Informatics in Education, 2007, Vol. 6, No. 1, 197–214



# Student Defensiveness as a Threshold to Reflective Learning in Software Design

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Received: August 2006

**Abstract.** Reflective practice is considered to play an important role in students' learning as they encounter difficult material. However, students in this situation sometimes do not behave reflectively, but in less productive and more problematic ways. This paper investigates how educators can recognize and analyze students' confusion, and determine whether students are responding reflectively or defensively. Qualitative data for the investigation comes from an upper-level undergraduate software engineering and design course that students invariably find quite challenging. A phenomenological analysis of the data, based on Heidegger's dynamic of rupture, provides useful insight to students' experience. A comparison between that approach and a sampling of classic sources in scholarship on learning, reflectiveness, and defensiveness has implications for teaching and education research in software design – and more generally. In addition, a clearer understanding of the concepts presented in this paper should enable faculty to bring a more sophisticated analysis to student feedback, and lead to a more informed and productive interpretation by both instructor and administration.

**Key words:** student feedback, confusion, learning, phenomenology, dynamic of rupture, defensiveness, reflectiveness, authenticity.

## 1. Introduction

The ideas of threshold concepts (Booth, 1997; Meyer and Land, 2006)and reflective practice (Boud, 2001) have begun to receive considerable attention in computing education research; the former to describe challenges facing students in the discipline, the latter to describe work required of students to meet those challenges. The term 'threshold concept' is defined as a concept which, once grasped, leads to a transformed way of understanding or a new phenomenological awareness. Transition to the new understanding (enhanced – or new – mental or conceptual models (Ben-Ari *et al.*, 2004)) or the new awareness is typically preceded by some period of difficulty (Meyer and Land, 2006).

In the literature, reflective practice, critical thinking, and learning are often associated. Plack and Greenberg (2005) provide an overview, referring to a number of researchers well-known in the field: Kolb (1984) links reflection to learning and describes critical thinking as taking time to revisit and process experiences from a number of different perspectives before drawing conclusions. Brookfield (1995) links reflection to critical think-

ing. Critical thinking uses the analytic process of reflection to extract deeper meaning from experiences. Atkins and Murphy performed a meta-analysis of the many definitions of reflection found in the literature and identified an essential three-element sequence common to all (Atkins and Murphy, 1993): A trigger event, typically an awareness of some uncomfortable (positive or negative) feelings and/or thoughts; then, a critical analysis of the feelings and thoughts, as well as the experience which gave rise to them; last, developing new perspectives as a result of this analysis. Many researchers note that while reflective practice is identified as important to learning, it has proven quite elusive to teach. Attempts to cultivate it often fall short (Booth, 1997; Boud, 2001).

### 1.1. *Confusion, a Part of Learning*

Brown *et al.* (2001) write of the confusion and uncertainty that attach to true learning, because it means encountering the unknown. Their comments indicate that the interval of difficulty which follows initial exposure to threshold concept material is filled with confusion, even when it is also filled with learning. Reflective practice is considered to play an important role in students' successfully navigating confusion. However, students in this situation sometimes do not behave reflectively, but in less productive and more problematic ways. Segal (1999) has studied the relationship between reflective practice – or its lack – and the interval of confusion among adult learners. He asserts that, most of the time, exposure to challenging material (such as a threshold concept) initiates in the student an instance of Heidegger's dynamic of rupture, which culminates in reflectiveness or, alternatively, defensiveness.

Students' engagement in a non-reflective pattern has not received much attention in computing education research. Computing educators would benefit by a clearer understanding of the relationship between reflectiveness and its less desirable alternative, and the origins and indicators of each. This paper uses findings from the literature (particularly Segal's work) and experience with a course to investigate how educators can recognize and analyze students' confusion, and determine whether students are responding reflectively or defensively.

### 1.2. *Not Just Good and Bad Teaching: Interpreting Qualitative Student Feedback*

Beyond student learning, the research has implications for understanding students' feedback, particularly their anonymous evaluations of the course and instructor. Applying Segal's analysis to this data not only enables better understanding and response to areas of students' difficulty. It also supports a more informed interpretation than simply 'yes' or 'no' votes on the course and instructor. A clearer understanding of the concepts presented in this paper should enable faculty to bring a more sophisticated analysis to student feedback, and lead to a more informed and productive interpretation by both instructor and administration.

Section 2 supplies motivation and background for the paper: how reflective practice matters to learning, the difficulty in cultivating it, and a preliminary look (the layperson's

view) at reflectiveness and defensiveness. Section 3 holds a deeper exploration of reflectiveness and defensiveness, and their role in the dynamic of rupture. Section 4 contains a very brief description of CSX, a software engineering and design course for upper-level undergraduates that students invariably find quite challenging, and from which qualitative data on student experience is drawn. Section 5 provides a representative sample of student feedback data, an explanation of the interpretation schemes used to analyze it, and preliminary analysis. Section 6 analyzes Segal's contribution in light of some classic literature on reflection in learning. Section 7, the conclusion, summarizes the relevance of Heidegger's dynamic of rupture – and the special nature of Segal's analysis – to interpreting students' course evaluations, and teaching software design; then looks to future work.

## 2. Motivation and Background

Anonymous student evaluations in CSX consistently exhibit a bifurcated distribution: either strongly positive of the form "Good course, I learned a lot", or strongly negative of the form "Bad teaching, disorganized course". The combination suggests that something more complicated, not simply poor teaching, is happening. To investigate that possibility and elicit more meaning from students' qualitative feedback, this paper lays the foundation for applying a Heideggerian analysis (Segal's explanation of the dynamic of rupture) to the data, and explores the special nature and implications of that analysis.

### 2.1. *Learning and Reflectiveness: Overview*

Booth discusses the distinction between two broad categories in approaches to learning: surface and deep (Booth, 1997; p.145). Surface approaches are associated with symbols or words. They direct attention on the sign, the representation itself. Students who use this kind of approach are more focused on the task per se, without consideration of its origins, consequences, or context. It can be summarized as "learning the text", and may take the form of literally memorizing course material.

In contrast, deep approaches focus on meaning, on that which is represented; it can be summarized as "learning through the text". Booth notes that deep approaches to learning are associated with quality learning outcomes, characterized by seeing the world in new ways, and understanding content from a multiplicity of critically different perspectives (Booth, 1997; p.138, p.146). The capacity to shift among different perspectives to suit the task at hand has particular importance in computer science, where different understandings have relevance to each of many tasks, including designing software, writing code, or determining requirements with a user. Deep approaches depend on bringing students' behavior into their awareness and subjecting it to reflection so that *[their] meaning schemes may be transformed by reflection on anomalies* (Meyer and Land, 2006; p.13). Counter-intuitive or threshold concepts (which form much of CSX content) are not learned in straightforward linear fashion, but rather require reflection (Meyer and Land, 2006; p.10).

Extending a metaphor from Plack and Greenberg (2005, p.3), the kind of learning to which CSX is directed (as an advanced undergraduate course) comprises two main aspects, and can be likened to the double helix of DNA. One strand holds the cognitive content particular to computing and software development; it is acquired by cognitive effort, including memorization. One strand is composed of context, meaning, and their interplay; it is acquired through reflection, a practice common to all fields of learning, and related to the ”deep learning” mentioned above. In her research, Booth draws on phenomenographic studies in multiple fields, because, as she notes, they all report similar findings with respect to learning, independent of content area (Booth, 1997; p.138). Schon's book addresses multiple disciplines (Schon, 1987). Similarly, for this paper I draw on literature from a number of professions, all directed toward the second strand of learning: that related to reflective practice.

### 2.2. *Cultivating Reflective Practice*

Three points frequently found in the literature with regard to cultivating reflective practice have particular relevance for this paper: First, the capacity for reflectiveness is founded in making explicit those factors which are typically left implicit, or making visible those assumptions which are typically taken for granted, unspoken and unseen (Booth, 1997; Segal, 1999). Second, some precipitating condition (Atkins *et al.*'s trigger event) gives rise to – and is required for – reflectiveness (Plack and Greenberg, 2005). Third, significant difficulties attach to teaching and cultivating reflective practice (Boud and Walker, 1998). Authentic reflective practice involves becoming aware of one's habitual behavior. Citing Nietzsche, Segal notes that if self-observation is done by rote, it leads to confusion rather than insight. *'Never to observe in order to observe. That gives a false perspective, leads to squinting and something false and exaggerated. . . . One must not eye oneself while having an experience; else the eye becomes an evil eye.' . . . [A] dogmatic commitment to observation produces a disengaged and decontextualised relationship to one's practice*. (Segal, 1999; p.75) citing and commenting on (Nietzsche, 1974). Authentic reflective practice is not done formulaically (Plack and Greenberg, 2005; p.1549). Reflectiveness must come from a student's internal process, and questioning arises out of her dynamic engagement with the content. Booth also notes that questioning done by rote, or imposed by the teacher in a formulaic manner, leads to disastrous results (Booth, 1997; p.145).

### 2.3. *Reflective vs. Defensive Responses: a Preliminary Look*

From the layperson's perspective, reflectiveness and defensiveness are understood as radically different from each other. Defensiveness is associated with an incident-specific increase in emotion that overshadows other aspects of an encounter and effectively prevents further discussion of the topic at hand; in shorthand, an ad hoc reaction of: ”NO, DON'T”. Reflectiveness is associated with diminishment of emotional investment, a kind of long-term stepping back to see better; in shorthand, an attitude of: ”Hmmm, I wonder...” Studies abound about the difficulty of engendering reflective practice (Boud and

Walker, 1998). These shorthand descriptions leave many questions unanswered, including: What makes reflectiveness so difficult to engender? What motivates it? How does defensiveness occur? Where does it originate? How can it be ameliorated? Both reflectiveness and defensiveness raise some difficult questions. The next section explores them more deeply, and lays the foundation to more precisely formulate and investigate the research question for this paper.

## 3. Heidegger: Dynamic of Rupture

According to Segal, in an article meant to support teaching and learning in adult education, reflectiveness and defensiveness represent alternate paths through Heidegger's *dynamic of rupture* (Segal, 1999) citing (Heidegger, 1985). The action of the dynamic is founded in Segal's observations of adult learners, informed by his knowledge of Heidegger. It takes the form of a three-step sequence: rupture, explicitness, response (either reflective or defensive). In this section, I draw on the literature to analyze the dynamic, and examine each of its steps in turn, as well as several underlying concepts on which they're based. This enables an expanded and refined description of reflectiveness and defensiveness, their origins, differences, and similarities; in preparation to address the research question specified in Section 3.4.

### 3.1. *The Dynamic of Rupture – Explicitness – Response: Overview and Underlying Concepts*

This dynamic can be explained by an example from Dreyfus (1993), familiar to anyone who's traveling internationally for the first time, perhaps to attend a conference: Each of us "knows" what particular distance to stand apart from an acquaintance when engaged in conversation. In general, we have no awareness of the specific distance, nor that it changes in proportion to the degree of our intimacy with the other person, nor that we have been socialized to it, nor even that we are doing it. This "know-how" resides in the realm of the unseen taken-for-granted. However, when we encounter conference host country natives who use a different conversational distance, we experience them as standing uncomfortably close (or uncomfortably far away), and we suddenly become aware of our accustomed distance. The discomfort thus becomes associated also with the emergence into visibility of our own behavior. According to Segal – and it is borne out by the student data from CSX – this discomfort is experienced either reflectively or defensively. Segal's explanation of distinct forms of differentness clarifies the two possibilities.

### 3.2. *Distinct Forms of Differentness*

Segal (1999, p.76) citing Bauman (1990, p.143) distinguishes between two kinds of differentness or otherness: the oppositional (in shorthand: 'enemy') and the unknown (in shorthand: 'stranger'). The oppositional is defined according to the same rules as we, but

oppositely. Continuing the example of interpersonal conversational distance, the international traveler may respond: ”These unrefined (host country) natives are standing the wrong distance away. I can’t possibly carry on a civilized conversation under such conditions.” Their differentness is thus defined in opposition: their ’wrong’ vs. one’s own ’correct’ distance, their ’unrefined’ vs. one’s own ’refined’ nature, their ’uncivilized’ vs. one’s own ’civilized’ actions. One’s concept of the correct distance, and who decides it, remains untouched. Defining the other in opposition, as ’enemy’, confirms one’s view of the world. Questioning of one’s own or the other’s behavior is not required; in fact, it has no place.

*Enemies share common boundaries; although they oppose each other, they have a common appreciation of the rules in terms of which they meet each other ...* ***[Enemies] function in the space of the existentially familiar****...* (Segal, 1999; p.76) quoting (Bauman, 1990; p.145).

Alternatively, the unknown is defined according to unknown rules, or perhaps not defined at all. The international traveler may respond, “What is happening here?”, and eventually, “What does this mean? Does it mean that I have an accustomed distance? If so, how did I learn it, what length is it measured at? Does it mean that they have an accustomed distance? If so, how do I learn it, what length is it measured at, and how do I figure it out? Is my lack of local know-how making them uncomfortable? How long will it take to learn, what will I do in the meantime? ...” Segal calls this *enter[ing] a state of inarticulateness* (Segal, 1999; p.78). Recognizing the other as unknown, as ’stranger’ evinces the inadequacy of our worldview. Questions – but no real answers – abound. This unmediated encounter with the unknown poses a considerable challenge. Bauman refers to it as the ’anxiety of strangeness’.

*Strangers have no established boundaries in common – not even terms of which they meet each other...* ***[Strangers] give rise to the existentially unfamiliar*** *... [T]here are no ways of reading [such] a situation that can be taken for granted. ...* ***The anxiety of strangeness is experienced not only in the face of the stranger but in the face of strange and unfamiliar situations – in any situation in which we cannot assume our familiar ways of doing things.*** (Segal, 1999; p.76) quoting (Bauman, 1990; p.145).

Enemies and friends, or enemies and oneself, represent two sides of the same coin. Strangers – or strange, unknown situations – represent a different coin altogether.

### 3.3. *Responses to Rupture and Explicitness*

Segal notes that both cognitive and emotional elements are involved in the consequences of rupture and explicitness, because high emotional arousal, either anxiety or excitement, forms an integral part of being attentive. Segal uses the term reflectiveness to mean the process of examining (and thereby possibly changing) currently held beliefs. He uses the term defensiveness to mean a refusal to examine, and a rigid holding to – even idealizing, currently held beliefs. Note that this requires something having been made explicit, in order to hold to it. Both reflectiveness and defensiveness (or dogmatism) are freighted with uncertainty and anxiety, and either can follow equally from explicitness.

Defensiveness serves a protective purpose: It shields the responder from having to experience the shock of estrangement (and concomitant engendered unease and uncertainty) from the everyday taken-for-granted context in which he encounters the world. It enables the responder to remain in the realm of the known and the unquestioned, without being forced to examine it. In a defensive response to explicitness, one disassociates from engendered uncertainty by recasting the unknown (strange) explicit as the known oppositional (enemy) explicit; one disowns engendered unease by projecting or displacing all responsibility for difficulty onto that recast source; for example the international traveler's first response.

Boud also speaks to the challenges of reflectiveness and the emotional elements involved, arising from the fact that *reflection involves a focus on uncertainty, possibly without a known destination* (Boud, 2001; p.15).

In summary, rupture is required for explicitness; explicitness serves as a pre-condition to both reflectiveness and defensiveness. Both reflectiveness and defensiveness arise from encounters with the unknown, and include significant affective components. A defensive response means avoiding the challenges of uncertainty and its affective components; a reflective response means taking on those challenges.

Terminology note: Segal consistently uses the terms rupture and explicitness to signify a sequence of two stages in Heidegger's dynamic. He introduces the terms reflectiveness and defensiveness as forms of explicitness, but also writes about them as distinct from explicitness: *explicitness can equally lead to defensiveness [or reflectiveness]* (Segal, 1999; p.88). I use the term "response" to signify a third stage in Heidegger's dynamic, consisting of either reflectiveness or defensiveness.

### 3.4. *The Research Question*

The most educationally productive question becomes clear: How to engender a reflective response in every student under all conditions, or failing that, how to transform defensiveness into reflectiveness. Addressing it requires understanding sufficiently the nature and origins of defensiveness and reflectiveness, to recognize and distinguish between them. This paper lays the groundwork by addressing a preliminary question: What in student feedback data evinces instance(s) of the dynamic of rupture, and how are reflective and defensive responses distinguished one from another?

To investigate this question, I analyze qualitative student feedback data from course CSX using a dynamic-of-rupture lens (Section 5). To better understand the implications of this analysis, I examine Segal's method in light of more traditional approaches to reflectiveness in learning (Section 6). As introduction, Section 4 contains a very brief (due to space constraints) description of CSX. The course description found in Koli Calling conference paper (Schwartzman, 2006) provides more information.

## 4. CSX Overview and Structure

CSX, a software engineering and design course, is offered to upper-level undergraduates. It is meant to teach software development fundamentals in a way that transcends soft-

ware tools and languages, yet engages students in the actual practice of software, not just a theoretical or anecdotal exposition. CSX is organized in three segments: two iterations linked by an intervening bridge. During the first iteration, students work on a series of individual 'design and development' assignments, motivated by two purposes: Each assignment is intended to make explicit some point(s) that play a significant role in software quality, but which are often left implicit in programming courses for a computer science degree; for example, subtle ambiguities in specification. Each assignment is also intended to identify and clarify some distinction(s) that play a significant role in software quality, but which are often not addressed directly in those same courses; for example, functionality vs. implementation. In order for students to concentrate on a particular aspect of development, rather than be distracted by the complexity of a problem's content, the content domain is chosen as the smallest problem that can bring that aspect of software development into focus. For some homework assignments, the content may appear simple, even trivial; but treatment of that content – what is intended for the students to learn – becomes both sophisticated and accessible.

The second iteration is devoted to a group project. Its multiple assignments reprise first iteration content in more challenging problems; for it, students also draw on each other as resources. Two or three assignments related to design for ease of change provide a bridge between the two iterations. The bridge covers possibilities for criteria used in modular decomposition, the design of module interfaces, and the implementation of designated modules in ways that support maximum flexibility.

## 5. Student Feedback Data

In choosing data to include in this paper, I attempted to select as representative as possible a sample of views expressed. However, I did exercise bias for one criterion, clarity: From among multiple student responses stating the same opinion, the most articulate was selected.

### 5.1. *Data Sources*

Recorded qualitative student feedback data on CSX is collected from a variety of sources; the variety has expanded over the eight semesters the course has been taught. Each time a new instrument for qualitative data collection was introduced for one semester, it has been retained for all subsequent offerings, sometimes with modification.

From the first course offering, students' end-of-term anonymous evaluations were recorded; and some quiz or exam questions were directed toward qualitative measures (e.g., `What worked well in your group? If something did not, how would you suggest doing it differently?`). From the second offering forward, students were assigned to keep logs during the group project, and end-of-term interviews with each student were instituted for evaluating student performance. The logs were kept for accountability purposes: each student recorded all communication with other group members, including dates and times, participants, and tasks accomplished;

they contained very little qualitative data. End-of-term interviews were conducted to determine an individual student's contribution to the group project and her knowledge of the course material involved; initially, only occasional notes were taken and preserved.

For the last three semesters, end-of-term interviews were recorded (by hand) for later analysis. They provide a means to better understand students' learning experience in CSX, and to refine teaching accordingly. In the most recent offering, during class discussions on the group project, students often spoke about material that they were clearly wrestling with, or thinking deeply about. In order to obtain an account in their own words, I invited them to record these thoughts in their logs; the students began to call them journals. Data sources are noted.

### 5.2. *End-of-Term Data and its Interpretation*

No student explicitly states that she experienced the dynamic of rupture, much less engaged in a reflective or defensive response. Therefore, conditions must be specified that establish a classification scheme for the student feedback data. (Note that from the vantage point of the research question in Section 3.4, the ideal specifying conditions – which may or may not exist – would cleanly partition the data into two sets: one definitively expressing reflectiveness, one definitively expressing defensiveness.) The actual classification conditions were devised by reasoning from the data, in the context of findings from the literature.

#### 5.2.1. *End-of-Term Indications of Reflectiveness*

As noted in Section 1, reflective practice is required for deep learning, which is characterized by new ways of knowing (Booth, 1997). Therefore, data which explicitly evinces an experience of real learning, or a change in thinking or practice, can be classified as definitively denoting reflectiveness. Examples of this include end-of-term interviews from spring, 2005:

Question 5. `Looking back over the course, does it appear different to you at the end of the semester than at the beginning or middle? If so, how?`

*(student_S7): I never knew another way of learning software development but to take that blind route. In this project, I'd thought the main focus was code. When we sat in the lab coding, and it wasn't working, I thought: there must be something to that module design document (I just happened to look at it while sitting in the lab). It said 'this invokes that' and we weren't doing it that way, and we were more focused on getting the code done. And I thought why did [instructor] give us [these three weeks of other assignments] before code, if it's all about code? Maybe it's not all about the code. ... With the [design in documentation already done], you just have to worry about the final step of coding it in [any] language. ...*

Question 6. `What will you take away with you from the course?`

*(student_S4): Analyzing problems, analyzing software, and ways to go about developing software. I used to code software offhand without going off and thinking about it*

*[first]. This course really helped me to go off and think about it. I'm not afraid anymore to program, I know that. The real duty behind software development isn't code. Code equals a small percentage. Really: it's sitting down and really thinking it out.*

Q: `What do you mean, 'afraid to program'? Did you used to be?`

*A little bit.*

Q: `Can you expand on that?`

*Like the [kwic index] program: if you think about how to proceed, it would get overwhelming, almost like, 'Where do you start?'*

Q: `And now you have an idea of where to start?`

*Yes, now: I don't think about program in terms of lines of code, how many functions. Problems don't seem as big as they used to, they're simplified. [Now,] I'd take a project, break it down to its core elements, and really focus on that...*

Q: `When you 'go off and think about it', what does 'think about it' mean?`

*What is the underlying problem, what underlying job needs to get done? Break down the problem into pieces, each piece has its own duty or task, functionality. Instead of a big, round ball, [it becomes] things more like blocks.*

And anonymous student evaluations from spring, 2003:

*(student_A9): This course is a great course. It is very intellectually demanding and academically challenging. I was thinking of suggesting this course be required for computer science, but I would not. I think this course is only appropriate for those who are seriously interested in software engineering. Should there be a 2nd course based on this course? Absolutely.*

5.2.2. *End-of-Term Indications of Defensiveness*

According to Segal, defensiveness is evinced by casting the source of explicitness (i.e., the teacher or the course) as a source of problems. Examples include anonymous student evaluations from spring, 2003:

*(student_A1): I think this class was much more difficult than it had to be. ... My main concern was trying to interpret what was being asked, instead of learning the material. – A separate point – we spent 2 periods going over the [kwic index program] – Why? Why the line by line analysis of the KWIC index program? This has little value – except to confuse and bewilder the class.*

*(student_A10): Could not ask questions and get a straight answer, answers were always left ambiguous. ... Gave no examples of personal experiences, homework assignments were changed during class and not a full understanding was given, never told us what [instructor] really wanted or expected, lecture was often not helpful in understanding material, I wouldn't take this course again, I wouldn't take this course if it wasn't required ...*

*(student_A12): ... It took me 3/4 of the course to understand the "purpose" of the course and the approach. Most of the time the instructor appeared to be unprepared and unorganized. I had the feeling of "drifting" and not going anyplace. ...*

### 5.3. *In-Process Data and its Interpretation*

Almost all data collected at semester's end (representing after-the-fact reportage) fits into one of the two classifications given in Section 5.2. However, for most of the group project, data recorded in the midst of students' actual process (entered several times per week in their logs) does not satisfy either defining condition. It does consistently display a heightened level of affect, even anxiety, even among students whose projects later turned out well.

#### 5.3.1. *In-Process Feedback: Indications of Anxiety*

Group project logs (during week 1 of 5) from fall, 2005, include entries:

*(student_S1): ... It seems to me that we were not getting anywhere very quickly and this undertaking was larger than I previously had thought. What seems like such a straightforward assignment has become very complex ...*

*(student_S2): ... I'm a very calm and balanced person, and never really get stressed out about anything homework-wise because of the timeline I usually follow when I work. This project is already starting to stress me out because of the seeming lack of progress that we've gotten through so far. It seemed to me to be a fairly straightforward assignment at first, especially given the examples of the circles and the KWIC index, and I had hoped to hammer out a good outline to the [documents] within the first two sessions. We're nowhere near that yet. ... It feels like we're getting nothing done, and right now I don't necessarily know where to work next on my own. ...*

These excerpted log entries confirm the relevance of Segal's analysis; students are experiencing the effects of explicitness. That is, they are experiencing a period of confusion after being exposed to threshold concept material, but before developing the corresponding mental or conceptual models or acquiring a new phenomenological awareness. The distinctions described in Section 5.2 between reflective and defensive responses do not fit this data. More work is required to identify and develop the skills for analyzing stand-alone in-process data. For now, it may be analyzed retrospectively, in the context of end-of-term feedback. A retrospective interpretation scheme can be explained through the example of the international traveler.

#### 5.3.2. *Retrospective Interpretation: Footprints*

In our example of the international traveler, a threshold concept regarding the existence and length of accustomed conversational standing distance might be phrased as: "I have been socialized to use a set of conversational standing distances particular to my culture. People in other cultures are socialized to the set of distances particular to their respective cultures. In any encounters, I can remain aware of our standing distance, continuing to adjust it as necessary until each of us feels at ease."

If, as a result of responding reflectively, the traveler can come to this concept, she will eventually manage encounters with host country natives relatively free of uncertainty and discomfort; and she will be equipped with this new awareness for all her subsequent travels. If, however, the traveler responds defensively, the heightened affect has little chance

to subside except by the traveler's returning home (without having integrated any learning). In subsequent journeys this traveler will likely continue to encounter the world at his original level of phenomenological awareness, and may well experience a repeat of the dynamic of rupture on the same terms as before. Note this means that the nature of the traveler's response (reflective or defensive) can be discerned after the trip by whether or not her view of the world has changed.

One can apply this same reasoning to interpret in-process CSX student data: Due to students' more highly charged state during response (of either type) to the dynamic of rupture, data collected in the midst of such experience may not offer clean delineations between reflectiveness and defensiveness. More information can be gleaned by comparing it with semester's end reportage. If in-process data indicates a student's heightened affect with regard to elements of CSX content or goals, one looks to that student's semester-end data, and examines the footprints. If his view of those elements has changed in any significant way, one can conclude – retrospectively – that he was engaged in reflectiveness. And if not, then not.

## 6. Reflectiveness, Defensiveness, and Authenticity

This section contains a comparative analysis of Segal's work with some classic, widely-cited sources on reflectiveness in learning: Dewey, Brookfield, Mezirow, and Schon. The analysis illuminates relationships between scholarship and practice, and provides a context within which to place Segal's contribution and to consider its implications for teaching.

### 6.1. *Addressing Reflectiveness: Similarities*

Segal and the classic sources cited here are all committed to the cause of reflectiveness in learning. All bring a thoughtful appreciation of its complexity, both as they encounter it in practice and as they study it in theory: All agree that encounters with the unknown initiate an interval of confusion, and real learning during that interval requires reflectiveness. All recognize the associated heightened affect: Mezirow enumerates a variety of difficult emotions involved; he writes about the importance of integrating cognitive and affective domains for critical thinking (Mezirow, 1991). Even as Dewey's rationalist view defined reflection to mean validity testing: *The concluding phase [of reflective thinking] is some kind of testing by overt action to give verification of the conjectural idea* (Dewey, 1933; p.113); he also realized that *[t]he origin of some thinking is perplexity, hesitation, doubt* (Dewey, 1933; p.15). Brookfield's inner discomforts (Brookfield, 1987) and Mezirow's disorienting dilemmas represent forms of a precipitating external trigger:

All recognize the critical role of examining assumptions as a form of reflectiveness, what Booth terms the *micro-level view of learning: ... [It] concerns the structure of human awareness and how certain pedagogical situations support a productive restructuring of awareness to lend greater understanding* (Booth, 2003; p.9). Segal concentrates entirely on this form, the others describe it as one among several. Dewey states, *[On the*

*path to becoming critical thinkers] we [must] try to explore and understand our assumptions, beliefs, and action*s (Brookfield, 1987; p.29). Mezirow categorizes reflection into three types: content, process, and (resembling Segal) premise reflection (Mezirow, 1991; p.107). He also discusses four forms of adult learning specified in transformational learning theory: learning through meaning schemes, learning new meaning schemes, learning through transformation of meaning schemes, and learning through perspective transformation. The last *begins when we encounter experiences, often in an emotionally charged situation, that fail to fit our expectations ... Illumination comes only through a redefinition of the problem* (Mezirow, 1991; p.93, 94).

### 6.2. *Addressing Defensiveness: Disparities*

Both Segal and the other sources label a heightened-affect, non-reflective response as 'defensiveness'. Similarities end there.

#### 6.2.1. *Value-Laden Scholarship*

The others rarely mention defensiveness at all, and never as an object of study in its own right. Brookfield appears to regard it as an ad hoc "NO, DON'T", reminiscent of the layperson's view: ... *[one may] resolve to accept external criticism without retreating immediately into a defensive posture of righteous indignation* (Brookfield, 1987; p.28). Dewey's response, emblematic of his time (although, as will be seen in Section 7.2, he also envisioned more), states: *Undergoing [experience] ... is never mere passivity. ... Even if we shut ourselves up in the most clam-like fashion, we are doing something; our passivity is an active attitude, not an extinction of response. The obstacles which confront us are stimuli to variation, to novel response, and hence are occasions of progress*. (Dewey, 1917; p.11). He seems to be exhorting "Don't even think about [defensiveness]; it won't work and you can do better."

Schon studied the education of practitioners in several disciplines (architecture, musical performance, and psychoanalysis) under apprenticeship-like conditions. Student learning is mediated through relationship with an instructor, in a series of one-to-one *reciprocal reflection-in-action* encounters. In practice, Schon is concerned primarily with avoiding defensiveness ... *escap[ing] the dilemma of how to convey negative information to [the student] without triggering her defenses* (Schon, 1987; p.154); or recovery from the learning bind induced when defensiveness does occur. Analyzing an architectural design review he writes, ...*[the] student must be able to enter the as yet unknown world of someone else ... [a student] needs a capacity for cognitive risktaking. Rarely [does] a student ... bring to the studio the strong sense of self on which this capacity depends. For most . . . the wish to avoid uncertainty ... makes it impossible [and creates a] learning bind...* (Schon, 1987; p.139). Schon then proceeds – without further analysis of what is happening in the student's response – to describe the steps an instructor can take that may effect an unbinding. His research does not address the origins or mechanisms of defensiveness itself, which he and the other classic sources appear to define as merely the absence of reflectiveness,

A simple but telling point: Indexes for texts by the classic sources cited here: (Brookfield, 1987; Dewey, 1933; Mezirow, 1991; Schon, 1987) ((Dewey, 1917) has no index) each contain at least a half column of entries for reflectiveness, but none at all for defensiveness. The authors appear to regard it as outside the scope of – even irrelevant to – their inquiry. Both their practice and their research are value-laden toward – and organized around – pursuit of reflectiveness.

6.2.2. *Value-Laden Practice, Value-Neutral Scholarship*

In his practice as an adult educator, Segal's motivation is also value-laden toward reflectiveness. However, in his scholarship as an education researcher he employs different values, both as motivation and as organizing principle. He wants to investigate – without precondition or bias – exactly what occurs at the point of encounter with the unknown. He seeks to understand the student's experience rather than to direct it to a particular (reflective) outcome, and that search is organized around the principle of Heidegger's dynamic of rupture. This value-neutral stance with regard to reflectiveness and defensiveness allows equal room to either outcome. It also yields information epistemologically prior to knowledge of the relationship between learning and reflection. Segal alone clarifies what occurs – and how learning does not occur – in the absence of reflectiveness, through his exposition of the dynamic of rupture.

In phenomenological terms, Segal is examining elements in the realm of the taken-for-granted unseen, and their transition to a realm of the (seen) explicit, i.e., the development of new phenomenological awareness. Such an orientation provides a conceptually less complex – but no less sophisticated – way of framing the investigation. Phenomenological analysis becomes a tool for investigating what occurs outside awareness. I would argue that this tool prepares Segal (in both senses of the word) to ask the simple, elusively obvious (Feldenkrais, 1981), epistemologically prior question that opens his inquiry to new possibilities. Segal's work on reflectiveness and learning is distinguished from the others' not by his approach to reflectiveness, but by his exploration of defensiveness.

6.3. *Segal's Contribution*

Segal and the classic sources treat reflectiveness similarly, and defensiveness quite differently. The classic literature treats defensiveness as a kind of 'terra incognita hic sunt dracones' (from medieval maps: 'unknown territory, dragons lurk here'), an impenetrable scholarly dead end that they ignore in their research. This leaves them unequipped to deal with it in practice; they avoid it as fixed and immutable. In his research, Segal (using Heidegger's dynamic of rupture as a framing device) explores its origins, nature, and mechanisms of operation. From this exploration, Segal comes to see reflectiveness and defensiveness as equally substantive elements within a gestalt of the dynamic. This sense of gestalt, and an appreciation of the complexity in each element, in turn informs his practice. It creates a foundation for learning how to prevent defensiveness, or failing that, how to interpret it and engage students who are experiencing it in order to bring them to reflectiveness. The contrast between these approaches is further illustrated in the next section.

### 6.4. *The Will to Authenticity*

The comments of Schon and Brookfield, quoted in Subsection 6.2.1, express a view from psychology that defensiveness arises from an individual's inadequacy to manage a situation, and the inadequacy dictates that individual's decisions. Heidegger's phenomenology frames the situation differently: *[He] calls defensive responses to rupture "inauthenticity"* (Segal, 1999; p.87). Student feedback data from CSX provides compelling evidence that the will to authenticity – to address the real problem and not be deflected by one's anxiety at doing so – can exert great influence, even in the face of significant difficulty; for example, a spring, 2005, end-of-term interview excerpt:

Q: `Looking back over the course, does it appear different to you at the end of the semester than at the beginning or middle? If so, how?`

*(student_S7): Very different, ... I'm understanding it better at the end. ... the importance of it is making more sense to me. ... how important it is to have a rational design process. I think if [developers of real software used this approach], the failure rate would not be so high. They'd know exactly where to . . . look for [the source of a] problem. I never thought of software that way before. It's fatal: not just with lives (it can be), it also can be fatal economically. ... After realizing it's not just about C++, I actually went back to the software requirements document – because I didn't understand it; then the module guide document [in order to] [f]irst establish what each module does, what changes might occur, to be prepared for. Second, [I turned to] the module design document, thinking about procedures, (I hadn't thought at all about procedures before realizing it's not just about C++) what it does, how to do it. . . . I had to keep going back again and again. ... It took awhile for me to get it, I kept talking about [C++ instead of procedures] with team mates. It was frustrating and difficult.*

Q: `What enabled you to finish the project?`

*... First, I had to understand it [my]self. It took 2 weeks; I looked at it each day, and talked with [a team mate] often.*

An 'inadequacy / adequacy' frame doesn't explain the student's comments, or suggest any way to cultivate similar experience in others. An 'inauthenticity / will to authenticity' frame explains it perfectly, and indicates possibilities for subsequent teaching.

## 7. Conclusions and Future Work

Segal's explanation of Heidegger's dynamic of rupture offers a tool to analyze students' experience of learning challenging material, and the confusion it elicits. It is explained in Section 3 through the example of an international traveler. Subsection 7.1 holds a summary explanation. Subsection 7.2 frames Segal's 1999 paper as a response to Dewey's 1917 call. Implications for interpreting students' qualitative feedback are found in 7.3. Subsection 7.4 enumerates some directions for future work.

### 7.1. *Reflective and Defensive Responses*

To summarize Segal's explanation: explicitness (the unavoidable – and unchosen – coming into awareness of some phenomenon previously outside of awareness) plays a significant role in real learning. Explicitness does not arise from a linear progression of events, but only as a result of rupture or disturbance, an unexpected encounter with the existentially unfamiliar, either persons or situations, that induce the anxiety of strangeness. In turn, it gives rise to either reflectiveness or defensiveness; these arise from encounters with the unknown, and include significant affective components. In contrast to a lay person's casual understanding (Section 2.3), a defensive response means avoiding the challenges of uncertainty and its affective components; a reflective response means taking on those challenges. Reflectiveness does not equal contemplation.

The disparity in practice between Segal and the others makes clear that a professional's assumptions (in research) regarding defensiveness play a significant role in that professional's framing of (in practice) – and response to (in teaching) – how students manage confusion and learn challenging material. Defensiveness merits further research.

### 7.2. *A Recovery of Philosophy*

In 1917, Dewey wrote about the historical importance of philosophy and its value as a discipline, but expressed doubts about *the genuineness, under the present conditions of science and social life, of the problems [currently being addressed by it]* (Dewey, 1917; p.5). He finished the essay, *Faith in the power of intelligence to imagine a future which is the projection of the desirable in the present, and to invent the instrumentalities of its realization, is our salvation. And it is a faith which must be nurtured and made articulate: surely a sufficiently large task for our philosophy* (Dewey, 1917; p.69). For a 'desirable in the present' defined as 'creating an environment that supports responsible learning and the teaching that leads to it', Dewey's call serves as further context for Segal's work: Heidegger's dynamic of rupture provides an instrumentality of realization by offering alternate possibilities to frame and interpret students' responses in encounters with difficult, existentially unfamiliar material. The power of Segal's intelligence uses that instrumentality to transform defensiveness from a seemingly impenetrable obstacle into learning opportunities for both student and teacher. As one whose professional life – in teaching, in research, and in practice – is concerned with how to manage the daunting complexity of software, I take his example to heart.

### 7.3. *Anonymous Student Evaluations: Beyond Good and Bad*

This paper illustrates the relevance of Heidegger's dynamic of rupture (as formulated by Segal) for analyzing students' learning in and experience of CSX, and its role in enabling a more sophisticated and productive interpretation of their course evaluations. That combination makes a strong argument for the potential value of the dynamic to other instructors in other computing courses, particularly as an interpretive tool leading to more effective use of their students' feedback. For example:

If student evaluations for a course exhibit a bifurcated distribution (one portion quite positive, the other quite negative), it may well result from thoughtful teaching of difficult material, particularly if some students speak about the value of the course for their learning. The students' feedback may indicate their experiencing the effects of explicitness (in Segal's terms) corresponding to a period of confusion as part of their learning challenging concepts; some are responding reflectively and some defensively. If the instructor is attempting to present the difficult material of computer science and the students are encountering the challenges it poses, the department's support of that instructor and her capacity to foster reflectiveness will benefit both students and the profession.

### 7.4. *Future Work*

This paper lays the foundation for future work in a variety of directions: course changes resulting from analysis with the dynamic; clarifying exactly what in CSX triggers the dynamic of rupture; refining analysis of students' in-process feedback data; cultivation of reflective rather than defensive responses; and identifying what supports students' will to authenticity in the face of software's challenging complexity.

**Acknowledgements.** The author thanks the anonymous reviewers for their suggestions and thanks Raymond Lister for his thoughtful comments and intellectual generosity.

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## Besimokančiųjų gynimasis kaip refleksyviojo mokymosi pradmenys mokantis projektuoti programinę įrangą

Leslie SCHWARTZMAN

Mokantis sudėtingo kurso medžiagų refleksija vaidina svarbų vaidmenį. Besimokantieji neretai sunkiai reflektuoja vien dėlto, kad pasirenka ne tokius produktyvius ir pernelyg sudėtingus būdus. Straipsnyje tiriama, kaip mokytojai gali atpažinti ir analizuoti besimokančiųjų sutrikimą ir suprasti, ar besimokantieji reflektuoja, ar ginasi. Kokybiniai duomenys tyrimui gaunami iš jau baigusių programinės įrangos projektavimo kursą studentų, kurį besimokantieji suvokia itin sunkiu. Fenomenali duomenų analizė, paremta Heideggerio lūžio dinamika, pateikia naudingą studentų patirties įžvalgą. Aiškus koncepcijų suvokimas, pateikiamas straipsnyje, turėtų įgalinti fakultetą paanalizuoti besimokančiųjų grįžtamąjį ryšį, ir įgalinti dėstytojus ir administraciją produktyviau bendradarbiauti. Taip pat pateikiama ir lyginamoji mokymosi teorijos analizė, refleksija, gynimosi teorija su fenomenais grįsta teorija.