomes |

## *Setting*
### *1. Uniqueness*
For the students, the cruise was a new environment—a tall ship on the open sea. On top of the new academic content, they needed to learn new skills and communicate using a new language of technical sailing terms, with people they had just begun to get to know and on an unusual sleep schedule. With what they expressed as 'no easy way to opt out', their psychological, social and physical patterns were broken.
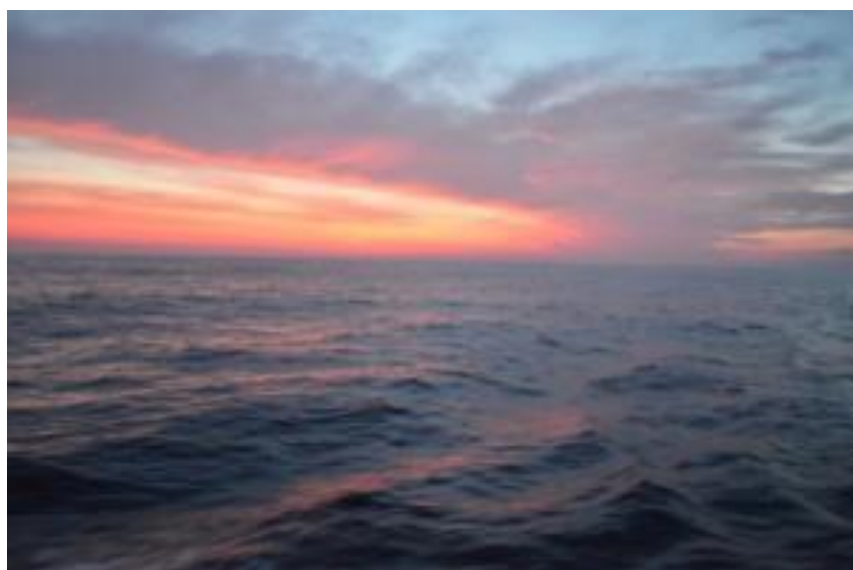


Figure 4. Sunset aboard SSV Corwith Cramer. From SSV Corwith Cramer Blog.

The power of place was especially strong: incredibly clear skies and stars; water in all directions; the rare green flash of sunset (Figure 4); constant movement of the waves; and recognition that our survival depended on the condition of the ship, for which we were collectively responsible. As one student stated, 'The experience of being out on the ocean is something you'll never forget'.

This unique environment held unusual potential for teaching/learning. A crewmember remarked:

> That's what got me into the tall ship world. What draws me to SEA and sail training in general is how easy it is to use a sailboat as a teaching tool. There is so much to learn that you'll never run out of things to teach, but it's such a simple machine that within a week or two students can start to feel comfortable enough that they can take on leadership roles.

### 2. Authenticity

From the outset, there was a concerted effort on the part of the faculty and staff to maintain authenticity, by which we mean believability in terms of representing what is relevant and true to the nature of the context and task (e.g., Donovan, Bransford, & Pelligrino, 1999). The students conducted real studies aboard a research vessel and contributed to valuable, long-term datasets. They acted as fully responsible crewmembers. Further, the intensity was consistent with what the faculty members perceived to represent actual work in research and policy development. Aboard ship, I observed students being asked to do nothing that others did not do themselves as responsible shipmates, and in the interviews, the students called specific attention to very minor deviations from what they perceived to be authentic.

### 3. Strength of culture

The organizational culture, evident in language, norms and a clear match between espoused values and behaviours, was distinct and strong. Some traditions of tall ship sailing were followed but adapted to the educational mission, and that mission permeated all else. All the faculty members, for example, expressed a deep belief in what they, and SEA, were doing. They spoke enthusiastically of the value of character development through science education—and of the process of working through discomfort as an important means of accomplishing such development. They used terms that expressed high expectations, such as 'rock star' for great success in science and 'style points' for advanced skill in sailing. They also modelled the expected behaviours at all times, not only when the students were present.

### People
### 4. Shared fascination

The faculty and guests were highly experienced scientists and teachers, excited about the challenge of bringing science and policy studies together. The crewmembers were highly competent and embraced their roles as teachers. They spoke with pride of each other's professionalism and skill at giving and accepting criticism as a means to continually improve. The students were intelligent, enthusiastic and self-selected for the challenge, and everyone involved shared a sense of adventure, a love of learning, an attraction to the sea and, especially, a fascination with and a deep desire to explore and understand the natural world.

### 5. Openness

To the extent that they could anticipate specifics, the students made a conscious choice to move outside their comfort zones and accept challenges. They opened themselves to the intellectual and physical demands and also to the possibility that their perceptions and perspectives would change. Faculty and crewmembers encouraged this openness and, not knowing specifically where a path might lead, sought to avoid interactions and responses that would close it off, for

example, strict orders when safety was not a concern.

*6. Helping relationships*

Collaboration was an essential part of the program. The students worked in teams, where the results depended on thoughtful communication and cooperation, and they served on watches, where the potential consequences of action or inaction were more significant.

Nearly all the students perceived the support system to be especially strong. The students and faculty members recognized the value of relationships and commented on the importance of a strong community. For example, one student stated, 'I think the social part of it really taught me that with the right social support you actually can do a lot more than the sum of individuals...'. Several crew members said they sought to replicate their own relationships with mentors. Six months after the program ended, the students said that they continued to keep in touch with each other and, where possible, get together. As the captain pointed out, once you are a shipmate, you are a shipmate forever.

### *Processes*
*7. Sustained focus on learning*

A dominant theme emerging from the analysis was the unwavering focus on learning. We found a thoughtfully designed, sophisticated and multi-levelled approach to teaching/learning, which was well aligned with the values and goals of SEA. Particularly aboard ship, the approach involved the following:

• hands-on learning by doing
• authentic situations and tasks, aligned with the students' interests
• primarily movement from concrete to abstract, allowing underlying principles to emerge, for example, through examination of causes and consequences
• logical progression of expectations and standards, just above what students believe they can manage
• embracing uncertainty and errors as learning opportunities
• continuous monitoring and adaptation
• inquiry-based processes of self-monitoring and questioning, encouraged by positive reinforcement and constructive criticism
• social processes of learning from and with others
• individualization and flexibility to use different communication and learning styles

Many of these characteristics could be seen at different levels—individual interaction, group instruction, curriculum, and whole program. First, they were evident in moment-to-moment patterns of individual interaction. For example, I observed crew members encouraging students to self-monitor, seek guidance and ask questions. Their responses were nuanced and often involved answering questions with reframed questions, posing what-will-happen-if scenarios and, within the limitations of safety, recommending that students try things themselves and learn from the consequences. 'Figure it out' was a frequent reply, with the goal that the students should not just solve the immediate problem but learn how to solve problems in general. The support was gradually diminished, and the students were given more responsibility. Opportunities, invitations and suggestions were offered rather than orders given, and I never saw one not taken.

Additionally, the open modelling of desired behaviours stood out over direct instruction. All faculty and crewmembers served as 24/7 learning facilitators, who modelled the teaching/learning process in their own interactions, including, for example, accepting criticism, honestly admitting a lack of knowledge and seeking assistance from others. There was an

explicit hierarchy of authority, but as it was based on experience, it worked for teaching/learning as well.

In some instances, I could infer stages as the students moved from task attraction to attempt, contribution, competence and habitual action, the latter including pride in their connection to the whole, the condition of the ship and the ship itself. The interactions were most productive in these instances when the pattern of instructor responses appeared to be aligned with the stages (see Table 2); that is, the instructor would make different responses depending on where she or he perceived the students to be. As the students were in different stages with respect to dozens of simultaneous tasks, this was very challenging. The instructors thus needed to constantly recognize, probe when the stage was unclear and respond wisely, often when many things needed to happen quickly.

Table 2. *Student states and instructor responses.*

| Student | Instructor |
|---|---|
| 1. *attraction* (want to do it but do not know how), enthusiasm, uncertainty | *demonstration* & *information* (spoken, referral to sources) |
| 2. *initial attempt*(s), partial success, error(s) | *encouragement* & *correction*, confidence (certainty they can do it) |
| 3. *contribution,* success | *praise* & *pointers* for practice |
| 4. *competence*, accomplishment | *confirmation* (I knew you could do it) |
| 5. *habit* (habitual action), pride | silence, *shared pride* |

Other levels of the approach appeared to be just as carefully conceived. The second level included strategies for small and large groups, for example, interdisciplinary seminars on shore, team projects, demonstrations when the content was relevant to all, and individual meetings with teams to give specific guidance. The third level included curricular plans for five simultaneous courses, the at-sea and on-shore components, the five-week cruise offering sufficient time for growth, a swap of watch officers affording experience with different skillsets and styles as well as basic, shadow and JWO phases aboard ship. The fourth level involved overall plans for interdisciplinary connections, particularly the blending of science and policy.

Across the levels were strategies for knowledge management. The crews participate in turnover weeks, in which information is passed from the crew of one voyage to the next. Student perceptions are gathered via questionnaires multiple times, and these along with debriefings of the faculty and crew—including a thorough debriefing with all faculty members, the dean and the head of marine operations after each program concludes—help to improve the programs.

*8. Intense engagement*
The faculty, crew and students described the program as intense: a full course load in a shortened semester, many requirements, multiple group projects, high expectations and potentially significant consequences of errors while at sea. Many students felt overwhelmed, mentally and physically tired and incapable of producing the quality they expected of themselves. They needed to adjust their attitudes, manage their stress, push themselves beyond perceived capabilities, learn to prioritize and help to keep spirits high. This resulted in a heightened emotional state that amplified highs and lows.

Countering all of this, the reward was clear and worthwhile. As one student stated, 'you achieve the unachievable'. Another described a subsequent job interview in which she was told

the job was intense. She replied, 'I was on a sailing ship. I can do intense'.

Importantly, for a majority of the students the challenge was intentionally chosen. As one student put it, 'challenge is what makes you strong'. Rather than externally imposed expectations, a fine balance seemed to exist between internal and external forces. Students were pushed hard, but they sought to stretch their horizons, embraced rather than feared change and came to see that they would gain more through a great challenge not fully met than a lesser goal easily accomplished. One student stated, 'The things that made it transformative were the things that made me look deeper inside my goals, my dreams, my aspirations ... It's not transformational if you are not changing, and you are changing only if you think about what is going on and decide that you want to be different than what you were before'.

At least one student, however, did not fully appreciate the nature of the challenges that would be faced. This student said that not everyone had fully understood what the program would involve, and some students had thoroughly participated, in part, because there was no easy way to opt out. The experience proved powerful, regardless, but the choice to be challenged was less informed.

For all the students, however, deep engagement appeared to be a key part of the intensity. The program required students, crew and faculty alike to be present with the tasks and with each other, and this contributed to the strength of the community and the support system for learning. The norm was, for example, 'what can I do to help?' rather than 'now I can relax because my part is done'.

## *Outcomes*
### *9. Individual outcomes*
The students achieved somewhat similar learning outcomes with regard to course content, but mastering that content was a secondary goal. As one crewmember stated, 'the content we teach is a cover for the character building we do underneath'. Each student , rather, appeared to gain something different, for example, a shift in his or her sense of priorities, a new perspective on the ocean and world, a feeling of empowerment with regard to leading change or a new appreciation for what others may contribute. One student described the latter as 'seeing how wrong I can be' when his initial impressions of another student proved to be false. Reviewing our data multiple times, it is accurate to say that there were 18 different outcomes for 18 students.

## Discussion
Stepping back to the broad question of why MBC and other experiences are powerful, similar themes to those above have frequently emerged in our previous studies. For example, when the participants referred to formal learning environments in which they have had powerful experiences, they often described the uniqueness and authenticity of the setting, the intense focus that was required and the importance of social relationships and being open to learning. Moreover, even when we have studied very similar groups and contexts, we have seen that outcomes are highly individual.

The themes from the present study also exemplify principles of experiential education (Association for Experiential Education, 2015), adventure education and sail training. For example, Sibthorp (2003) speaks of the importance of social learning and modelling, and authenticity in learning transferable skills through adventure education, and McCulloch, McGlaughlin, Allison, Edwards, and Tett (2010) describe the growth of self-confidence and the capacity to work collaboratively through sail training. Mackenzie, Son, and Hollenhorst (2014) further describe how such themes can be connected to theories of learning, and to such connections we now turn.

### *Theories of Learning*

Like Mackenzie, Son, and Hollenhorst's (2014) observation, some of what we found could be explained by classic psychological theories. For example, MBC involved the memorization of terms and the repetition and reinforcement of low-level skills, both of which could be explained by stimulus and response pairing associated with behaviourism. Similarly, the program involved a great deal of individual and group-based problem solving, which could be described in terms of the information processing mechanisms associated with cognitive psychology.

More specific to the learning outcomes of interest in this study, several versions of transformative learning theory are relevant: Mezirow's (1991) emphasis on perspective transformation, although with less emphasis on rational and analytic processing than his theory suggests; Boyd's (Boyd & Meyers, 1988) focus on social processes and individuation, that is, the 'discovery of new talents, a sense of empowerment and confidence, a deeper understanding of one's inner self, and a greater sense of self-responsibility' (Taylor, 1998, p. 13); Wilson and colleagues' indicators of personal meaning, competence, and relationships (Wilson & Parrish, 2011); and their description of transformative learning as an 'epic journey' (Wilson, Switzer, Parrish, & The IDEAL Research Lab, 2007). The latter authors, in particular, build from assumptions of constructivism, to which we find some strong links.

Constructivism emphasizes the construction of knowledge from experience, particularly from social interactions with knowledgeable others. Individual learners are assumed to be unique and complex and to develop personal understandings through an active sense-making process, which is influenced by their backgrounds and worldviews (e.g., Vygotsky, 1980). Others cannot directly cause learning, but they may foster learning by creating conducive learning environments. These environments typically emphasize activity, in particular, learning by performing authentic tasks in personally meaningful contexts (see, e.g., Wilson, 1996). Learning guidance is sensitively applied, and challenges are issued that are just beyond the learner's current level, which Vygotsky calls the zone of proximal development.

This description matches what we observed in MBC fairly well, perhaps more strongly in some areas than others. However, while constructivism (and to a lesser extent cognitive and behavioural theories) appear to explain the learning that occurred, they do not appear to explain powerful learning, that is, why the specific MBC experience stood out above others as having great power. The question remains: Why do MBC and perhaps other SEA Semester programs stand out for many students and have such profound and lasting effects? A key observation not given above may help.

As we categorized the data into themes, we found that we were frequently copying the same statement into two or more categories. At first, this caused us to question the quality of our categories, but we found that we had independently identified similar themes and consistently categorized data into them. Instead, we realized that many statements included multiple elements, with explicit or implied connections between them, and the act of discrete categorization was concealing these relationships. Subsequently, we found that themes were simultaneously distinguishable and intimately connected. Rather than discrete factors that would add up to impacting power, we were observing a web of related factors, gaining power through interconnection—a system of elements and relationships, from which emerged something unique, and ultimately, powerful. Sibthorp and Jostad (2014) make the same observation regarding factors that work together to create the 'complex, dynamic and interconnected [social] system' (p. 69) of outdoor adventure education.

As an example, one SEA student, without transition, related going outside of one's comfort zone with social relationships:

…for something to really change your life you have to, it really has to knock you out of your comfort zone. It's not only the academic challenge but the physical and emotional challenge. You can't stay the same person. You never feel that you are going through something alone. You pretty much operate as a WE rather than I.

Another related uniqueness and high expectations: '[to have a powerful experience you need] to be in an environment where you are held accountable and you have very high expectations on you in something you are really new at and unfamiliar with so it forces you to make big changes and adaptations quickly'. Several described a necessary balance between internal and external pressures—being highly motivated to succeed and being pushed hard—and the need to remain open-minded to where the external pressures might lead. Evidence of this need for balance came from a student for whom the program was less powerful: 'A lot of it has to do with the student feeling motivated to do it by themselves. What made it so hard to feel that [MBC] was powerful was that it felt very imposed'. Other statements connected elements such as authenticity and uniqueness, authenticity and flexibility, flexibility and sophistication of approach, and high-level investment and social relationships. Again, the individual elements seemed to be necessary but insufficient. It took a special alignment to lead to power, for example, as a crew member stated, 'a combination of the students and the teachers and the program'.

### *Complex systems*
Recognizing that the experience gained power as a process of emergence from interconnections led us to literature on systems, particularly to the special properties of complex systems, such as interdependence (Brown, 2002), non-linearity (Waldrop, 1992), sensitive dependence (Gleick, 1987) and emergence (Morowitz, 2002). We found that the characteristics of complex systems matched what we observed in MBC. Elements of the program, including the themes above, were interconnected and interdependent. That is, a change in one affected others. While some secondary outcomes were predictable (e.g., sailing and research skills), the primary outcomes relating to personal growth and character development were highly individual. The faculty and crew anticipated such growth and development but had little ability to know or directly control the nature of what each individual would gain. Additionally, the power of learning was not merely a sum of the program parts but something special that emerged from their interactions, both at and across multiple levels. In particular, when things worked especially well, the instability of intense, multiple demands in a unique and unfamiliar setting seemed to create a special container, with characteristics of a 'space for novelty' (Stacey, 1996) or 'edge of chaos' (Waldrop, 1992), in which powerful learning emerged.

In such containers, paradoxes are common, and, when humans are involved, the experience of time becomes fluid and emotions run high. This is typical in special psychological states that some call liminal (Jackson, 1990), peak (Privette & Bundrick, 1997), the sweet spot (Jerome, 1980), being in sync (Strogatz, 2003) or flow (Csikszentmihalyi, 1993). Aboard the ship, the strict watch schedule was often contradicted by perceptions that time was going especially fast or slow. Emotions were consistently heightened, both in positive and negative directions. And many individuals aboard ship experienced the very odd feeling of being alone in close quarters, and of being outside but still aboard the ship when sitting in the netting off the bowsprit. Perhaps this was part of the 'strangeness at sea' described by Melville (1849), and often quoted by the captain.

The emergence of greater complexity matched the MBC students' perceptions as well. They described changes in themselves, new relationships, new knowledge and skills, and seeing the world differently as simultaneously enhancing their sense of identity. (In the complexity literature, this would be recognized as a view of evolution as the 'continuous reproduction of continuity and potential transformation of identity' [Stacey, 2001, p. 183]). As one student put

it, 'I think one of the most important things about a transformative learning experience is to take you out of your element so that you realize what your element is.' Often, this included something familiar becoming unfamiliar and then familiar at a new level of understanding.

Other connections we made to complexity included a balance of diversity and redundancy (Davis & Sumara, 2006), which was evident in the range of student backgrounds and their shared fascination with the natural world; interdependence and nested structures apparent in the strong culture and the emergence of greater complexity at multiple levels (Alhadeff-Jones, 2012); and the complexity itself clear in the real setting and tasks.

Taking this further, we considered the possibility that what we observed was not just the behavior of any complex system but of a complex adaptive system (CAS), one in which agents 'learn or adapt in response to interactions with other agents' (Holland, 2014, p. 8). For example, MBC students, faculty and staff, taken here as agents, interacted in continually changing pairs, trios and so on, constantly adapting to circumstances, the perceptions of which were affected by factors such as prior experiences, roles, goals, how information was communicated and physical and emotional states. As suggested by Davis and Sumara (2006), we could apply this notion of complex adaptive system to a hierarchy, with knowledge at each level emerging from interactions of agents at the level below: construct—>schema—>individual—> team or watch—>2013 MBC class—>MBC—>SEA—>society. However, this understanding felt incomplete, particularly in terms of explaining the nature of interactions, and like other authors (e.g., Jorg, 2009), we found the concept of adaptation unsatisfactory. For example, individuals were more than agents, interacting without a collective consciousness or awareness of multiple levels. Rather, they were acting with the intention to create knowledge—to make scientific discoveries, to learn to sail the ship and to transform themselves in meaningful ways. They were doing so in a way that could be described as mutually causal (Morin, 2008), perhaps mutually enabling, and the nature of their actions was not only intelligent; it was intentional and mutually enhancing.

Others have made similar observations of human activity systems and have proposed alternative mechanisms. For example, Jorg (2009) describes the process of learning through interaction as reciprocal or generative, and Stacey (2001) proposes the concept of 'complex responsive processes in the living present' that are more responsible for what actually happens in a system (e.g., what knowledge emerges) than more formal structures and processes. In MBC we could, in fact, see greater learning from the interactions that were fostered and that evolved from moment to moment than from pre-planned instructional content and strategies, and these interactions seemed guided by what could be taken as intelligent, complex responses. In systems terms, the knowledge that emerged from strategies of control *of* or *over* appeared to be secondary to that in which control was *within*, with self-organization being more important than other forms. However, we continued to see intentionality as more important than these alternatives seem to suggest.

Ultimately, our exploration of adaptation and alternative processes reinforced that we were seeing not only complex systems but also intentionally guided processes of complexification (i.e., emergence of simultaneously greater differentiation and integration; e.g., Csikszentmihalyi, 1993). Then, the notion of intentional guidance led us back to the starting point of the overall inquiry into PLEs and the apparent disconnect between powerful learning and instructional design theory and practice (Rowland & DiVasto, 2001). As noted earlier, there have been efforts in the field of instructional design toward fostering more meaningful or transformative learning, for example, through the development of constructivist learning environments (e.g., Tobias & Duffy, 2009; Wilson, 1996). Further, some in the field have begun to speak of teaching and learning using concepts such as emergence (e.g., Wilson, 2013). However, these efforts have not yielded a deep understanding of the powerful learning that we have observed in experiences such as MBC, and which we have begun to see as a form of

significant complexification.

Table 3. Connecting concepts of constructivism, complexity and design to MBC themes.

| Themes | Constructivism | Complexity | Design |
|---|---|---|---|
| **Setting** | | | |
| uniqueness | context dependence, problem- and case-based learning | edge of chaos, space for novelty | container and contained |
| authenticity | authentic learning environment, relevance, real-world problems | complexity of real settings and tasks | studio approach |
| strength of culture | learner cohort, learning community | interdependence, nested structure, continuity and transformation | design team, conspiracy |
| **People** | | | |
| Shared fascination | self-motivated learners, embrace of individuality, instructor as co-learner | intelligent agents, diversity and redundancy | stakeholders, throwness |
| openness | openness to uncertainty and others' ideas, error as feedback, flexibility, multiple perspectives, eclectic approach | positive attitude toward error, unpredictability, requisite variety | divergence, what-if and over-the-edge thinking, imagination |
| helping relationships | social interaction and negotiation, sensitive guidance, peer instruction | local interactions of agents, interdependence, mutual causality, autopoiesis | mutual shaping of container and contained, mutual enhancement, co-design, homeopoiesis |
| **Processes** | | | |
| sustained focus on learning | knowledge construction, high-level and negotiated learning goals, collaboration, scaffolding | complexification, surprise, adaptation, control parameter adjustment, complex responsive processes, growth, evolution, curation of emergence, requisite variety, enabling constraints | composition, supersaturation and crystallization, the expected unexpected, design judgment, design dialogue, wicked problem setting/framing, generative dance, over-conceptualize and under-specify, productive constraints |
| intense engagement | reflection, self-regulation, learn through activity | presence, mindfulness, second-order cybernetics | intentionality, liminality, flow |
| **Outcomes** | | | |
| individual outcomes | a-ha moments, insights, seeing the big and little pictures | emergence, unpredictability, non-linearity, sensitive dependence on initial conditions | ultimate particular, the parti (seed) |

As a tentative step, we revisited design and considered design concepts that might connect to the MBC themes. This proved interesting, as did the inclusion of concepts from constructivism and complexity, admittedly added in seeking complementarities rather than contradictions (see Table 3, constructed from a range of sources, e.g., Cross, 2011; Fostnet, 2005; Holland, 2014). We saw potential in drawing these sorts of connections across the three areas (i.e., constructivism, complexity and design), particularly, in thinking of design as an intentional guidance of complexification that, in the context of human learning, might be fostered via a constructivist approach. We think the potential for this is strong, partly because the implications of complexity science and many of the design concepts included in Table 3 are not widely known, or at least not widely applied in the instructional design field. A step to a recent field of design seems even more promising.

### *Systemic Design*

Systemic design is a recent phrase referring to design that attends especially to the larger whole, and to interdependencies at and across multiple levels (e.g., Nelson, 2014; Sevaldson, Jones, Nelson, Ryan, & Barbero, 2011). Banathy (1991, 1996) refers to this combination as 'systems design', while Sevaldson (2010) prefers 'systems-oriented design'. Sevaldson, Jones, Nelson, Ryan, and Barbero (2011) refer to systemic design as an integration of systems thinking and systems-oriented design.

Systemic design connotes a shared vision of serving the greater good, for example, the needs and purposes of larger systems, and is thus enhanced by the participation of diverse stakeholders. While it shares characteristics of any design process, such as tackling 'wicked' problems (Buchanan, 1992) and the intentional imposition of productive constraints (Biskjaer & Halskov, 2014), systemic design attends to relations and patterns of interaction more than to boundaries, and it appreciates the unpredictable nature of complex systems. For example, a respect for the unpredictability of outcomes of interaction is inherent in the advice to over-conceptualize and underspecify rather than the reverse (Weick, 2004). As Nelson and Stolterman (2012) state, at a basic level, 'systemic design unifies thinking holistically with acting courageously, creatively, and responsibly' (p. 58).

Typically, the concept of systemic design is applied to very large, complex social systems, but we think the match to MBC is quite strong. The program was designed as a flexible, multi-layered container in which intense and productive interactions were intentionally fostered. Core vision and values relating to science education and character development permeated the walls, but the outcomes were left largely to a dynamic and creatively guided process of unfolding inside. As Troncale (2013) describes, managing and participating in the learning environment involved 'husbanding the conditions that make it ripe for emergence rather than designing the specifics of the emergence itself' (p. 69). Nelson (1991, personal communication) makes this same analogy and describes design in terms of the creation of the container and the contained. He describes how the designer makes the cedar bowl (container) that interacts with the saké (contained), from which a unique and special taste emerges. Elsewhere, Nelson, and Stolterman (2012) describe the contained as a (chemical) solution that becomes super-saturated, to the point that it abruptly crystallizes, forming the seed or 'parti' for the design—essentially the breakthrough insight that leads to the new form.

MBC, as a container in this sense, was not a static creation but rather an on-going dynamically, intentionally and intelligently (i.e., both rationally and intuitively) shaped space, adjusted at the individual, pair or group level depending on who was in it, what was happening and where and when. Various elements and their relationships were constantly shifting in ways that promoted or constrained learning, and everyone—faculty, crewmembers and students— was engaged in creating, monitoring and responding to them in the moment. Symbolically, this

mirrors sailing and conducting research aboard the ship. The Cramer was our container, productively closed in some ways and open in others, and sailing her was our challenge, requiring us to manage interactions to move forward, balancing powerful and constantly changing forces. Insights emerged through the relationships with and within that container, and, importantly, impact at the larger system level—the larger container (e.g., how an individual insight helped the team and how a research team's work served science and society)—was always a key criterion.

**Conclusions and directions**

While some of the learning and pedagogy that we observed in the MBC SEA Semester program could be explained by common theories of learning, we gained further insights from connections to concepts associated with complex systems and design. This led us to describe the set of instances of powerful learning in MBC as intentionally guided complexification. The initial structure, which might be seen as a 'container for learning', along with some instructional heuristics that would be applied, appeared to have been defined before the 2013 program began. However, much of what became a powerful learning experience appeared to be due to complex, responsive, multi-levelled, constructive processes that unfolded over time. This description is consonant with the definitions, goals and processes of systemic design and leads us to speculate that connections between the two could be useful in a number of ways. Sample follow-up questions include:

• In circumstances where the intention is to enhance the power of learning or foster powerful learning experiences, how might it help to engage explicitly in systemic design, not only in preparing the learning environment but also in guiding what happens within it?
• Reversing the lens, what might be revealed about powerful learning and potential means to foster it by studying powerful learning experience as a type of systemic design?
• How might doing either of the above inform the exploration of complexity in the field of education, for example, questions regarding the nature of interactions (Jorg, 2009), the imposition of constraints (Davis & Sumara, 2006), the preparation and roles of teachers (Seltzer-Kelly et al., 2011) and the role of the knower in knowledge (Alhadeff-Jones, 2012)?
• If an instructor's role were conceived as seeking to foster and guide complexification, what would be the nature of guidance? Would it help instructors to think of 'curating emergence' (Wilson, 2013) or maintaining a 'delicate balance … between sources of coherence that allow a collective to maintain a focus or purpose/identity and sources of disruption and randomness that compel the collective to constantly adjust and adapt' (Davis & Sumara, 2006, p. 147)? With multiple, simultaneous levels of concern and the requirement of rapid in-the-moment responses, would it be more accurate and productive to see guidance in terms of a pattern of pedagogical heuristics, such as those in Table 2, or as an on-going stream of design judgments, perhaps even a performative act akin to jazz improvisation?
• With the goal of fostering powerful learning, would engaging in systemic design as a type of design-based research (e.g., Design-Based Research Collective, 2003) or research through design (e.g., Jonas, 2007; Zimmerman, Stolterman, & Forlizzi, 2010) lead to valuable principles of process or product, for example, 'local theories' that other instructional designers could apply, or would it be more helpful to capture processes and experiences in design cases as precedent material for other designers (Boling, 2010)?
• Systemic design is known to benefit from visualization tools such as Gigamapping (Sevaldson, 2012) that help to widen the scope of consideration across scales, explore relations across categories, question boundaries and manage the heavy cognitive load in working with complex systems. How might these tools help those seeking to foster powerful learning experiences?

Figure 6. 2013 MBC faculty and students (C-247).

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