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# Casting a Wider Net: Deepening Scholarship by Changing Theories

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Research questions are shaped, explicitly or implicitly, by the theories we bring to bear upon our scholarship. Broadening our theoretical perspectives allows us to frame richer, deeper questions about the teaching and learning happening in our classrooms. This paper explicates the research implications of three broad theories of learning (constructivist, socio-cultural, and complexivist), exploring what scholarship framed by each theory might look like and some of the strengths and limitations of each framework. The authors use their experience engaging in research on teaching and learning in an undergraduate interdisciplinary science program to illustrate the argument that changing theories can help improve the scholarship and practice of teaching and learning in higher education.

**Keywords**

Theories of scholarship, Constructivist theory, Socio-Cultural theory, Complexivist theory, SoTL

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## Abstract

Research questions are shaped, explicitly or implicitly, by the theories we bring to bear upon our scholarship. Broadening our theoretical perspectives allows us to frame richer, deeper questions about the teaching and learning happening in our classrooms. This paper explicates the research implications of three broad theories of learning (constructivist, socio-cultural, and complexivist), exploring what scholarship framed by each theory might look like and some of the strengths and limitations of each framework. The authors use their experience engaging in research on teaching and learning in an undergraduate interdisciplinary science program to illustrate the argument that changing theories can help improve the scholarship and practice of teaching and learning in higher education.

## Asking New Questions

> Though employed in different ways and to different degrees, the scholarship of teaching and learning entails basic but important principles... It means viewing the work of the classroom as a site for inquiry, asking and answering questions about students' learning in ways that can improve one's own classroom and also advance the larger profession of teaching. (Huber & Hutchings, 2005, p.1, italics added)

Huber and Hutchings note that as practitioner researchers, scholars of teaching and learning ask and seek answers to questions about their students' learning with the goal of improving teaching in higher education. Questions form the basis of the scholarship of teaching and learning (SOTL), and theories shape those questions. Hutchings (2007) inaugurated this journal by reminding readers that theory should, and is starting to be discussed openly in the SOTL community. We believe that one way to deepen SOTL research is to consciously change the theories that frame a potential research project, bringing into attention different aspects of teaching and learning. This, in turn, enables SOTL researchers to ask new questions about what is going on in their classrooms. In this paper, we engage in a hypothetical SOTL research project aimed at explicating the learning that occurred during an episode of the first author's teaching in a senior undergraduate interdisciplinary science program. We explore four theoretical lenses to highlight the possible range of research questions that can emerge when we consciously change the theories that frame our scholarship. Although the SOTL project we discuss is hypothetical, the learning episode we present and the questions we generate draw from actual teaching and research events that serve as the basis for the first author's dissertation.

## Background: Reflecting on the Need for SOTL

> "This class is different." It's November, near the end of term, and Scott is quick to talk about the interdisciplinary class on measurement and instrumentation he is co-teaching with a faculty member from Zoology. Scott is new to teaching explicitly interdisciplinary undergraduate science courses, and he eagerly tells me that the students in this course seem more engaged than the students he is used to teaching in his home department of Physics, that the discussions are livelier, and that is enjoying the experience. I listen, smiling and nodding in recognition. I have co-taught the same course, have since taught other interdisciplinary courses, and have just as eagerly shared my own similar beliefs about what students can and do learn in these contexts. "Yes," I think, "I too believe that these classes are different, but how and why?" <Gillian, 2004>

This conversation was a catalyst for Gillian's decision to engage in the scholarship of teaching and learning by reminding her of the promises for student learning that appear in the literature on interdisciplinary higher education. We are defining interdisciplinary approaches as ones where two or more disciplines are brought together and start to overlap with the overall goal of initiating a dialogue across the disciplines, integrating or synthesizing their insights into a conceptual whole. We understand integration from the Oxford English Dictionary (Integration, 2004) as "the making up or composition of a whole by adding together or combining the separate parts or elements." Students in interdisciplinary programs and courses reportedly gain in critical thinking and problem solving skills (Apostel, Berger, Briggs, & Michaud, 1972; Berlin & White, 1994; Newell, 1992), develop a higher tolerance for uncertainty (Apostel et al., 1972; Armstrong, 1980; Gardner & Turner, 2002), and learn to make connections across disciplines (Armstrong, 1980; Meister & Nolan, 2001; Van Kasteren, 1996; Wallace, Rennie, Malone, & Venville, 2001). Gillian wanted to believe these promises about student learning, in part because they fit with her own experience and observations. Like Scott, her experience indicated that there was something special about interdisciplinary programs and courses. However, there was little compelling evidence in the literature to validate the claims being made about the value of interdisciplinarity for enriching the learning experience.

Much of the writing about interdisciplinary teaching has emphasized students' mastery of fixed bodies of knowledge, despite the fact that the primary object of learning in undergraduate interdisciplinary courses and programs is the development of complex ways of thinking (Field & Lee, 1992; Klein & Newell, 1996). In fact, integration, as the making of connections and the bridging of disciplines, although a major emphasis in undergraduate interdisciplinary education (Armstrong, 1980; Barisonzi & Thorn, 2003; Elliott, 1990; Gabella, 1995; Klein & Newell, 1996; Lattuca, 2001; Meister & Nolan, 2001; Newell & Green, 1998; Newman, Whatley, & Anderson, 2003), has not been extensively researched. Instead, interdisciplinary students' learning has been measured through grades in and rates of admission to discipline-based courses, and by performance on disciplinary standardized exams (Elliott, 1990; Newell, 1992). There is a need for studies that determine how

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undergraduate students understand and experience interdisciplinarity, and for research that clearly establishes what students learn, other than disciplinary content, in interdisciplinary settings (Field & Lee, 1992; Lattuca, Voigt, & Fath, 2004; Venville, Wallace, Rennie, & Malone, 2002). Different questions need to be asked and different evidence needs to be collected.

### The Teaching Episode: 'Be the System'

> It's the third week of class at a Canadian university in a third year interdisciplinary science course titled Principles of Biological and Artificial Control Systems. This is the third year the course has been offered, but the first year I've taught it. Most students come with life-science backgrounds, although a few are from computer science or engineering. My students have been struggling to understand what I mean by the systems terms of inputs, outputs, and feedback, so today we become systems. I pass around paper and scissors, and the students, working in groups, organize themselves into three systems to make circles, squares, or triangles. I instruct each student to perform a single function (cut, trace, move paper, etc...) and to communicate (sending output or receiving input) with two other students in their system. Later the three shape-making systems become a larger one, trying to meet the needs of my teaching assistants who act as collectors and rejecters of sequences of shapes. In our discussion afterwards, several students liken the activity to DNA translation, then to transcription of DNA to mRNA, in the process teaching me about Biology. Others relate the activity to manufacturing, to the conditions of work in "sweatshops," or to the way computer programs call sub-routines.
>
> All students comment on having a better understanding of systems after this class, and this becomes evident in the entries they write in their learning journals that night. Still, over the next few weeks and years, I constantly wonder what the course is really about, what the students should be learning, and how. Should I repeat this 'kindergarten activity,' (to quote one of my students), next year? How can I help students develop systems ways of thinking? How can I teach control systems concepts without using advanced calculus? What can I, as a mechanical engineer, hope to teach science students about biology? <Gillian, January 2001>

## Scholarship from a Classic Cognition Perspective

To illustrate our argument about the ways that theories structure research questions, our hypothetical SOTL project seeks to resolve some of the Gillian's 'wonderings' about her course. Our first task is to compose researchable questions, a task that is shaped by the theoretical framework of our scholarship. Underpinning traditional post-secondary science classes is the theory that there is an objective, external reality, and that information about this reality can be transmitted and received (Maturana & Varela, 1992; Osborne, 1996). From this positivist perspective, information is transmitted by the professor, received by the student, and learning happens when the student successfully maps an internal representation of that external reality (Davis & Sumara, 1997).

Approached from this classic, information-transfer view of cognition, our SOTL research question might be: How many students learned what Gillian set out to teach? If we operationalize our SOTL research based on this question and theoretical perspective, we would expect to find that the students learned what the instructor transmitted, that is (a) that they should work in small groups; (b) that they can talk to only two other students; and (c) that the primary class objective is the production of paper shapes. However, the students in Gillian's class reported learning more than this. For example, in an interview after the course, Diane remembered that through the 'Be the System' activity she "figured out there's a bigger system at play, and everything's adding up to this and different components of the system, and ... every person can think {of/up} things in a different way and this can all be put together to one" (February, 2004). Clearly, if knowledge can be transmitted and if learning is a simple reciprocal process of taking in that knowledge, then the students in this class should not have been able to develop a better understanding of systems. That they did suggests that other questions may need to be asked about the teaching and learning taking place in this interdisciplinary classroom. Scholars who write about interdisciplinary approaches to teaching and learning are generally dissatisfied with defining learning as information transfer. Their writing is most often informed, either explicitly or implicitly, by the theory of constructivism.

## Changing Theories – Constructivism

Constructivism is an umbrella term covering a cluster of related theories about knowledge and learning: theories about "what knowledge is", and "how one comes to know" (Fosnot, 1996, p. ix). Constructivist theories challenge the ontological view that reality is independent of its observers and that a complete understanding of reality can be achieved solely through direct, objective observation of the physical world. Proponents of constructivism contend that knowledge is tentatively constructed by those doing the observing (Phillips, 1995). From a constructivist viewpoint, understanding is dependent upon the observer since what is observed is interpreted through the lens of the observer's prior knowledge, and the learner's mind is the site for the formulation of new meaning. The unit of attention within constructivist theories ranges from individuals' cognitive processes to the interactions of individuals within groups (Cobb, 1994; Cobb & Bowers, 1999). Reflecting constructivist theories, faculty members report that in teaching interdisciplinary courses they shift their classroom role from being disciplinary experts who are the source of information to being co-constructors of knowledge with their students (Apostel et al., 1972; Armstrong, 1980; Gardner & Turner, 2002; Lattuca, 2001). Faculty in interdisciplinary programs also note that their students change, beginning to view knowledge as provisional (Gabella, 1995; Newell & Green, 1998), and to seek understanding rather than information (Barisonzi & Thorn, 2003).

For our hypothetical SOTL project, a constructivist lens enables us to examine the interplay of teaching and learning in interdisciplinary settings by shifting our attention from students' knowledge of particular facts to students' understanding and application of the processes of integration and making connections. Adopting a constructivist perspective, our research questions might now read: What information did Gillian intend to teach and how does that compare to the information students believe they learned? Did students' ability to define and use systems terms change over the course of this class? What kinds of interpersonal interactions facilitated these changes?

To answer these questions we could examine students' assignments to see how their definitions and use of systems terminology change over the term, and we could explore through classroom observations and student interviews what class/course events precipitate the changes. This data could be augmented with extracts from Gillian's course outline, assignment questions, and reflective journals written as she taught the course. Using a constructivist lens helps us shift our research questions to focus around how students learn (Cobb, 1994).

## Socio-cultural Theories of Learning

Questions and data emerging from constructivist theories help us probe more deeply into what happened in the 'Be the System' teaching episode, but there are still some questions left unasked. If we are also curious about the consequences of interdisciplinary learning and what, if anything is unique about interdisciplinary education, then again we need to draw upon different theories.

Socio-cultural theories of learning are based on the assumption that learning is not an individual activity but rather a social phenomenon (Wenger, 1998), and a "way of being in the social world, not as a way of knowing about it" (Hanks, 1991, p. 24). If, in our SOTL research we accept Lave and Wenger's (1991) argument that learning changes who people are, then to understand what students learn we must scrutinize and make sense of what practices they participate in, how they understand what they do, and how they grow and change through these practices. In other words, learning goes beyond acquisition of knowledge to the engagement in activities, the building of identities, and the acquisition of cultures. All of this happens within a social community (Wenger, 1998).

From a socio-cultural perspective, community building and collaboration among students and faculty are necessary components of, and important outcomes for, undergraduate science programs (Casey, 1994; Foundation, 1996; Venville et al., 2002). Socio-cultural theories challenge us to think about the learning and teaching taking place in Gillian's interdisciplinary class as a set of social and cultural practices embedded within the highly disciplinary structure of the University. University science faculties are typically steeped in a culture where faculty members identify most strongly with the community of their disciplines (Altbach, 1996). However, students electing to join the interdisciplinary program and enroll in the course being analyzed here consistently report that they do not identify with the single-discipline cultures they experienced in the initial years of their undergraduate science education (2004). Instead, they feel that learning requires transcending the disciplines and bridging the borders between them. In other words, they find a disciplinary viewpoint limiting. If disciplines do play a defining role in the communities and thus the identities that most faculty and students develop, then our research ought to consider the consequences for students of enculturation into an interdisciplinary perspective.

Thinking about learning and teaching as socio-cultural practices spawns new questions about our 'Be the System' episode. Some of these questions are inspired by the research of Aikenhead, Jegede, and others who have identified the difficulties students can face crossing cultural borders between the worlds of their family and of school science (Aikenhead, 1997, 2001; Aikenhead & Jegede, 1999; Jorg, 2004): What disciplinary backgrounds did students and teachers bring to this class? Did the 'Be the System' activity help to build a sense of community among this disciplinarily heterogeneous group of students? If so, what aspects of the activity contributed to this? To what communities do students in integrated programs feel they belong? How easily do students and faculty members cross the borders between one another's disciplines? What activities can help students and teachers cross the borders between disciplines?

To research these questions we need to speak with students about their experience, using methods such as semi-structured interviews and focus groups. We can ask students directly and indirectly about their sense of belonging and their interactions with students and faculty members from diverse disciplinary backgrounds. We would seek themes and patterns in their responses in our effort to begin understanding the context of interdisciplinary learning, and how it is experienced by students.

Socio-cultural theories give us a lens through which to examine what students do and who they become. These theories are relevant for researching how students experience learning in a particular context, in this case an environment where faculty and students are trying to bridge the disciplines and promote a more in depth understanding of science. By moving the focus of our attention from the individual to the social and cultural environment, these theories foreground interactions and help us to see the importance of these interactions for learning. However, processes like human interactions and making interpersonal and conceptual connections across disciplines are dynamic, generative, and difficult to identify and document (Capra, 1996). The processes involved in learning, like the behaviours of learners themselves, are variable, constantly changing, and multifaceted. This leads us to search for theories that can help us make sense of this complexity.

## Beyond Socio-Cultural Theories to Complexity

Complexity theories arose out of a desire to understand dynamic systems, those whose behaviour cannot be predicted through linear, cause-and-effect models of relationships (Capra, 1996). Maturana and Varella (1992) argued that in dynamic systems, environment and living beings "act as mutual sources of perturbation, triggering changes of state" in each other (p. 99). Complexity theories draw from a systems way of thinking, which looks at life as structured in networks and webs of relationships. These networks are nested in the sense that each element of the network can be viewed as a system in itself and as a part of a larger system (Capra, 1996). Complex systems are characterized by non-linear dynamics, the utilization of both negative and positive feedback, self-organization, and emergent or synergistic properties (Klein, 1996; Waldrup, 1992).

The interdisciplinary classroom we describe is clearly a dynamic system. The learners cannot be neatly separated from their context, their pasts and futures, their co-learners and teachers, their departments or their disciplines. Varela, Thomson and Rosch (1991) explain that "knowledge ... is inseparable from our bodies, our language, and our social history" (p. 149), in that sense, knowledge is "embodied." Complexity theories can provide us with new insights into what students are and should be learning in seemingly simple yet highly contextual, interactive, and dynamic classes like Gillian's.

### The Teaching Episode Continues

> Back in my class, I ask my students to define a system and they struggle. In small groups, they discuss and debate their definitions, asking each other questions: Where do we draw the boundaries around a system? Where does one system end and another begin? They look to me to give them the answer. "It depends", I say - a

> phrase that becomes a theme for the course. I struggle to explain that systems to me are abstractions humans create in order to understand the world. How we define a system's boundaries depends on what it is we want to understand and to explore. Finally, I ask my class, “Would systems exist if people didn’t?” “Of course”, some answer, “the solar system exists independently of us.” I re-phrase my question: “Does the concept - solar system - exist on its own, independent of anyone to think about it, talk about it, or look at it?” “Well, no!” they answer, and then “Oh — so — it depends.” The students acknowledge that the definer and the system cannot be separated. From here we spin off into further discussions about boundaries and systems, about whether they’re arbitrary, universal, useful, about why we might think of them, and about the role of the definer’s background, beliefs, and intentions in drawing them. <Gillian, 2001>

Complexity theories help to make visible the content of this course, and help Gillian identify what the course is about and what she should be teaching. These theories can also help frame different research questions about the course. Complexity theories suggest that learning is a conversation between knower and world, between students, teachers, and subject. Understanding emerges in the midst of shared actions and relations in the class activities, much in the way that the topic of a conversation emerges in the process of conversing (Davis & Sumara, 1997). From this perspective, our SOTL research can now ask: How does the dynamic of the classroom help the instructor and her students to make sense of the course for each other? What unexpected learning emerged for both the students and the instructor in this course? What actions and activities preceded the emergence of this learning? (How) can instructors maintain a dynamic and emergent learning environment once a course becomes routine to teach? How much uncertainty is too much (and too little) for both students and teachers?

Again, consciously adopting a new theory has allowed us to observe and ask new questions about a teaching episode. Through complexity theory, we explore the generative possibilities of the instructor’s and the students’ confusion and uncertainty. We will need to take a long-term approach to answering these questions – examining the instructor’s and the students’ learning journals over several years, observing classes, and noticing who initiates changes in course activities and whether the learning that results from a given activity is consistent term after term. We could also take an active approach to this research – creating deliberate interventions, adding new constraints and trying to identify the teaching practices that help to create a dynamic and generative learning environment.

## Conclusion

Theories provide lenses through which to see and interpret the world around us. Different lenses clarify different aspects of that world, and every perspective tells part of a “good story” (Cobb, 1994, p. 17). In the scholarship of teaching and learning, theories shape the questions that can be asked about students’ learning and teachers’ practice. Taken together, different theories (here constructivist, socio-cultural, and complexity theories) can help us look from a multiplicity of angles at the teaching and learning that happens in our classrooms.

In our hypothetical SOTL research, constructivist theories help to focus our attention on individual learners rather than simply the teaching, teachers, or the class in general. These theories frame learning as an active process on the part of learners, a process that depends as much on what students already know as on what a teacher tells them. Constructivism can help teacher/researchers see that what we tell students may not be what they learn, and that every student in a class may learn something different from the same activity. Constructivist theories can also help SOTL faculty evaluate our role as teachers in facilitating knowledge building rather than simply evaluating knowledge acquisition, and to think about how a group of students may build new knowledge together. In the context of the 'Be the System' class, constructivist theories can help us find evidence that supports Gillian's belief that students who participate in interdisciplinary learning are able to build new knowledge and to become more actively engaged in their learning.

Through socio-cultural learning theories, SOTL researchers can begin asking questions about what learners are doing and who they are becoming, and about teachers' and students' practices, identities, and communities. In our hypothetical SOTL project, socio-cultural theories can help us start to understand if and how students are making connections and beginning to integrate across the disciplines. Finally, complexity theories, as an extension to socio-cultural theories, turn our eyes towards the 'big picture' of learning and teaching as embodied, dynamic, and complex processes. Here we see learners, teachers, content, and context interconnected and interrelated.

Hutchings noted that while theory is used and understood in a variety of ways in the SOTL community, the "theory most at issue is that which informs [teaching] practice" (2007, p. 2). Teachers interested in improving their practice consciously cast around for different ways to help students make sense of things. As teacher/researchers, it seems appropriate for members of the SOTL community to use a similar conscious casting-of-a-wide-net in our research into our teaching practice and our students' learning (Cobb, 1994). Cobb reminds us that it is important to be aware that we have used particular theories for particular reasons. When our purpose is to gain a deep and broad understanding of learning in our courses and programs, changing theories allows us to think about our classrooms in different ways. Changing theories allows us to ask new questions, deepening the nature of our scholarship and ultimately of our teaching practices. Let us be bold and explicit about the theories we draw from and why, and let us be open to the questions that can emerge when we consciously cast a wider net in framing our research through new and different theories.

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