FEATURE ARTICLE

Getting out of the way: Learning, risk, and choice

LEE S. BARNEY
Brigham Young University-Idaho (USA)

BRYAN D. MAUGHAN
University of Idaho (USA)

Students learn best when teachers get out of the way. Unfortunately, university classrooms continue to be intensely teacher-centric, are driven by the teacher's agenda and calendar, and embrace simple models rather than complex alternatives. These simple types of learning environments frustrate students' development of the risk-taking and choice making confidence they need in the workplace. Bain (2004) makes the point that environments embracing choice as a priority, welcoming risk-taking, and nurturing students who make mistakes, better prepare students for professional success. In this article, we intend to provide context to the conversation about how learning-risks and agency impact and promote the individual growth of the student when the teacher gets out of the way. Using a Rapid Assessment Process (RAP) (Beebe, 2001) combined with Action Research (AR) (McNiff, 1988; Stringer, 2007; Schön, 1983; Argyris, 1993) we devised an experiment to determine if a university course would invite more student growth when the environment changed from being teacher-centric with highly structured assignments and critical assessments, to one that embraces the tenets of complexity theory. The purpose of this approach was an attempt to challenge the status quo; to show how complex interactions between risk-taking, agency, learning culture, teacher-facilitator-mentors, peers, coursework, and outcomes are important to students' preparation for successful professional work. To accomplish this we experimented within a software development course at a large university in the northwestern United States. We found students appeared to be more prepared to move on to the professional workplace and demonstrated professional ways of being when they had experienced risk-taking and agency in a learning environment based on

complexity theory principles. Without many examples of complex research or course design processes to follow, we envisioned and applied processes for both.

Getting Out of the Way; Learning, Risk, and Choice

In recent commencement addresses, industry leaders showed agreement on two key abilities necessary for graduates to succeed in the workplace: risk-taking and the use of agency (Yoder, 2013; Rochester Institute of Technology, 2013; Hoffman, 2013; Kendall, 2013; News at Princeton Staff, 2010). These leaders expect new graduates to invigorate their companies with the sustainable production of innovative ideas yet these industry leaders recognize that university courses do not typically promote the characteristics of risk-taking and expressing agency students need once they enter their profession. Instead, courses tend to focus on fostering the collection of discrete pieces of information and skill application in proscribed situations. To aid university faculty in encouraging students to use their agency and take risks in courses the students experience, we propose the need for a rethink of the structure of courses, technical information delivery, and student assessment.

By executing an Action Research (AR, McNiff, 1988; Stringer, 2007; Schön, 1983; Argyris, 1993) and Rapid Application Process (RAP, Beebe, 2001) inquiry with complex systems, we found a complexity theory based course design methodology while designing a course that fostered increased application of student agency and risk-taking experiences. As a result of these experiences, students developed an increased ability to face unpredictable challenges and apply tacit learning—the absorption of information not explicitly expressed—in combination with technical knowledge that is the hallmark of successful professionals (Polanyi, 1966).

Problem

Computing professionals creatively apply technical knowledge. For software development professionals this may involve communicating with customers to cooperatively discover the customer's needs, productively participating in detailed, loosely bounded design meetings, creating systems or applications, and a set of other creative, interpersonal activities (Matturro, 2013). To thrive in complex environments such as this requires more than up-to-date fluency in the continually growing computing knowledge base, yet commonplace higher education course designs do not foster the risk-taking and agency desired by industry leaders (Yoder, 2013; Rochester Institute of Technology, 2013; Hoffman, 2013; Kendall, 2013; News at Princeton Staff, 2010), nor do they give students opportunities to experience complex environments. Additionally, since only complex systems can generate other complex systems (Kampis, 1991), a complex course design methodology is needed to aid in the creation of designs for complex courses.

Significance

Understanding the lived-experiences of students could assist course designers in creating effective courses based on the complexity theory principles of educational practice, agency, and the taking of learning-risks. An understanding of the complex interactions between risk-taking, agency, teacher-facilitator-mentors, peers, coursework, and outcomes could improve course designs and students' preparation for industry. An example of a complex course and how it was designed is documented and explored here. The course design was built to support the concepts of student agency and taking learning-risks. Students that took the course appeared to become more prepared for work professionally and technically.

Research Questions

- Can a university course invite more student growth when the environment changes from being teacher-centric with highly structured assignments and critical assessments, to one that embraces the tenets of complexity theory?
- Can experiencing complex interactions between risk-taking, agency, learning culture, teacher-facilitator-mentors, peers, coursework, and outcomes help students prepare for successful professional work?
- In such a course, will students take learning-risks, and, as a result, experience personal and professional transformations?
- Also, how would students express their readiness to enter industry after participating in a course where there is space for agentic expression and learning-risks?
- And finally, what are the implications for course designers of a complexity based course design methodology and combining risk-taking, agency, and complexity theory in the courses designed?

Conceptual Framework

Complexity theory, AR, and RAP are distinctive, yet there is an overlapping set of principles and purposes that allow these three conceptualizations to reinforce and complement each other. In order to more easily visualize the overlap, we have numbered the principles of complexity theory, AR, and RAP as we describe them below. After the descriptions are complete, the numbers for each conceptualization are color-coded and displayed in a Venn diagram.

AR, as described by combining the works of McNiff (1988) and Stringer (2007), has as its primary purpose the aiding of practitioners in affecting the societies and situations within which they find themselves. They define AR as (1)[1] practice based inquiry where the practitioner performs research to enable them to (2) make meaning from lived experiences by interpreting actions and activities. This meaning is then (3) applied to the practitioner's professional practice as a primary research purpose.

[1] The parenthetical numbers in this and the subsequent paragraphs will assist in interpreting Figure 1

Implied in this application is a secondary purpose: (4) to learn through action in context while acknowledging changes they make to their practice; (5) affect the communities and societies to which they belong. All of this is approached with an attitude of humility due to the understanding that (6) the practitioner has limited understanding and must leverage the experience and understanding of other research participants and stakeholders. Action research is intended to (7) "link praxis and theory" (Levin & Greenwood, 2011, p. 29). In this way, research results are solutions that have impact on the practice of the practitioner. Additionally, AR (8) encourages interaction between the researcher and the participants. This results in a "cogenerative inquiry" (p. 29) where the research comes alive through the expression of the combined experiences of researcher and participants. AR predetermines no research methodology but RAP (Beebe, 2001) supports both cogenerative inquiry and the linking of praxis and theory.

RAP (Beebe, 2001) arose from the need to perform (1) qualitative research in short enough time frames to (2) propose solutions to immediate problems where time delays may cause continued or increased problems. RAP implementations do this through (3) intensive, short-term rather than long term research. To accomplish desired impacts in short timeframes, the research is (4) team-based with a heterogeneous team consisting of people with insider and outsider perspectives. These perspectives are applied to (5) triangulate understandings gained by performing (6) repetitions of data analysis, data collection, and team member triangulation followed by member checking. Only after additional understanding is not achieved is the repetition terminated and (7) potential solutions are created and proposed.

Like RAP, complexity theory is the result of a need—the need to describe and understand complex systems. Its principles can be deduced from chapter 6, *Complexity and its Increase*, of Kampis' (1991) in-depth assessment of complex biological and cognitive systems. He describes the task of complexity theory as (1) the emphasis, not the minimization, of system changes triggered by shifts of environmental attributes external to the complex system. This implies (2) a hermeneutic move from knowing information about complex systems to understanding the complex systems where (3) this understanding is a product of the system itself and therefore can only be accomplished by someone who is part of the system.

As an aid to understanding, an important piece of information about any complex system is its description yet (4) the only accurate description of a complex system is itself. Any simplification is inaccurate. This implies that (5) any concrete description of a complex system must acknowledge the existence of unknown, and potentially unknowable, factors that contribute to the system's complexity. Thankfully, (6) the degree of completeness of such descriptions is irrelevant to deciding to use them since complex analysis of the containing environment will point out any descriptive inconsistencies.

Kampis also claims (7) all complex systems continually and recursively modify themselves where recursion is defined as "relating to or involving a … routine of which a part requires the application of the whole, so that its explicit interpretation requires in general many successive executions" (Radford, 2008). In short, one part of any recursive routine is the routine itself. Or in terms of complex systems, part of a complex system's existence is to bring itself into existence anew—to continuously emerge—or as expressed by Kampis, to evolve. This evolution results in (8) the increasing complexity of complex systems. Yet (9) the degree of complexity of any system is not quantifiable but is relative to the complexity of the system's previous versions and to other systems. Additionally, as systems increase in complexity, emergence of new system components, sub-systems, or entirely new complex systems may occur. Emergence of these (10) is impossible to predict, logically or computationally, from the combination of the initial complex system and the environment of which it is a part. Therefore, anything predictable cannot be the result of emergence.

Grouping the complexity theory principles with those of AR and RAP under descriptive names reveals their relatedness and the amount of enrichment each conceptualization provides when they are used together. In Figure 1, each descriptive name is associated with one or more principle numbers from the descriptions above. The groups are placed in a Venn diagram with each principle color-coded to match the conceptualization of which it is a part. The numbers representing RAP principles are in orange, AR principles in blue, and complexity theory (CT) principles in red.

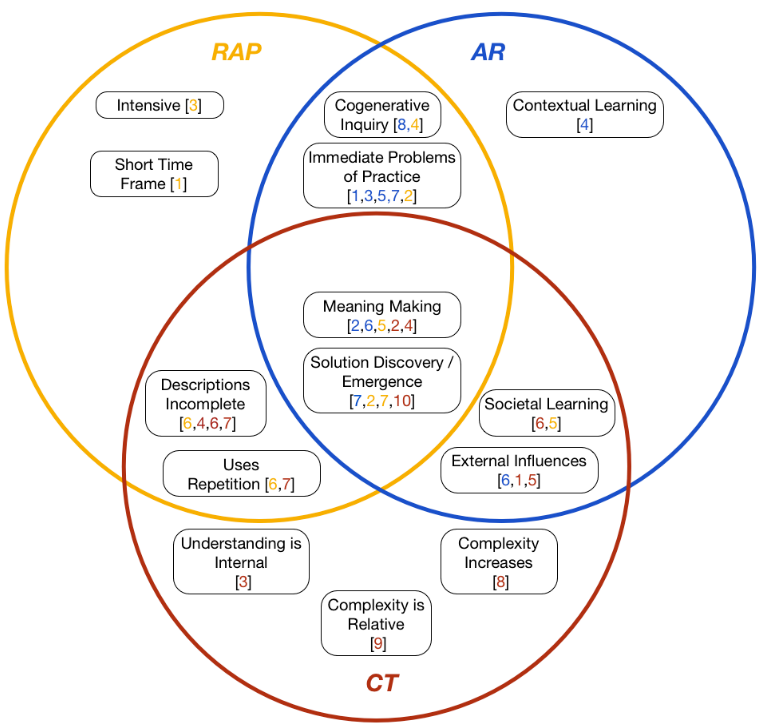

Figure 1. AR, RAP, Complexity Theory Overlap.

The *Meaning Making* and *Solution Discovery/Emergence* groups are shared by all three conceptualizations and encapsulate nine principles but AR, RAP, and complexity theory also provide eight that are unique and unshared. Therefore 68%, or 17 of 25, of the principles are shared to some degree. As potential components for a research design, this much sharing indicates a strong affinity between AR, RAP, and complexity theory yet their differences provide enrichment.

Complexity Theory, Enframing, and Research Design

While inquiring deeper into complexity theory we encountered Ricca's (2008) principle of enframing. In order to explain enframing, Ricca examines classical frames of reference, as used in Physics and other sciences, and their limitations with regard to complex systems. Put succinctly, classical frames of reference are used to limit, in a positive way, what is being studied and to exclude the observer; like looking through a framed window. In practice, classical reference frames are applied to non-complex systems or non-complex models of complex systems. In this way classical frames of reference can yield useful perspectives when the models or systems are either simple, where inputs are known and yield consistent readily predictable results, or complicated, where all inputs are known and the results are consistent but potentially non-obvious (Kampis, 1991).

Ricca claims that applying classical frames of reference to complex systems produces problematic results. This led him to consider a new approach he called enframing (2008). Ricca's definition of enframing is "to treat the subject of the research, the researcher, and the process of the research simultaneously" (p. 116). Like AR, this definition necessitates the inclusion of the researcher as part of the research. Ricca also indicates that enframing is to be self-reflective and use reflexive examination so as to enable enframing emergence.

Enframing recognizes the emic (external perspective) and etic (internal perspective), as does phenomenological bracketing, but there is an ambiguity of the boundaries between them (Kampis, 1991). Because of this ambiguity of boundaries and expanding on Ricca's (2008) definition, an inquiry's enframing generally blends itself, the researcher, the research, and the complex system(s) being studied into an inquiry as seen in Figure 2. The inquiry's design was left out of the diagram since the enframing process, itself being complex, implies the possibility of the inquiry's design emerging rather than being completed prior to doing the research.

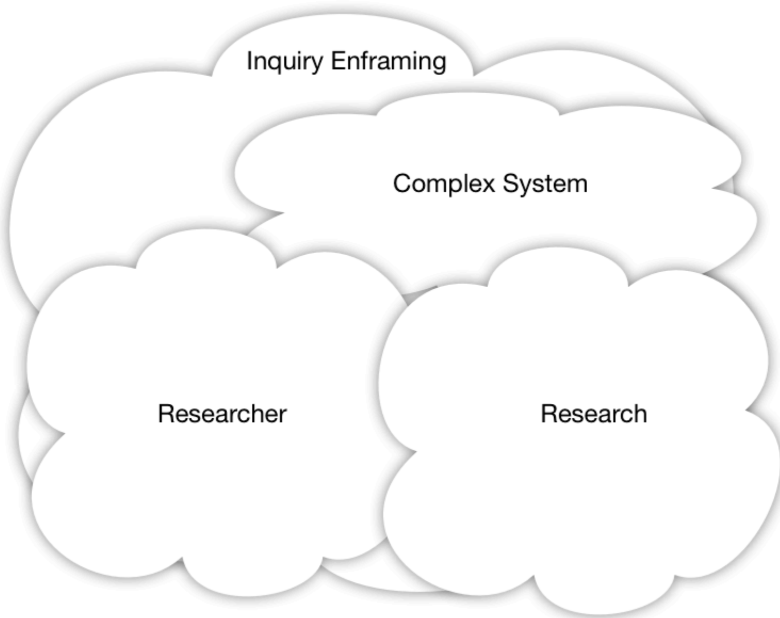

Figure 2. Inquiry Enframing.

Complexity Theory, Agency, Risk-taking, and Practice

As part of Ricca's (2012) work examining complexity theory and its implications for commonplace educational practice, he offered three critiques; (1) planning and execution of lessons are unsupportable, (2) traditional methods of content delivery are insufficient, and (3) the complex interactions needed for learning between the student, the teacher, and the discipline are often missing. Additionally, Jonas-Simpson, Mitchell, and Cross (2015) used a complexity theory lens to express their concern with learning experiences. They claimed in commonplace practice "students learn to look for what teachers want" (p. 2) rather than finding new ideas and exploring them deeper, which complex learning environments enable (Doll, 2012).

If Ricca's (2012) critiques were inverted three actionable principles would be generated: (1) creation and execution of pre-planned lessons should be avoided or at least questioned, (2) non-commonplace content delivery must be achieved, and (3) the teacher, students, and the discipline must continually interact with each other—where continually is defined by Vaill (1996): "recurring at short intervals" and "never comes (or is regarded as never coming) to an end" (p.5). These three principles describe complex learning environments where the students are agents of independent action contributing to how learning objectives, content delivery, and learning interactions are achieved rather than organisms primarily reacting to external forces. A student's sense of agency can be fostered and her or his sense of accomplishment increased when they accept and take learning-risks (Lupton & Tullock, 2002). But agency in learning situations is not unlimited. In complex learning environments loosely, not tightly, constrained agency is required for the emergence of learning (Kampis, 1991; Davis & Sumara, 2006).

Not all of the constraints students will experience are knowable and some may arise as students make choices. Morrison explained how this might be. He proposed, "We exert our own agency and intentionality, creating, producing and reproducing systems through our daily interactions, and in turn those systems constrain and influence the way in which we behave" (Morrison, 2005, p. 313). In learning situations, when students, instructors, and others make choices (agency), other choices become unavailable (constraint). Sometimes the constraints generated by student choices influence, both positively and negatively, the cognitive and affective outcomes of the students' peers (Johnson, Johnson, & Scott, 1978). The dispersed impact of choices made, when examined through the lens of Morison's ideas on agency, and the effect of constraints due to the choices, implies that learning situations consist of societal-influence-relationships forming a complex multi-nodal web. This web swaddles all learners, including students and teachers, and is partially composed of relationships between themselves, between themselves and the societies to which they belong, and between themselves and the knowledge surrounding them.

Movement and the Act of Becoming Professional

Gaining knowledge therefore is not a localized or purely individualized activity (Dall'Alba & Barnacle, 2007); it is an act of becoming—the fundamental basis of what it means to be a person both independently and in community with other people (Carlisle, 2005). Becoming is a continuous act dependent upon personal and community desires and goals. The continual movement of becoming (Carlisle, 2005) occurs as one makes meaning from available information. As part of becoming, external knowledge progresses to the kind of knowledge that is tacit. Kierkegaard (1865) refers to this state of being, or becoming, as inwardness; a space where meaning is formed and formed again deeper still. Knowledge therefore is internalized in a place of solitude and privacy where meaning eludes any human power to articulate it. As Polanyi (1961) suggests, we know "far more than we can tell" (p. 467), and we cannot tell what we know since the meaning we have made is "unformalized knowledge" (p. 102).

Thus meaning begins with external, formal, technical knowledge and advances to inward knowledge gained from awareness of, and connections with our surroundings. Heidegger (2010) described this as "receptive spontaneity…that is an attentive and responsive way of dwelling in one's environment" at a particular moment in time (as cited in Dall'Alba & Barnacle, 2007, p. 685). Attentiveness to environment—to complex webs of happenings in time—moves knowledge toward intuitive actions sparked from a continual deepening process. This movement is inspired by self-reflection rather than obligatory, stagnant, superficial, formalized procedures, rules, and regulations such as the rewards and punishments customary in commonplace educational settings (Heidegger, 2010; Polanyi, 1966; Khon, 1993). Therefore, Barney (2014) suggests the use of meta-cognitive and self-reflective exercises to encourage inwardness and environmental attentiveness. These are intended to help students advance beyond formal processes and toward situational awareness of materials/curriculum, peers/colleagues, instructors/mentors and industry. This suggestion follows Dall'Alba and Barnacle's (2007) argument that there needs to be a "shift in focus from knowledge transfer or acquisition to ways of being" (p. 686).

Ways of being and the becoming they engender are permeated by the philosophical constructs of ontology (Dall'Alba & Barnacle, 2007). What we are, what we are becoming, and our way of being is our inwardness. The consequence of inwardness is a movement of meaning; a continuous evolution and deepening of understanding. This is to say the development of technical and tacit knowledge, and the movement toward greater intuitive activity involves both epistemological and ontological implications, but with less focus on teaching and more focus on learning (Dall'Alba & Barnacle, 2007).

Becoming, as an ontological construct, includes awareness of how one is being-in-time—in their relationships—and how one responds to what surrounds them (Heidegger, 2010). Becoming professional (Dall'Alba, 2009) is to heighten awareness of one's surroundings in the present learning environment or in other words, being swaddled in and aware of the complex web surrounding one is the act of becoming professional, becoming more, becoming a new person.

Complexity Theory and Course Design

In order to help students become professional, it may be necessary to rethink the course design process. A generic system design model commonly used in course design is comprised of five steps—Analyze, Design, Develop, Implement, and Evaluate (ADDIE). Because it is widely known, understood, and accepted, ADDIE has a large community of educational practitioners and a number of example course designs to draw upon.

It appears that when new educational practitioners are exposed to ADDIE, most, but not all, learn to apply it iteratively—to design and produce a course, try it, evaluate how it worked, and then loop back around to the analysis step. But is this really how teachers who are called good by their peers create the successful courses they teach? Bain (2004) argues that the best teachers adapt their courses to individual students during the class on any given day. Such teachers think on their feet and alter their course in response to immediate situations in the classroom. The linearity of ADDIE and how many new teachers learn to implement it implies ADDIE is not particularly helpful for the complex in-the-moment experiences Bain describes.

To address this gap Chun (2004) created the Agile Teaching/Learning Methodology. As part of his proposal he adapted the agile software development community's (Agilemanifesto.org, 2015) value statements to teaching, and affirmed agile learning processes, such as his, should value (a) students, teachers, and interactions between them over learning or teaching approaches, (b) doing over knowing, (c) learner-teacher communication, and (d) responding to learner needs instead of following schedules. Some of the three complexity theory principles of educational practice can be seen in Chun's work, but it leaves space for further exploration of how agile learning and course design processes could be expanded to more fully support the complex interaction webs found in classrooms and fully embrace complexity theory.

Our Research Design and Process

With an understanding of enframing, the principles of complexity theory, and AR, we decided to combine them with RAP to draw on their combined relatedness and enrichment of each other. The impact of using RAP in this way becomes visible in how we intended to accomplish RAP's phases.

Beebe (2001) describes distinct phases of the RAP research process. We applied these phases to our research and worded our descriptions of them as:

1. make any team, participant membership, or research tool adjustments;
2. collect data;
3. analyze data;
4. triangulate using team members perspectives and understandings;
5. member check;
6. repeat steps 1 - 5 if the team's understanding has changed significantly;
7. propose potential solutions.

We chose to use RAP recursively—a part of our process was the entirety of our process—in conjunction with complexity theory. We used it to find valuable insights for understanding and adapting complex educational systems that attempt to promote learning, growing, and becoming.

RAP, Complexity, and an Emergent Research Design

Each of our inquiry's RAP recursions included creating or modifying the inquiry's components. This approach meant the research topic, purpose, question, enframing (Ricca, 2008), and data collection tools and techniques emerged from our research system. As evidence of this, during phase 1 of our first RAP recursion, we uncovered Dall'Alba's (2009) concept of "becoming professional" (p. 38). Because of the emphasis on *becoming* found in the university's learning model (Brigham Young University-Idaho, 2013), and the desire to have the Computer Information Technology (CIT) 360 course, taught by one of us, help students prepare for industry, we thought an understanding of student *becoming professional* expressions as they experienced a complex learning environment would be useful. Assessment tools were created to see if students would reveal professionalism changes while taking the course. The first tool consisted of a pre and post-course questionnaire (See Appendix A). The intent of including this questionnaire was to measure the students' becoming.

Another data collection tool was an end of semester summative assessment in which the students were asked, in a generic fashion, to express what changes, if any, they had experienced over the semester. They were instructed to be deeply reflective in their work and were given a rubric (See Appendix B) that encouraged reflection, meta-cognition, originality, and creativity. When these summative assessments were analyzed, we were surprised to find that all 31 participants in the first RAP recursion discussed taking learning-risks in one form or another. It became obvious to us and to the students that the research purpose had to evolve. Instead of gaining an understanding of the students' "becoming professional" (Dall'Alba, 2009, p. 38) experiences we needed to gain an understanding their experiences with the professional attribute of taking learning-risks.

We also worked with these students to gain a better understanding of the applicability of our data collection tools. One result of this interaction was dropping the pre and post-course questionnaire from the inquiry. Students stated they felt the questionnaire did not help them understand their experiences as they continued on the path of becoming professional, the initial primary information sought. They also indicated it didn't contribute to their and our perceived initial research purpose nor the new one—investigating taking learning-risks.

As the result of continued emergence during two more RAP recursions, the research purpose, questions, enframing, and support materials for this inquiry no longer shifted to any significant degree. Recursive stabilization had created an inquiry that effectively focused on a group of students, their experiences taking learning-risks, and their reflections on their becoming professional. The focus was non-naïve and had a holistic perspective (Kampis, 1991); the entire research system, including the students, teacher, researchers, the course and other systems, was recognized as being complex. The emergent research questions and purpose were those described at the beginning of this article and the emergent enframing, data collection tools, and data analysis tools are described below.

The Emergent Enframing

As mentioned earlier, Ricca's (2008) definition of enframing is "to treat the subject of the research, the researcher, and the process of the research simultaneously" (p. 116). When examining this definition during phase 1 of our first RAP recursion we recognized the complex, simultaneous interactions inherent in Ricca's subject-researcher-research enframing would be ignored if enframing were not an early and continual part of our research. With a desire to improve the CIT 360 course (research subject), help the students (research subject), gain deeper understanding of ourselves (researchers), and increase the probability of our research producing productive insights (research) we realized a need to create an initial enframing that could evolve as part of the RAP recursions.

As a result of these desires and our understanding of enframing, we created a list of enframed systems that included those we thought might significantly affect or be significantly affected by the subject, the research process, or us. At our request, teachers of other CIT courses and other researchers contributed additional potential systems to the list. All of these were used to create our initial enframing list (See Appendix C). Creating this list surfaced our preconceived notions regarding the systems available for and applicable to our inquiry.

As part of our application of the RAP process, we recursively examined this enframing list. Each recursive examination included:

1. gathering input regarding the systems in the list and their potential impact on the research results;
2. evaluating if including the system would yield greater clarity in our results, and then retaining or rejecting the list item; and
3. evaluating if there were other items that may need to be added to the list.

From this recursive process the enframing for our inquiry emerged.

As part of our second RAP recursion, a phone call was made to B. Ricca. During the conversation the then current enframed system list for our research was discussed. As a result of Ricca's feedback we decided that though both universities would be impacted by and in turn impact our research, the influence of each on our research would be negligible so we removed them.

In the end, the emergent enframing included student participants, the design of the course, and the emergent class society jointly created by the students and the faculty as being among the open, complex, fuzzily bounded, enframed systems. Conversely, including the university, higher education, the professional practice of computing, and other systems did not appear to strengthen any implications for practice we might find if they were included. Therefore they were dropped from the list.

Figure 3. The emergent research enframing.

Figure 3 displays the systems included as the inquiry's final enframing. These are shown as extending beyond the research enframing since the boundaries perceived by us may not be the natural boundaries for the selected systems nor the research enframing. This is a reflection of Kampis' boundaries claim; "The units of our observation and the units that define natural boundaries for the systems may not coincide" (Kampis, 1991, p. 266). In other words, our perceptions of the system boundaries and what they actually were, may not have been the same.

The Emergent Data Collection and Analysis Tools and their Application

Nottingham (1998), discussing the educational environment encouraged within specific businesses, claimed employees, through self-reflection, "must have a meaningful understanding of themselves to maximize their individual effectiveness" (p. 72). In accordance with Nottingham, we chose to include summative student self-reflective artifacts as data collection tools along with student interviews, and reflective public postings made by students for the class.

As part of the research's first recursion the professionalism questionnaire was removed as mentioned earlier. After examining the public postings as part of the second RAP recursion, the students and we could see no additional, useful data that was not captured more fully and succinctly in the self-reflective artifacts, so we removed the public postings as a data source. As a result of the RAP recursions, the final data collection tools consisted of student-created self-reflective artifacts in written, audio, video, or other formats and student interviews.

As part of the third recursion, six students were purposefully selected to participate in the interviews. We felt selecting six interviewees was sufficient to cover those who did well and poorly in the course and to include male and female participants from differing ethnic backgrounds. The interviews had a loosely structured design (See Appendix D) that enabled the interviewees to express their lived-experience with taking learning-risks and the becoming they may have experienced through inwardness. Follow up interviews were performed with three of the six students as we discovered the need for answers to clarification questions. These interviews and the self-reflective artifacts were coded (See Appendix E) to provide a deeper and richer thematic understanding of the students' becoming.

Research Limitations and Delimitations

The majority of the participant pool did not plan on becoming software developers. Historically, only a minority of the students taking the CIT 360 course in any given semester view software development as a future career. However, the course used in this inquiry was a required course. Because of this, the level of student interest was outside the realm of research control.

Also, a non-commonplace (Ricca, 2012) course design can cause anxiety in some students. These students viewed the design of the class as being dramatically different from any other course they had experienced. This caused reactions in multiple students ranging from stress to panic. When asked why they were having this reaction, the stressed and panicked students indicated they were so used to being told what to do and when to do their course tasks that they couldn't conceive how to accomplish the course's outcomes in a different type of environment. The deep student-teacher interaction that emerged as a result of attempting to accomplish the task of calming the students and the strong teacher-student mentoring relationships developed, may have caused participants to express a more positive sentiment in their interviews and other pieces of research data than would be expected if a more distant relationship, a more alienated understanding (Gadamer, 2008), between the students and faculty had been possible.

Out of a total population of 89 students for the three RAP recursions, 75 students volunteered to participate, an 84% acceptance rate. Of these 75 participants, 54 were part of the first two RAP recursions. These volunteers gave feedback on the data sources to be used as part of the final recursion and whether they felt these data sources were valuable. The artifacts they created were also used to help hone the research enframing, questions, and purpose as described earlier.

Twenty-one volunteers participated in the final RAP recursion from which the data for this article, their self-reflective artifacts and the semi-structured interviews, were collected. Most of these 21 participants were junior or senior CIT students, though there was a scattering of CIT minors. They were also mostly United States citizens of Caucasian descent. Two were sub-Saharan Africans, one was Malagasy, and one participant was Asian-American. The median age of the participants in the final recursion was 25 and 71% were married. Each of the first two recursions had lower percentages of Caucasian volunteers. The difference was a series of Brazilian students participating in the first two recursions that were not found in the third.

Additionally, we have limited influence with the designers and instructors of other courses, both in and out of CIT. We felt this inquiry could not be conducted in courses over which design control was not maintained. Therefore it was not possible to perform a longitudinal study following the students to other courses where similar experiences could be evaluated but where the course type, for example an English course, and the instructor varied. This limited data collection to a single semester-based course.

Findings

CIT 360 is a required software development course at a large university in the northwestern United States. One of us, having come from industry, recognized a change to some existing courses could help students become more fully prepared for their careers. The design of the CIT 360 course used at that time was very commonplace. It used repetition and examination to drive home programming concepts. The design was not complex nor did it foster innovation as expected by industry (Aaen, 2008). It minimized agency and risk-taking by both students and teacher, yet agency and risk-taking are needed to be successful in the current entrepreneurial software development industry (James, 2013). A new complexity theory based course was needed to help students to develop inwardness and become professional.

The Emergence of a Complex Course

The design of the CIT 360 course at the beginning of our inquiry consisted of eight mini-projects defined and selected by the teacher to expose the students to a knowledge set. Except for the absence of exams and quizzes, the course used a commonplace software development course design with instructor-determined materials, activities, and schedule. The perspective of the teacher, one of us, was that the course was limiting the students, encouraged students with weak understandings to hide their lack of understanding behind their team's work, and was exhausting to teach due to continual push-back from students regarding course content, bad team dynamics, the mini-projects selected, and the schedule.

Having an understanding of complexity theory, the three educational complexity theory principles, and Dall'Alba's (2009) concepts regarding becoming professional, the teacher, one of us, began experimenting with enframing the course as part of our RAP process. During the third RAP recursion, a course design emerged that included among other items a series of standard course design components (outcomes, resources, activities, rubrics, and assessments) shown in Figure 4.

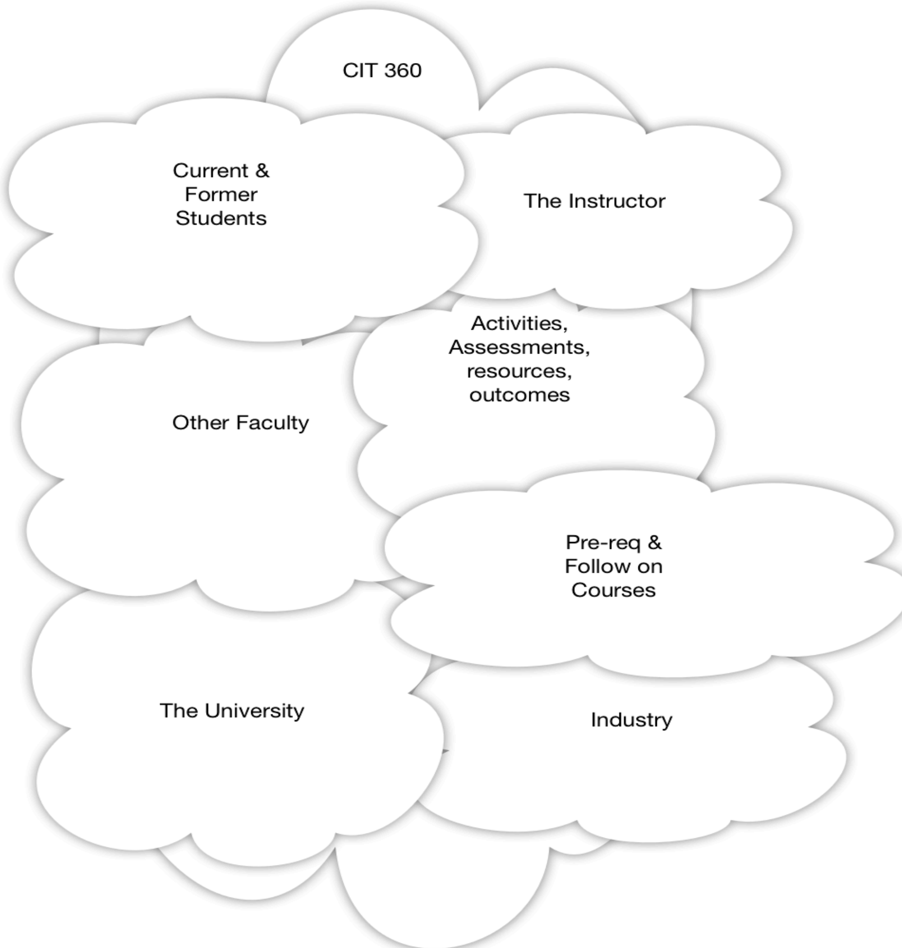

Figure 4. CIT 360 course enframing.

The learning resources supplied to the students were implemented as portions of a blog. This included a list of web page links, found by both students and the teacher, which were used as suggested starting points for other students' exploration of software development. These pages were chosen based on their alignment with a minimal list of topics suggested by industry experts, the teacher, and the students. A web link resource for a topic was deemed sufficient if it gave the student enough vocabulary to continue their individual exploration without being too complicated.

Additional resources included in the blog were a rubric for a summative self-reflective/meta-cognitive report (See Appendix B), due at the end of the semester, a series of outcomes expressed as potential becomings (See Appendix F), suggestions for success from previous students, and hints and tips on being successful in the class from the teacher.

Over the three RAP recursions the course design emerged and formative assessment became a major part of it and was done continually in and outside of class. From these formative student-teacher interactions, grew a qualitative understanding of the students' fluency, with fluency defined as the ability to professionally discuss, write, and creatively apply the topics. Interactions occurred repeatedly as the student explored and found new questions, new ways to apply the topic, and new topics to explore.

Lectures were dropped and the teacher's role became that of an active learning-team member and mentor. Common teacher tasks included (a) encouraging student exploration by answering questions, (b) aiding students in finding additional resources if they had already expended meaningful effort doing so, (c) advising teams and team members regarding team issues, (d) brain-storming with the students as peers, (e) regularly encouraging the students to give back to the discipline by aiding others and by creating technical blogs for public consumption, and (f) attempting to obtain, through observation and interaction, a defensible qualitative understanding of each student's technical fluency.

With student fluency being formatively assessed throughout the semester, it was not required that the timing and learning of topics be pre-defined. Rather, the students determined the timing of their learning as they engaged in small self-selected learning communities. This enabled the students, individually and/or collectively, to focus on, investigate, and learn any of the course's suggested topics in addition to others of their choice as they felt the need. It also allowed students to begin learning where they were, as adults who brought pre-existing experience to the course and their team rather than assuming some initial set of knowledge and skills gleaned from previous courses.

A summative assessment occurred only at the end of the semester. This consisted of the students producing self-reflective/meta-cognitive reports of their experience—those used as data for this research. During the semester the students were encouraged to keep of journal of self-reflective and meta-cognitive experiences, a type of formative self-assessment. This journal was not turned in and never viewed by the teacher or the other researchers. Instead, the students were encouraged to meet the requirements of a rubric (See Appendix B) and use their journal as source material for their report.

Participant Data Analysis

These summative assessments and the participant interviews provided a rich dataset to draw from. As a result of the in vivo and comment based coding of the dataset (See Appendix E), a series of themes emerged. These themes were:

- Taking learning-risks
- Journeying from discomfort to comfort
- Recognition of change
- A feeling of readiness for industry

These were applicable to three of our research questions regarding risk-taking, agency, student growth and expressions of readiness for industry.

Risk-Taking, Agency, and Transformations

While observing the CIT 360 course, with its complex interactions between the teacher, the students, their peers, and the emergent course, we found it interesting that even though there was no request for such information to be part of their self-reflective documents, students in all three RAP recursions overwhelmingly included descriptions of the learning-risks they took and what they learned from taking those risks. The students appeared to implicitly understand the risk-taking advice given by industry experts (Yoder, 2013; Rochester Institute of Technology, 2013; Hoffman, 2013; Kendall, 2013; News at Princeton Staff, 2010).

Through taking risks, most students experienced a journey from discomfort to comfort with agency and risk-taking; from statements of "where do I even start?" to confidently striding into areas unknown to them. One way students accomplished this was by coming to a realization that they needed to get out of their comfort zone in order to do and take risks. For some students, getting out of their comfort zone meant giving up full control of a team project in order to get a good grade. The participant Mary is representative of others. In teamwork in her previous classes she "would just go with the decision" made by her teammates. Yet in this course, she decided to "stop following the crowd" and be more vocal about decisions the team was making. From taking this learning-risk she realized "doing so helps the team members be on the same page." She also claimed "everything flows more smoothly" when she participated through rationally discussing solutions with her team.

In contrast to Mary's interpersonal comfort zone experiences, Jill vividly described engaging with the course as a source of discomfort. "In the beginning of this class I refused to be a part of it. Application development … just made me want to throw up…. [it] was so far from what I wanted to do as a career that I didn't see the benefit of the class." Eventually she opened herself to opportunities the course presented and through self-reflection came to value the software development skills she was able to acquire and the learning experiences the course enabled. Her perspective on how her professionalism changed, her becoming professional, is enlightening.

> If it weren't for this class I'd still be very dependent on others to teach me what they think I need to know…. Now I know how I can learn when it comes to my own life and my future career. I'm grateful I had the opportunity to take this class.

Jill's perception of her becoming through inwardness and her increased craftsmanship of learning shifted her attitude toward the entire class experience. In an unplanned and unrequested conversation Jill explained while she still didn't want to do software development as her career, she was no longer afraid of it, understood its importance, and could see how others could enjoy that career path.

Student Growth in the Complex Course

After experiencing the complex CIT 360 course, most students claimed to have grown in their understanding of the purpose of education, the meaning of learning, and how to learn in a more professional way. Joseph, representative of others, expressed these new understandings. As professionals "we need to get out of our comfort zone and learn something new so we can make ourselves more valuable. In this class I had to get out of my comfort zone and *learn* (emphasis added to reflect vocalization)." He went on to explain what he meant. He claimed by being responsible to his team instead of the teacher and for the pacing of his own learning as part of the CIT 360 course, he had been able to learn, remember, and see the value of more information than he had in any commonplace course he had taken. He wished "that all my classes had been taught this way." In those other classes he claimed he "had to memorize and regurgitate" and focus on the completion of the assignments, quizzes, and exams along with the requirement that he "march to their due dates." Shifting from a focus on "getting those done" to one of interaction, becoming, agency and risk-taking, he felt, was the reason for his increased learning and professional growth.

Expressions of Readiness for Industry

The industry leaders cited earlier expressed a desire for skills in risk-taking. Students taking risks means they will make mistakes. The CIT 360 course was designed to allow each student, in their own way, to make mistakes. These mistakes were welcomed and expected throughout the course. Mistakes participants made often involved personal communication, team interaction, and soft skills. Other common mistakes were as simple as writing a small piece of code that was syntactically incorrect. Sam faced this and must have felt it a transformative experience since it was a major subject in his summative self-reflective work. As part of his discussion of risk-taking he claimed,

> What I found the most helpful was to go out, read about something … and then make some test code, get frustrated when it didn't work, Google it and find the answer; fix it and watch it work. This was a simple but revolutionary way for me to think and learn—to be able [to] do this just for fun.

In experiences like Sam's and other soft and hard skill situations, students learned from making mistakes, gathering additional information, discovering why each mistake was a mistake, imagining potential solutions, and choosing and applying one or more of those solutions. Regardless of the apparent depth of the students' risk-taking and the severity of the mistakes made, the students described an increased feeling of professional preparation. Mary expressed this claiming, "I feel that now I'm more prepared to succeed in life." This feeling of increased preparation was true even for those who initially expressed a dislike for the courses' design.

As part of their journey, a large portion of the students described an increased understanding of the need to work in teams after they graduated. Yet at the beginning of the course they disliked—and one, Bob, said "hated"—working in teams. These students then went on to explain how they overcame distrusting their teammates, learned to value others' contributions, or how they developed a strong personal work ethic, and eventually become more other- c`1, rather than self-oriented. Bill wrote,

> Changes in myself that I can directly trace to this class…have, in my opinion, made me more professional….[I have] become a stronger learner and team member, who can appreciate a creative, original, and working solution—yet remain open-minded to recognize where it can improve.

In a classroom where complexity theory's three principles of educational practice are embraced, time for honest self-reflection is available that in commonplace course designs may be filled. Unfilled and unplanned time aided the students' understanding of their individual professional and personal weaknesses, faults, and strengths through interactions with others, the teacher, and the industry. These emergent understandings ranged from realizing that behaviors they thought were benign were actually harmful to enjoying software development, something they had not previously considered. Bill affirmed that midway through the course and during a period of self-reflection he was horrified to discover he was sexist. He found his attitudes repugnant and immediately set out, through inwardness, to become more than he was and rectify his problem before it could destroy him and his career—he was becoming professional.

Reflections

From teamwork to recognition of personal changes, as students reflected deeply, the course helped them build a bridge from their student types of understanding to "their full engagement in the workplace" (Cairns, 1995, p. 2). They crossed that bridge to places they never thought they needed to go; certainly nowhere they expected to go while learning software development. They transformed themselves and felt more prepared for their careers. Repeatedly students claimed the course saved them the greater embarrassment and professional risk of discovering profound weaknesses after they graduated.

Career Preparation in a Complex Course

While computer software development requires a high degree of technical rigor, the focus of this inquiry could be broadly described as examining software development students' self-perceived growth in the realm of tacit learning. While being loosely bound, the CIT 360 course provided sufficient structure to enable the learning of technical software development concepts. Yet, based on employer feedback and additional information seen below, it appears the course system was unstructured enough to encourage the absorption of tacit knowledge in order to achieve skillful performance (Polanyi, 1974). Concerns have been raised that in complex, multi-nodal learning community systems such as CIT 360, students may not have engaged with technical knowledge as deeply as they might in a more controlled, defined, bound, and teacher-centric course.

In reality, employers who recruit from this university consistently return and claim graduates who took this software development course were better prepared to work in rigorous software development environments than those who had experienced commonplace structured courses. A surprising amount of anecdotal evidence confirms these employers' claims. Over the course of the last two years we can see, based on former students current career advancements, that high degrees of rigorous technical information were learned.

After graduation several students who participated in the complexity-structured course spontaneously reconnected with the professor and expressed appreciation for the way the course has benefitted them in their newfound careers. For example, a recent undergraduate, now working for one of the worlds' largest international retailers, is on the forefront of the movement to revitalize their customer interaction and other business platforms. This graduate wrote in an email, "After only 18 months…I have been moved to the architecture team on my assigned project". Jumping from an undergraduate student to an engineer in only 18 months is unusual and requires strong technical knowledge and skill. It also requires strong risk-taking abilities.

Another graduate, now an employee of a Fortune 500 insurance and financial services company, as part of his email expressed initial dislike for the course structure when he was a student—"your class was one of my least favorite because it required a new way of thinking,"—yet found value in it after being promoted to a position that, as he wrote, "requires me to think more critically [about] problems and requires me to sort through processes I am not familiar with". In his email he wrote, "I recognize *now* what you were trying to teach…thank you!" (emphasis added).

Emails such as these suffer from self-selection bias, yet reports from other faculty peers as they visit former students and their employers indicate the same gratitude. When gathering feedback about changes needed at the degree level, peer faculty consistently report former students finding the CIT 360 course experience to be one of the most useful in the graduates' current jobs. Our discussions with and email from employed graduates often include statements suggesting the department and degree would be improved by implementing more courses with the same or similar designs. Suggestions for change from graduates typically include encouragements to reduce the already minimal amount of scaffolding included in the course.

As evidenced by the participants' comments and students' post-graduation communications, the complex nature of the CIT 360 course provided students with a format that aided them in their processes of becoming professional. It presented an environment that helped them become comfortable applying four constructs important to professional success: agency; taking learning-risks; making mistakes; and learning from those mistakes. Combining this comfort with a heightened understanding and use of self-reflection and self-driven change fostered substantive career preparation.

An Enhanced View of Course Design, Complexity, Agency, and Risk-taking

At the beginning of our inquiry we had an understanding of becoming, complexity theory, and agile development principles and processes. Further exploration of complexity theory led us to Ricca's (2012) three complexity theory critiques of commonplace educational experiences. We inverted these to produce a series of actionable principles for complex course design. These are: (1) pre-planned lessons should be questioned if not avoided; (2) non-commonplace content delivery methods must be employed; and (3) there must be continual interaction between the teacher, the students, and the discipline. Initially we tacitly applied our understanding of these three principles along with our understanding of becoming, complexity theory, and agile development to the design of the CIT 360 course.

Later, while reflecting on this tacit application of our understandings, and having gleaned principles of complexity theory from Kampis' (1991) work, we reviewed Chun's (2004) adaptation of the goals of agile software development, combined all of these with Dall'Alba's (2009) concept of becoming professional, and the work of Kierkegaard, Heidegger, Polanyi, and Khon, and used these to reflect on our experience in this inquiry. As a result we propose that course design processes would be improved if they were to embrace and apply the following set of complex course design principles where a Complex Learning System (CLS) is equated with a complex course system experience.

1. The highest priority of CLS design is to create learning systems where becoming happens in emergent ways. This becoming is the measure of design success.
2. The best learning designs, outcomes, and opportunities emerge from self-organizing teams of learners, teachers, and designers. The team continually reflects on how the system can be more effective, then tunes and adjusts the design accordingly.
3. CLS design promotes sustainable change. The team should be able to maintain a constant pace indefinitely.
4. CLS's promote in-the-moment adaptation to varying and changing needs, even during learning experiences, since these needs can be the result of unknown and unknowable inputs to the system.
5. CLS's emphasize, rather than minimize, in-the-moment system changes to the advantage of the learner.
6. CLS designs promote delivery of learning opportunities in non-commonplace ways adapted to the learner's needs.
7. The learners, teachers, and designers that are part of the CLS work together continuously to find emergent course system designs.
8. Those who experience a CLS can have a deeper understanding of it because they were present. Any description of a CLS created for an outside observer is

incomplete. Discrepancies between a CLS and its description will be made manifest by experiences of those who are part of the CLS.

9. Determining the quantity of a CLS's complexity is impossible. The complexity of a course is unquantifiable yet relative course complexity is observable.

Having shifted these nine principles from the tacit sphere of our experiences, we did the same thing for the course design process we had used. As we did, a CLS design framework we call Enframing As Design (EAD) emerged. EAD is an expansion of Ricca's concept of enframing. It moves enframing beyond the realm of research. Our definition of EAD is to work with courses' interconnected components, (subjects, learners, teachers, designers, outcomes, activities, interactions, materials, assessments, and others) continually and simultaneously while realizing unknown forces, external to the enframed systems, can affect learning results. EAD also shifts the designer and teacher's focus from the preparation of lesson plans, a typical type of artifact produced by applying ADDIE, to helping the students achieve well-described and measurable outcomes in-the-moment. This is not meant to imply that all outcomes are quantitatively measurable—those for the CIT 360 course were assessed qualitatively.

EAD's simultaneity of work is another point of divergence from the defined, mostly linearly applied steps and classical reference frames that are part of ADDIE and other non-complex course design processes. While ADDIE would have us complete materials and other components of a course's design before applying them, EAD states we must have initial versions of these and other components but they will continually evolve as the course is being taught.

EAD views a course's components, including the teacher and designer, as part of a complex system and loci of emergence, adaptation, and evolution. In EAD, changes in one system component, be it a teacher, learner, activity, or assessment, may trigger needed in-the-moment changes in other course components or spawn the emergence of new components. For example, an activity may need to be changed as a learner comprehends and uses a part of the activity. Or a new activity may need to be created as a learner exposes a perspective on the subject not as of yet considered by the teacher, designer, or other learners. Using EAD allows the course's design to emerge from the interactions that are part of all CLS's.

Being CLS components, the teachers' and designers' roles in EAD are to continually consider, evaluate, and adapt the course components, including themselves, to meet the learners' immediate needs. Descriptions of the adapted components can be recorded for later use. These, or the un-adapted versions, can then be introduced to other learners in the same or other classes as loci for further emergence, adaptation, and evolution.

By embracing these EAD teacher and designer roles, and enframing both the learner and the teacher, EAD enhances the teachers' and designers' opportunities for becoming professional (Dall'Alba, 2009) and inwardness (Kierkegaard, 1853). Teachers and designers of courses usually begin with a depth of understanding and a breadth of professional experience beyond those of the learners, yet in EAD designed courses teachers and designers are also learners. As part of their emergent professional becoming, they can be energized by the opportunity to gain new information, see new perspectives, and experience new understandings as they and other learners share discoveries. Because of the sharing of experiences, and the emergent rather than static course design, experiences of EAD designed courses are sustainable—by focusing on current, not assumed, needs, teachers, learners, and designers apply themselves to changes producing impact and minimize time and effort applied to non-impactful work. This helps all those involved emerge anew through growth as part of their becoming professional process. Figure 5 shows a generic enframing diagram that could be used as a brainstorming starting point for applying EAD.

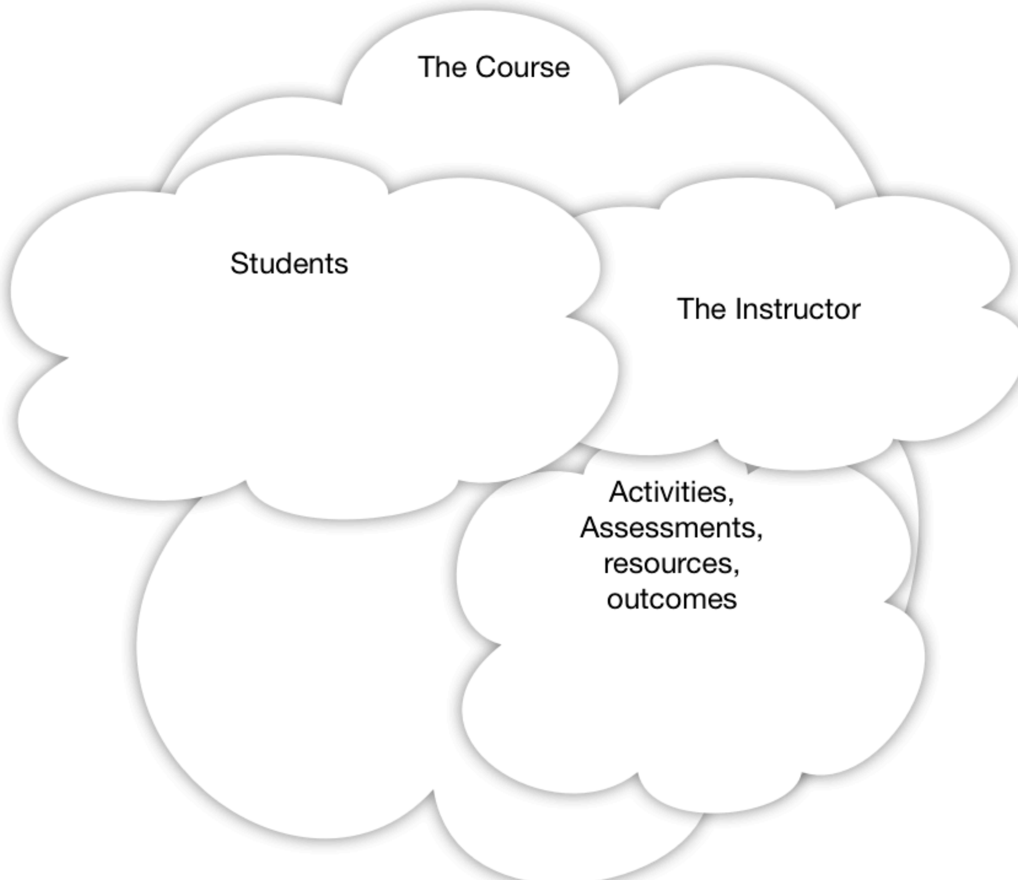

Figure 5. Generic course enframing.

Applying EAD

Having a tacit understanding of the nine complexity theory principles of course design and as of yet having not formalized EAD, the teacher, one of us, throughout the three RAP recursions continually enframed the course and applied the nine principles. Through self-reflection, meta-cognition, and interaction we, the research team, gradually gained an increased understanding of the nine principles. Eventually they and EAD were formalized. This occurred as part of our reflection on the research experience and in conjunction with the continued application of the principles since the course is still emerging and being taught by one of us.

By using EAD, the CIT 360 course's design came to exemplify the nine principles found above. A listing of manifestations regarding how the course met each principle is illustrative. Each principle is listed by number and a short explanation of how the principle was manifested is described.

Principle 1. Based on the research data cited above, the students' becoming was encouraged and aided by their experience in the course.

Principle 2. Student teams and individuals in conjunction with the teacher and industry outsiders iteratively and recursively modified the course outcomes, timings and types of assessments, the programming and design topics suggested to be learned, and the course materials.

Principle 3. The complex course design enabled the students to learn the technical information required with a reduction in the number of students dropping the course prior to completion. We consider this reduction an indicator of increased learning sustainability. The teacher found the course structure to be invigorating because of increased cooperation with the students rather than attempting to get them to conform.

Principle 4. Students were observed adapting the course in-the-moment to meet their needs. The students would often divide the technical topics, plan out who would learn and be responsible to teach each topic and when the teaching would occur and update the plan as the semester progressed. The instructor was not involved in these decisions but did provide mentoring type suggestions in-the-moment in response to student needs.

Principle 5. As students explored and experimented with the technical topics they began asking pointed questions such as "I have been exploring [some topic] and am struggling with [a specific point of understanding]." This allowed the instructor to tailor learning discussions to the students' immediate needs rather than provide pre-planned topic discussions.

Principle 6. Continual design checks were performed both in and out of class. These included discussions with students regarding what was and wasn't working well and ideas for change. These ideas were explored and experimented with as a team. One example of this has led to including students' expressions of their class experiences as helps for students in future classes. This was student driven and has come to include textual and video resources.

Principle 7. During the semesters the course has been taught, the course description and support materials were and are updated to meet the needs of the students and the experiences of the teacher.

Principle 8. As the instructor discussed the CIT 360 course with other faculty members it became apparent that their understanding, while correct, was less rich than that of the students and the teacher. To rectify this, the other faculty members were invited to participate in the class.

Principle 9. This course appears to be more complex than it was originally and more complex than similar courses taught in other colleges and departments.

These manifestations of EAD's nine principles imply EAD can be used to create other CLS's as well. We suggest CLS's must be designed using EAD or some other complex course design process. CLS's can differ markedly from courses developed using non-complex processes. In CLS's teachers are freed to concentrate their time and efforts on developing a connected rather than alienated understanding (Gadamer, 2008) of the students' tacit and technical learning. They are also freed to help the students on their journey of becoming professionals (Dall'Alba, 2009). A concordant shift of the students' experiences also occurs. The students move from consuming a series of pre-planned lessons to an involvement in supportive, in-the-moment adaptations of the course to the student's needs and existing understandings. This is not meant to imply that the course should be unbounded. If it were, it would cease to be complex. The teacher's experience, connected understandings, and the adaptations of the course are accomplished through continual interaction within the complex, multi-nodal social web that is a CLS and are used to appropriately establish the loose boundaries of the course.

Designing for Risk-taking and Choice

Multi-nodal social interaction webs allow students to see the impact on themselves and others of risks they take. Yet in order for students to take learning-risks, they must feel they are not permanently penalized when they or others make mistakes. For this reason, course designers and practitioners using agency and allowing students to take learning-risks in their courses should not assess failure. Instead, mistakes should be viewed as positive, a part of the growth process. To not assess failure and allow individual students' mistakes to drive their learning, student assessment should be continuous in nature, "recurring at short intervals" and "regarded as never coming to an end" (Vaill, 1996, p.5). This is not meant to imply that courses should be designed to equalize outcomes.

With assessment being continuous and formative, each assessment event can disregard any old assessment data. Students are then free to take additional risks, make more mistakes, learn from their mistakes, and continue to change. Continuous assessment aided the students experiencing the CIT 360 course to gain, improve, and exhibit the hard and soft skills heavily sought by industry. Experiencing this environment before graduation helped the students make major progress on their journey of becoming professionals.

Potential Futures

Complex Learning Systems continuously emerge as long as complex course design processes such as Enframing As Design are applied. This means a CLS's design is never complete. Its continued emergence is a movement into infinite unknown and unpredictable potential futures as long as the course is taught. What will a course become? What becomings will the teacher and students experience? No one knows.

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Dr. Lee S. Barney is a faculty member of the Computer Information Technology Department. His current research interests include; the application of complexity theory to course design, the roles of agency, risk-taking, and becoming in learning, and computer algorithm optimizations applicable to encryption and computer security.

Dr. Bryan D. Maughan serves as the Director of the Professional Practices Doctoral program at the University of Idaho. He serves as a member of the Dissertation in Practice (DiP) committee for the national Carnegie Project for the Education Doctorate (CPED). His current research interests include organizational analysis; translational and practitioner research methods; the role of tacit, tribal, and technical knowledge among leadership.

Appendix A: Professionalism Pre and Post- Questionnaire

1. Give a concrete example of a situation that shows what you think is central to the work of an IT professional.

2. Give a concrete example of a situation in an IT professional's day that can be difficult to deal with.

3. What attributes, attitudes, and life perspectives do IT professionals have?

Appendix B: Self-Reflective Journal Report Rubric

The work exhibits evidence of imagination
The work exhibits evidence of originality
The work exhibits evidence of openness to new ideas
The work exhibits evidence of the ability to rationally evaluate options and explain why options are selected.
The work exhibits evidence of student self reflection/meta-cognition.
The work exhibits evidence of the ability to communicate well.

Appendix C: The systems included in the initial enframing diagram

- Each student in the CIT 360 course
- Each student that will take the CIT 360 course in the future
- The design of the CIT 360 course
- Lee Barney (researcher)
- Bryan Maughan (researcher)
- An external RAP team member
- The Java and Android professional development communities
- Future employers and coworkers of the students taking the CIT 360 course
- BYU-Idaho College of Business and Communications
- BYU-Idaho Department of Computer Information Technology
- University of Idaho College of Education
- University of Idaho Department of Leadership and Counseling
- Administration and administrators at both universities
- BYU-Idaho students who have not taken the course
- BYU-Idaho students that have previously taken the course
- BYU-Idaho courses the students will take after completing CIT 360
- Relatives, friends and other associates of the students taking the course
- The society developed among the students taking the course
- The qualitative educational research community
- The complexity theory educational research community

Appendix D: Interview Protocol and Questions

The interviews were loosely bound. This meant as participants answered questions the direction of the interview could change and the interview questions could shift in directions the interviewee and the interviewer found enlightening, important, and more revealing of the participant's lived experience. With this in mind, the initial, planned interview questions were perceived as loosely binding us to a general area of interest.

The main interview question we used was "In what ways, if any, do you feel you have changed regarding your ability to accept and handle risk taking from the

beginning to the end of the course?" Sub-questions included:
Personal acquaintance

Personally get acquainted with participant (family, personal interests, etc. if appropriate)

Course specific questions

- What has it been like for you to be a member of this course?
- In what ways would you say this course affected how you view risk taking, your approach to your current or future career, and learning?
- During this course, what, if anything, would you say surprised you the most?
- How has your participation in this course affected the way you might work in other classes? (or perhaps in "your future profession")
- In what ways would you say this course has affected how you view your ability to learn? (can you provide an example?)
- Has this affected how you view others, such as your peers, as fellow learners? if yes…"In what kinds of ways?"

Concluding Script: Thank you again for taking your time to answer these questions. This will help me in my professional efforts to teach college students. Do you have any questions for me?

Appendix E: Data Coding Process

With a dataset consisting of 6 hour long interviews, a series of follow up interviews, and 75 self-reflective artifacts, many of which were several pages long, we deemed it wise to write an application that could help us manage the data. This new application allowed us to do the initial in-vivo coding by highlighting one or more words. Each highlighted word set became a code. The application counted the codes for us and displayed them in an organized way. When comments were added to the data the application tracked them as well. They were added by the application to the list of in-vivo codes.

The application aided us in building understanding of the data by enabling the instant display in one view of all the occurrences of any selected code or comment withal of its contexts. The context of each occurrence consisted of the 50 words before and the 50 words after the code or comment. This rapid access to all instances greatly reduced the organizational and access time required for such a large dataset compared to paper based methods.

With a list of codes and comments easily available and having gained an understanding by viewing their contexts, we placed each code or comment on a small piece of sticky paper and stuck them on a wall. Our external RAP team member and one of us then grouped and regrouped the papers until, through discussion, stable groupings with which we felt comfortable were found and information rich names were generated for them. These names provided the themes from which we could easily draw original data due to recording which codes and comments were associated with which theme. These themes were then presented to the other of us as a triangulation check, additional discussion was done, and groupings changed as needed.

Appendix F: The outcomes for the CIT 360 course

By taking advantage of opportunities this course provides, you may become more professional by:

- becoming fluent in the concepts found in a list of Java topics and designing, testing, and creating an Android client and a Java server,
- becoming more aware of the entirety of the software development process in addition to the development component,
- becoming a learner that embodies the BYU-Idaho learning model. This includes, but is not limited to individual preparation, teaching others, and pondering,
- becoming more open to ideas of others,
- becoming more self-reliant in your learning,
- becoming more productive and empathetical in team environments,
- becoming more productive and appropriate in your communication with team members, managers, and mentors,
- becoming more aware of the impact of your decisions on team members and others,
- becoming more aware of your own thought processes, attitudes, and biases through self-reflection and meta-cognition,
- becoming more analytical in making and defending decisions, and becoming more creative through exploring and applying the concepts found in the list of Java topics associated with this course in interesting ways.