# When Conflict Helps Learning

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## Abstract

We describe techniques, implemented in a junior software engineering course, for creating an environment of safety and for regulating the amount of conflict so that students can learn how to use conflict to benefit their learning and the project instead of being overwhelmed or discouraged by it.

Inter-personal and intra-personal conflicts are inevitable in our lives and in the workforce, so learning to deal effectively with conflict is essential to becoming an effective engineer. One way to do this starts with realizing that conflict, such as perceptions of problems in other people, internal uncertainty, and dissonance between one's desires and abilities, can be valuable. Conflict motivates learning because people do not like to repeat frustrating, embarrassing, or painful experiences. Conflict inspires innovation by illuminating areas of misunderstanding, invalid assumptions, personality or value differences that, when explored, can result in greater value to everyone involved.

To maximize learning, it is important to balance conflict with safety. Too much or the wrong type of conflict can be detrimental to learning. The techniques we used, some of them borrowed from professional leadership training programs, had a deep and positive impact on the students, as revealed by their weekly reflective essays and by individual communication with them during and after the course. Students, perhaps subconsciously, created conflicts that enabled them to learn lessons they needed to learn.

One aspect of safety is how to limit the damage of mistakes while encouraging learning from mistakes. To that end, we chose not to have a real-world customer whose dependence on the project success would have increased the damage from a potential project failure. Our focus was on the learning – in the true spirit of academia – in order to prepare students for successful engineering careers.

## 1. Introduction

That view that conflict can help learning and be a source of innovation is not a new concept [Crum 1987, Fischer 2002], but it does appear to be an uncommon and thus largely unadopted view in academia. This paper discusses how conflict helps learning and provides a simple model for strategies to create a course around this thesis and for strategies to regulate the level of conflict in the course. We support our assertions with examples from a junior-level undergraduate software-engineering course taught at the University of Washington in 2002.

By conflict, we mean the inner feeling when, informally speaking, a person is not getting what she wants. This is closest to Merriam-Webster's definition 2a and 2b:

1: Fight, battle, war
2a: Competitive or opposing action of incompatibles: antagonistic state or action (as of divergent ideas, interests, or persons)
2b: Mental struggle resulting from incompatible or opposing needs, drives, wishes, or external or internal demands
3: The opposition of persons or forces that gives rise to the dramatic action in a drama or fiction

Our thesis is that this type of conflict is an important part of how learning occurs. Conflict urges changes in behavior and thus helps us learn by making it too uncomfortable to not change old (behavioral) patterns.

Conflict, in the sense of definition 2b above, is about a person's perception of the distance between their wishes and abilities. This includes the person's perception of how much control they have over achieving their desires: the less control, the higher the perceived cost. The greater the cost, the more effort is required to get

what they want, and thus the more intense conflict feels. Only when the cost of not changing is high enough will investing the effort and time to effect a change be worthwhile.

While "conflict" is a term loaded with negative connotations in our society, and some colleagues suggested using other terms such as "challenge" or "disequilibrium," we prefer to use "conflict" because that is how students *feel* when they are in the midst of it. However, it is a valuable tactic to change their assessment of a situation from "conflict" to "challenge" or "disequilibrium." This reduces their stress level, which promotes learning. It transforms conflict into a learning opportunity. Once students realize that (temporary) chaos and internal conflict are necessary parts of learning, they become more comfortable being in those states and sometimes even welcome them. One of the course's goals was to have students make this transition more quickly.

This paper describes a model for designing a course that uses this interpretation of conflict. We also describe the strategies we used to promote student learning, including strategies to reduce stress associated with conflict. Student writings and conversations during the course and their feedback four months after the course indicate that while their conflict levels were sometimes high, many of the students valued the experience and appear to have changed certain aspects of their behavior due to the course. Of the students that gave us feedback four months after the course, most have adopted several of the suggested techniques to deal with working in teams.

Section 2 provides theoretical background for the role of conflict in learning. We describe the course design and our teaching goals in Section 3. Section 4 outlines models for classifying the strategies for a course that explicitly addresses the conflict inherent in experiential learning. Sections 5 through 7 briefly describe the strategies used in this course. Section 8 provides examples of how conflict influenced learning in our course. We conclude in Section 9.

## 2. The Role of Conflict in Learning

While conflict can be harmful, it *is* part of our daily lives. It also is an important part of how people learn [Weinberg 1985, Finkel 2000, Crum 1987]. Internal conflict indicates areas for learning and innovation by causing discomfort that, if severe enough, makes it worthwhile to try different ways of acting in the world. Changing behavior and not reverting to the old ways takes substantial effort and commitment, so there is good reason to not invest the effort to change unless the need is sufficiently high.

Once the insufficiency of the student's current models causes enough internal conflict to motivate change, the student starts actively (even if subconsciously) looking for new models to try. Such new cognitive models may come from peers or instructors, or the student may construct them as he[1] struggles with the limitations of his existing models. Looking back over our lives, many of the most significant learning experiences we have had were ones that we constructed, usually in the course of some internal struggle. These were the "Aha!" moments where a new model suddenly clicked into our existing set of stories about how the world worked.

This process of *constructing*, not receiving, knowledge is the essence of the Piaget model of learning [Finkel 2000] underlying experiential learning models [Weinberg 1985, Tener 2001]. Through external pressure the learner is provoked to examine his cognitive models. This foreign element, as it is referred to in the Satir Change model [Weinberg 1997], causes the student to enter a period of chaos. During this period of disequilibrium the student struggles to find a model that explains the world of apparent chaos. He may try to assimilate the situation into an existing model. He may throw out his existing models and adopt new ones. Alternatively, he may move back and forth between these two extremes and in the end *construct* new knowledge, new mental models, that work for him. For this reason, this is sometimes called the *constructivist* theory of learning [Kahn 1999].

The key to all of this is to get the student to the point where he *wants* to learn. Homework, quizzes, exams, projects, deadlines are some standard mechanisms to try to engage students. All of these serve to increase the level of (internal) conflict for students. They impose constraints that require the adoption of new models and skills in order for the student to complete the work successfully. We claim that by recognizing and using the role of conflict in learning, instructors can enhance student learning.

This is not to say that all conflict is conducive to learning. If the level of stress is too high, as in a battle, it may hinder or even stop learning [Jensen 1998]. If, however, the level of stress or disequilibrium is too low, there would be no reason to learn, since existing models may work well enough.

[1] In order to keep students in our class anonymous, from this point on we will refer to individual students as "he."

One problem with this view of conflict is that many students and instructors view conflict as negative *only*. As Fischer [Fischer 2002, Table 2] states, the traditional western culture views a breakdown as an "error to be avoided." He argues that for us to be more effective we need to migrate to a culture where people are actively engaged in design. Such designer cultures view a breakdown as an "opportunity for innovation and learning." One of the goals of this course was for students to see this possibility.

To maximize the chance of students viewing breakdowns as opportunities for design and learning, students should be able to discuss areas of conflict among themselves and with the instructors. This can be helped by (a) creating an environment where they feel safe enough to do this, (b) directing their attention to this issue, (c) welcoming discussions about conflict, and (d) providing them with tools to identify and resolve conflict.

In the next sections we describe how we structured a software engineering course to facilitate learning in the face of the types of conflict typical of team projects.

## 3. The Course

This section provides a more detailed discussion of individual techniques we used in our 9-week course in software engineering at the junior undergraduate level. There were 22 students – two graduate students and the rest were computer science undergraduates. Nine women and thirteen men.

One of our main goals for this course was to teach students the value of the "soft skills" that are extremely important for doing projects successfully. Most undergraduate computer science students have little appreciation or understanding of these soft skills, perhaps because they have not needed them to be successful in academia.

As we discuss in our paper on teaching reflective practices [Socha 2003], in order to teach students an appreciation of these skills, we designed this course around an experiential learning model [Weinberg 1985] with all students working on a single project. The need to collaborate in a large team forced them to deal with the team and project coordination issues commonly experienced in industrial projects. We, the instructors, largely acted as facilitators and taught with our mouths shut [Finkel 2000]. Students were in charge of running the entire project and had a lot of freedom. We wanted them to be challenged enough by the team and project issues that they would realize the need for these "soft skills."

Following this learning model, we designed the class to stimulate certain types of conflict in areas that we wanted the students to explore and learn from. This is not to say that we introduced stress or conflict: that is a dangerous technique requiring superb skills at early conflict identification and resolution. Instead, we created a complex adaptive system [Highsmith 2000] with the expectation that certain types of conflict would emerge, such as people being angry at others for not pulling their own weight.

## 4. Classification of the Course Strategies

A common model of reflection classifies it into three phases: reflection for-action (before action), reflection in-action (during action), and reflection on-action (after action) [Jolly 2000]. Similarly, the strategies we used to design and run this course with sufficient, yet not too much, conflict to enable learning may be categorized as strategies for-learning (prepare before), strategies in-learning (act during), or strategies on-learning (learn after) (Fig. 1). The for-learning strategies helped to create an environment with enough conflict for effective learning. The in-learning strategies helped to reduce the stress level during the course if it became too high. The on-learning strategies helped to bring a sense of closure and tie up any loose emotional ends at the end of the course.

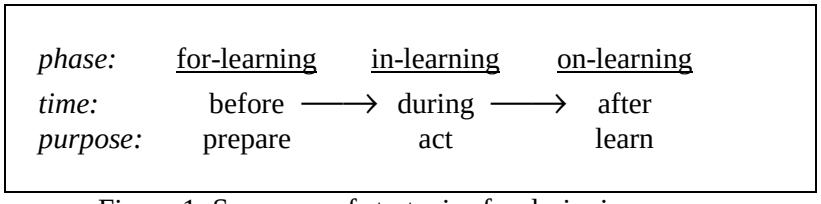


Figure 1: Sequence of strategies for designing a course around the use of conflict to promote learning

The in-learning strategies may also be categorized with a similar set of three phases: for-dealing-with-stress (before), in-dealing-with-stress (during), and on-dealing-with-stress (after) (Fig. 2). The for-dealing-with-stress strategies helped to avoid unnecessary stress before internal and inter-personal conflict arose. The in-dealing-

with-stress strategies helped to reduce stress as conflict was building. The on-dealing-with-stress strategies helped to notice and reduce stress after the event(s) causing the conflict had happened.

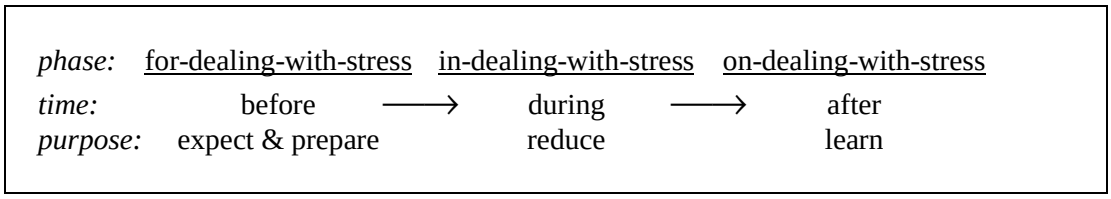


Figure 2: Sequence of strategies for dealing with stress resulting from the conflicts students experience during the in-learning phase of the course

The complete list of strategies we used and their position in these models as implemented in the class appears in the Appendix. In the next sections, we look at each of these strategies in more detail.

## 5. For-learning Strategies

In order to create an effective experiential learning situation that would provide enough challenge to the students, yet fit within an academic context, we designed the course around several for-learning strategies:

1. *Project based, a single large team*. To require students to deal with the team and project coordination issues that could be missed in smaller teams, the course was designed to be project-based where *all* 22 students worked in a *single* team for the duration of the quarter.
2. *Resembling real life*. To maximize the practicality of student learning, the project was done in an environment as close to industry as possible within the constraints of an academic 5-credit course. The main exceptions were that student learning was emphasized as more important than project success and there was no real customer[2]. The students faced challenges similar to those they could experience in industry jobs.
3. *Experiential learning; Teaching with our mouths shut; Large amount of student freedom*. To maximize student learning, instructors focused on being facilitators within an experiential learning environment. In the first class session, the instructors led a discussion with questions from *Teaching With Your Mouth Shut* [Finkel 2000, p. 6] whereby the students used their own experiences to derive the experiential learning model. There were only a couple of traditional-style lectures. Instructors provided some project requirements[3], choices, observations, facilitation, and minor guidance. After an outside marketing person presented the customer requirements for the product, the students had a lot of freedom and responsibility for running and managing the entire project.
   In order to provide sufficient time for experiential workshops, we had three 2-hour class sessions per week (instead of the standard 1-hour session format). Both a classroom and a computer lab were reserved so that we could either do work around chairs, tables, and whiteboards or work on computers.
4. *Experiential simulations*. To challenge students to reflect and give them reflective guidance, we invited several outside experts from industry to facilitate 2-hour-long experiential simulations. Example topics included “What do you do when you don’t know what to do?” [Schmaltz 2002] and “Exploring Tradeoffs: Quality versus Speed” [Smith 2002].
5. *Emergent behavior & Complex adaptive system*. To allow students to regulate their own level of stress and find their own places for learning we created a complex adaptive system where behavior and conflict could emerge. Complex behavior emerges from simple rules and rich relationships [Highsmith 2000]. A complex adaptive system is “an ensemble of independent agents, who exist at multiple levels of organization, who anticipate the future, and who form groups that occupy diverse niches” [Highsmith 2000, p. 34]. Very similar to a team or company environment. The advantage of a complex adaptive

[2] We would think carefully before having a *real* customer for such a course because this would increase the cost of failure, which in turn may prevent the students from taking risks and trying something new. Academia is *not* the real world, and it may be best to use that to our advantage by doing things that are not easily done in the real world, such as encouraging students to focus on learning *even if it may lead to project failure*.

[3] We restricted the set of tools so that (a) students would not spend too much time in that choice, and (b) we could provide them with an industrial level set of development tools.

system is that "innovation, creativity, and emergent results are born in the transition zone at the edge of chaos" [Highsmith 2000, p. 37].

We created a complex adaptive system by specifying a few simple rules and then letting students act as they choose to. Containing rules bounded student and instructor behavior (e.g., 2-hour class sessions; respect others; instructors intervene if stress is too high). Aiming rules oriented students toward goals (e.g., grading emphasized learning over project success). Diverging rules gave students freedom to choose (e.g., to decide how to lead and run the project and then do so). This allowed behavior, conflict, and learning to emerge.

6. *Emphasis on learning*. To promote learning, we emphasized that it was our paramount goal and set up the grading rules to reinforce this. We also repeated this, the model of learning from mistakes, and other such strategies throughout the quarter.
7. *Expert practitioners*. To ground our assessments of the importance of soft skills in industry, we had eight class sessions where expert practitioners led experiential simulations or told reflective stories of their work. These guests often introduced other models of interpreting the world (e.g., the Satir Change Model [Weinberg 1997]), and that testing *is* science). One of the students also organized a tour of Microsoft where a panel of program managers and developers gave short presentations and answered questions from the students.
8. *Need-for over how-to*. To fit within the constraints of a 9-week course, we were more concerned with teaching need-for than how-to knowledge. The need-for is about appreciating that there is a need for some type of action, while the how-to is about how specifically to perform that action effectively.
9. *Challenge students*. To provide students with different views of what was happening, we gave assessments of the students' individual work and the project status. This included questioning their design decisions in class, as well as weekly assessments of the project status in the second half of the course. At times this caused conflict in the recipients, but the advice was always delivered with as much respect and integrity as possible. We, the instructors, taught by example, both giving and receiving such assessments between each other.
10. *Public presentations*. To force students to objectively evaluate their product and put those assessments in the perspective of what brings value to the customer, we required them to give two verbal presentations to the entire class. One was a presentation by each team on their part of the software architecture. The second was a final presentation to the surrogate customer on the day when they handed over the complete product including an installation disk as well as written technical and user documentation.
11. *Openness of reflective essays*. To promote student learning from the reflections of peer students, the weekly reflective essays were submitted to a publicly visible web site. One student mentioned reading some of these, but our perception is that most students were too busy elsewhere and did not read them. For the next version of this class, we plan to ask students if they did so on the end-of-course evaluation and questionnaire.
12. *Peer evaluations*. To promote learning from their peers' assessments, on the last day of class we had each student anonymously evaluate each of the other students. The instructors then consolidated the results and sent each student his results, including any comments written by other students. Although this is valuable feedback, it could cause discomfort if a student's perception of his own value differs significantly from the perceptions of others.

## 6. In-learning Strategies

In order to keep the stress at a level appropriate for learning, we used a number of in-learning strategies. These strategies are classified into for-, in-, and on-dealing-with-stress.

### 6.1. For-dealing-with-stress Strategies

We used several for-dealing-with-stress strategies to prepare the students to avoid unnecessary stress due to the conflicts that might occur:

1. *Safety conversation*. To put the students' attention on the need for safety in a team, and to help create a supportive team environment, the first conversation each team had after forming was a safety exercise[4]. Each team spent 30 minutes answering the following two questions – "What must happen in order for you to feel safe in your team?" and "What must *not* happen in order for you to feel safe in your team?" – and discussed these with the entire class. Feeling safe reduces stress, so creating a safe team environment is important for avoiding unnecessary stress.
2. *Team conversations*. To provide the students with the necessary tools to be members of an effective team, we gave them a list of ten conversations that lead to effective teams [Dunham 2001]. Example conversations include committing to creating a team that is safe for its members, and committing to choose a leader and to abide by that leader's decisions. The teams had these two conversations in class. The rest we left for them to do, or not do, as they choose.
3. *Being on a path to mastery*. To make students aware of the need for persistent practice in order to learn and excel in any aspect of life, the first reflective essays in the course were on the book *Mastery* [Leonard 1991], a reflective book in itself. The students were asked to write about how this book related to the course topic (software engineering) and to themselves.
4. *Learning cycle; Teaching With Your Mouth Shut test*. To prepare students for accepting the conflict that is part of learning, we spent the first class session on a set of questions from *Teaching With Your Mouth Shut* [Finkel 2000] to *construct* the learning cycle that is at the heart of experiential learning. This was also their introduction to our style of teaching with our mouths shut, for we provoked the students to construct this model themselves in response to questions from us. David remembers standing in front of the class after asking these questions, waiting for the students to speak up, and wondering how many days it would take for them to realize it was up to them to act.

### 6.2. In-dealing-with-stress Strategies

The class design included several in-dealing-with-stress strategies to reduce the stress that students created as they dealt with their conflicts:

1. *Teaching by example.* In order to be congruent and to emphasize the importance of our claims, we taught by example as much as possible. During the journal writing periods[5] David wrote in his expensive leather-bound journal, visibly demonstrating the value he attributed to his own journaling and perhaps making it easier for students to do something that might have looked silly. The instructors intentionally spoke when they thought the other instructor had said something wrong, or left out something important, and accepted the criticisms with grace, demonstrating that disagreeing was acceptable and showing techniques for doing so. When one student repeatedly acted in a manner that was unacceptable to teammates and others, David "fired" him from his leadership role, demonstrating that certain behaviors are not tolerated and can lead to drastic action.
2. *Instructor as on-request facilitator*. In order to help students resolve their inner or inter-personal conflicts, the instructors offered to talk to students and facilitate between students as needed, and repeated this offer several times during the course. Sometimes students became emotional about some of the conflicts they encountered, especially inter-personal conflicts, so the instructors had to take care to facilitate well.
3. *Instructor as observer + un-requested intervention*. In order to reduce the stress level in the class, we, instructors, sometimes intervened (but rarely unilaterally so) if we judged the stress level to be too high for effective learning. This was a last resort strategy for us, since it removed the opportunity for students to learn how to deal with such situations. More frequently, we would offer our observations (but not suggestions) as fodder for student learning and action.
4. *Openness of reflective essays.* In order to provide an opportunity for students to realize that others are having similar problems, and perhaps to make them not feel so stressed about themselves, the weekly reflective essays students wrote [Socha 2003] were placed on a web site visible to all. Of course, their stress level might go up if another student posted something against them, but this never happened.

[4] See Norm Kerth's *Create Safety* exercise [Kerth 2001, p. 108] for another example of a safety exercise.
[5] The first and last 5 minutes of each class session

5. *Challenge students (see Section 5).* In order to provide students with different views of what might be possible, we sometimes challenged their assessments of what was possible with respect to resolving conflict. For instance, on several occasions when students were angry at other students, we suggested that choosing the most favorable interpretation of why another student did something might bring one closer to the true intentions of that other student.

### 6.3. On-dealing-with-stress Strategies

To notice and understand conflict after the events causing the conflict were largely over we used the following on-dealing-with-stress strategies:

1. *Reflective practices*. To maximize student learning, we embedded this project within a system of many individual and team reflective practices, such as journaling [Socha 2003]. Reflective practices helped students notice, resolve, and learn from conflict.
2. *Instructor as observer*. To help notice patterns, it is useful to have an observer outside the team (outside the system) who provides feedback to the team. The instructors and guest facilitators helped fill this role by pointing out things that students may not have noticed or were likely to miss. One of the guest speakers, for instance, realized after observing one class that the most valuable thing for him to teach the students was the need to always ask, "What value am I providing to the customer?"
3. *Retrospectives*. To help the students try many ways of identifying and resolving team and project issues, we held retrospective exercises for 30 minutes every other week, and for a full 2-hour session in mid-quarter and again at the end of the quarter. Many of these were taken from [Kerth 2001]. These exercises allowed students to both hear other students offering different interpretations of what happened, and get a sense for the amount they had accomplished. Of course, retrospectives can also uncover issues that students had not been, or did not want to be, aware of.

## 7. On-learning Strategies

In order to create a sense of closure and new understanding at the end of what turned out to be a fairly grueling course, we used several on-learning strategies:

1. *Customer presentation*. In order to focus the students on the "whole product," not just the coding, they were required to give a customer presentation to our surrogate customer in the last week of the class. They presented the final product (CD-ROM, User Manual, and Technical Manual) and gave a PowerPoint-based presentation on the product's features, demoed the product, and finally presented a list of features that could be added in future versions of the product along with their respective cost estimates.

   Many of the students were surprised when we suggested that exaggerating a product's capabilities might be a bad business strategy. They thought that they had to make the project appear more successful than it was.
2. *Personality types*. In order to help students understand some of the inter-personal conflict due to the course, in the second-to-last session we had them take an online Myers-Briggs personality test and then discussed the results in class. Understanding that other people *really do think differently* can make it much easier to respect them. What might have earlier looked like malicious intent on another student's part might now be reinterpreted as good intent based upon a different story around the same events.
3. *Appreciation*. In order to leave with a sense of accomplishment and appreciation for the other students, even if it was because they caused challenge, we did the Appreciations exercise [Kerth 2001] in the last session. This exercise takes the form of saying, "Joe, I appreciate you for …" while looking at the person being addressed. Using exactly this form creates a powerful sense of being appreciated. Having to find something appreciative for each person helps focus people on the many good things that happened. First, we demonstrated this by saying an appropriate such phrase to each student. Then we had members of each sub-team do the same among themselves.

## 8. Did Conflict Appear to Help Learning?

We used several mechanisms to assess student learning. We read their weekly reflective essays. We observed them in action on the project. We talked to them personally when we found that they were struggling with a situation. We read their final exam essays where they wrote about what they would do the same or differently.

We analyzed an anonymous take-home questionnaire, filled in before the last day of class, where students rated the value they got from each of 64 aspects of the course. Each item was rated "from –2 (negative value to you) to 0 (neutral value to you) to +2 (high value to you)." Finally, four months after the class ended we asked the students several questions about what they would change or keep in the course, what they valued in the course, how the times when people were uncomfortable effected their experience, and which of the practices they have continued to use. See [Socha 2003] for a report on reflective practices that the students valued and continued to use after the class.

Determining whether conflict actually helped students learn (and if so, how much) is somewhat difficult. Results of end-of-the-quarter evaluations may be biased toward what students enjoyed and not what helped them learn. Still, we did get some relevant indication from their post-class feedback.

### 8.1. Examples of Conflict Helping Learning

This section lists some notable examples of conflict helping learning, observed in our course.

1. Working in a team of 22 students created a lot of conflict for people. The students had never needed to coordinate much with others, and many initially did not believe in the need for it. As they demonstrated in their actions and in their reflective writings, for many of them this was a difficult lesson to learn. By week five, this lesson was sinking in. "I learned from the class last week ... the importance of communication and coordination." "I realized this week that I cannot single handedly make this project succeed." "I can't control everything even though I think I can" These students continued to struggle with these issues of the limits of their individual power.

   The need for team coordination exploded in week six, when we, instructors, noticed that the project was in chaos. All the students were focused on the coding. The Lead Team was not spending much time coordinating. Teams were acting largely on their own and fighting with each other over who should change their side of the vaguely worded software interfaces. Some students were trying to control other students. It had become a sea of us-versus-them.

   This was one of the rare times we intervened, but the chaos level was too high. We sent an email giving our assessment of the dangerous state of the project, and listing 15 areas of concern. We scheduled that Friday's session for each team, including the Lead Team, to present the design of their component and to get feedback from the rest of the class. Each team would have 20 minutes, and the presentations were to include diagrams and the "key design decisions, assumptions, customers, business rules, etc."

   That Friday session was a turning point. It became clear to everyone that the team was in chaos, as many of them noted in their weekly reflective writings. One student wrote: "What I learned this week could better be called a realization of what I've been learning about for the whole quarter. On Friday, each group presented its status, and it became clear that we were off-track ... now I have a better understanding that all that 'rhetoric' we've been hearing throughout the class about communication, project management, etc., is real and dangerous to neglect." Another student wrote that "the learning I had this week was tremendous: the importance of a team orientation, and not a group v. group stance of what's mine and what's yours; that communication may not work even if both parties are trying hard to do so, but are doing so in different ways; that no matter where the project is going, its welfare, though I take responsibility for it, should not engender emotional attachment - I realize that it is destructive to the moral and above mentioned 'team orientation.'" And a third said, "Before last week, I didn't realize how much preparation and effort the team leads needed in order to steer 20 other people to productively and effectively work on a project."

   What had been there but not spoken, was now out in the open. This enabled students to take charge, which is precisely what they did. After that class session, the Lead Team gathered to discuss what to do. The result was an email to the entire class acknowledging the problems and outlining a plan to "quickly pull together and recover from a project that has gone off track." They created a spreadsheet to list the remaining tasks for each team and collect estimated and actual effort for each task. They scheduled a set of meetings that weekend for the teams to fill in this spreadsheet. What resulted was a goal for having two use cases working by Monday morning. All with *no* involvement by the instructors. From that point on, the project pulled together. In the next two weeks they created a product with tested features, an installer, and documentation. As one student wrote, "Realizing that the project was getting off track was a major milestone. It was not until we came into terms with it that we started considering ways to control and reduce the level of

confusion. We are currently taking action and using the lessons learned during this chaotic period to better organize our work and ourselves."

2. An extremely common theme was the importance of communication, dealing with teams and teammates, and managing teams. "Last week I learned that dealing with people is just as important a part of work as coding... In order to deal with people you need to be able to communicate effectively." "Friday I was reminded (yet again) of the difficulties of trying to get a number of bright and motivated people to agree on a plan for attacking a complex and difficult matter. I learned first hand the need for a leader." This was the dominant theme in the final exams. The importance of team and project coordination appears to have been one of the big eye openers for many of the students.
3. Another situation in which some students felt uncomfortable but appeared to learn from was when they were singled out to answer a question posed by a guest facilitator and did not have a good answer. The expert gave a short session on how important it is for software engineers to create value. He then asked several individuals what value they brought to the project. At least one student noted how uncomfortable he was when he was pointed at and "miserably failed to answer the question." Many students reflected on this question, even though only a few were actually asked the question. Perhaps they had a moment of discomfort wondering if *they* would be called next and not have a good answer.
4. A common frustration among students was finding limits to their power as individual contributors. Several of them wrote things like "I can't control everything even though I think I can."
5. Several students commented on how journaling helped them resolve conflicts. One student said he first saw the value of journaling when in the process of writing about a problem his sibling was having the issues became so clear that he copied sections of that writing almost verbatim to send to his sibling. He says he now writes about anything that is bothering him.

Overall, the students expressed much appreciation for this course despite the discomfort it had caused them. Example comments are:

- "Working on the class project was a lot more challenging than I had anticipated. It was not so much the programming part but more so the coordination and management aspect of the project. I have realized that without the proper management even the most qualified team of developers would be subjected to unavoidable failure. Therefore in the future I will be more willing to follow a leader and I will have a less individualistic approach. In fact, I will make sure that I am working in a team with a clearly established leader and goals."
- "I learned it is even more important to have a "good communication" after miscommunication takes place."
- "My experience in [the course] helped me when I worked in a group and probably made it easier to work in a team (because now I know that you most likely run into a problem)."
- "It's been an intense and worthwhile experience, but it would have been nice if I hadn't had to go through the pain of being yelled at."

## 9. Conclusion

Conflict is an interpretation of our feelings, and a fairly limiting one. Viewing a situation as conflict tends to cause us to look for solutions in the domain of zero-sum games. We seek ways to fortify our positions, to attack their defenses, and to win the fight. Perhaps this is due to the battle metaphor that is the first definition of conflict. The result usually is to become more rigid and focused on a limited space of winning over someone or something, rather than on finding a solution.

A more generative interpretation of conflict is "challenge." Challenge tends to open our solution space to include win-win solutions. It also implies that the solution may involve changing *us*, rather than changing *them*. Given that we have very little power to change other people, starting with ourselves is a lot more realistic. It allows us to learn and innovate in situations that need precisely that.

Using this interpretation allows students to more readily accept the conflict inherent in the learning process and use it as a sign that a learning opportunity has arrived.

Designing a course with appropriate strategies for creating, regulating, and learning from these types of conflict provides an opportunity for valuable learning, as demonstrated by the post-course feedback of our students.

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## Appendix. Classification of Conflict-Related Strategies

Table 1 below shows the complete list of conflict-related strategies we used and their position in the respective for-, in-, and on- models as described in this paper.

Note that some techniques can change places or appear in multiple categories. Several colleagues and students, for instance, recommended moving 'Personality Types' to the on-dealing-with-stress category so that the students would have this tool available during the course. The choice of where to place a strategy is likely to change how that strategy is implemented and the impact that it has on student learning.

Table 1: The conflict-related strategies used in our course, classified according to their role for learning or for dealing with stress

| Technique | Brief Description | Purpose |
|---|---|---|
| **For-learning Strategies** | | |
| Project-based, a single large team | • All 22 students worked together on a single project | • Force students to experience the need for team and project coordination |
| Resembling real life | • We created a project that was as close to industry as possible within the constraints of academia | • Provide students with challenges similar to industry |
| Experiential simulations | • Create challenging exercises with expert facilitators guiding resolution of the conflict that emerges | • Demonstrate how to use conflict to learn |
| Teaching with our mouths shut | • We created an environment for experiential learning, used facilitation, and avoided lecturing | • Instructors will not make decisions for students<br>• Students expected to do things they do not know how to do<br>• Allow appropriate conflicts and lessons to emerge for each student |
| Emergent behavior & Complex adaptive system | • A team of people working together is a complex adaptive system where behavior emerges due to the independent action of the people | • Conflict and learning opportunities emerge without the instructor's intervention |
| Emphasize learning | • We repeatedly stated that we were most interested in learning<br>• Reflections were a major part of the grade | • Foster culture of lifelong learning<br>• Make it acceptable to fail … *if* this triggers learning |
| Expert practitioners | • Expert practitioners from industry told stories of what worked and did not work for them | • May contradict students' beliefs<br>• Helps students see that their problems are common |
| Need-for over how-to | • We aimed to create an appreciation for certain skills, even if we could not teach those in their entirety | • May frustrate students trying to do what they do not know how to do |
| Challenging students | • We provided honest assessments of students' and project performance, including challenging their own assessments | • "Expert" feedback may contradict students' beliefs<br>• Produce enough stress to create an opportunity for learning and force new models |
| Public presentations | • Teams presented their component architecture<br>• Final official customer presentation | • Force students to look at the big picture<br>• Force enough stress for learning<br>• Final presentation provides a sense of accomplishment |

| Technique | Brief Description | Purpose |
|---|---|---|
| Openness of reflective essays | • Student essays stored digitally in a public domain site<br>• Strictly confidential essays were accepted too by exception and not stored there | • Promote sharing of ideas and experiences<br>• Enable learning from peers<br>• Promote understanding that others too face problems and that is okay |
| Peer evaluations | • Each student anonymously evaluated his peers | • Could unsettle students if peer evaluations do not match their own self-assessment |
| **In-learning Strategies** | | |
| **For-dealing-with-stress Strategies** | | |
| Safety exercise | • What must happen for you to feel safe?<br>• What must not happen for you to feel safe? | • Put attention on the need for safety<br>• Start the process of building safety |
| Team conversations | • 10 types of conversations that effective teams have regularly | • Provide tools for running teams<br>• Build trust in team to allow for conflict resolution |
| Being on the path to mastery | • Students read the *Mastery* book and wrote about it | • Proficiency takes years of practice<br>• Be ready to learn from experiences and conflicts<br>• Instill the culture of continual learning |
| Learning cycle | • Do; reflect; introduce new models; do again | • Prepare to continually learn from experiences and conflicts<br>• Do not expect clear-cut recipes! |
| *Teaching With Your Mouth Shut* test[6] | • What were your most significant learning experiences in life?<br>• Was an instructor directly involved? | • Get students to reflect<br>• Learning is achieved by doing<br>• Learn from "mistakes"<br>• Instructor's role is to facilitate |
| **In-dealing-with-stress Strategies** | | |
| Teaching by example | • We showed respect for students and each other<br>• We demonstrated that it was okay to disagree | • Encourage students to model these behaviors |
| Instructor as on-request facilitator | • We invited students to talk about their problems, in private, with us as facilitators | • Create an environment of safety<br>• Demonstrate ways to resolve conflicts<br>• Resolve conflicts |
| Instructor as observer | • We offered to facilitate students in addressing their inner or inter-personal conflicts | • Provide help when students are stuck |
| Openness of reflective writings | • (see above) | • Other students may have different views of the same situation |
| Challenging students | • (see above) | • (see above) |
| **On-dealing-with-stress Strategies** | | |
| Journaling | • Writing in journals for the first and last five minutes of each class session | • Helps students notice conflict<br>• Helps students understand conflict<br>• Helps students construct ways to avoid the same conflict in the future |

[6] A set of questions drawn from Teaching With Your Mouth Shut [Finkel 2000]

| Technique | Brief Description | Purpose |
|---|---|---|
| Reflective essays | • Weekly 1-page reflective essays<br>• A take-home Final Exam | • (same as journaling)<br>• Can read other people's reflections |
| Instructor as observer | • Instructors pointed out things that students may have missed | • Notice conflict or introduce alternative models<br>• Adjust level of conflict to benefit learning |
| Retrospectives | • Group reflective exercises | • See different people's views of the same situation<br>• Place to acknowledge the good and the bad |
| **On-learning Strategies** | | |
| Customer presentation | • Presented final "product" to customer | • Be honest with the customer<br>• Gave sense of accomplishment, which reduced stress |
| Personality type test | • All took the Myers-Briggs personality test and discussed its results | • Expect people to be different<br>• Promote respect for differences |
| Appreciations | • We directed brief statements of appreciation to each student during the last session<br>• Students did the same among themselves in teams | • Promote civility and starts the process of reconciliation and healing of wounds from past conflicts<br>• Reinforce the value of approaching people positively and teaches the value of treasuring them even over disagreements<br>• Remind that disagreements are rarely to be taken personally |
| Peer evaluations | • We conducted a 20-minute anonymous peer evaluation on the last day of class<br>• Results were announced shortly after | • Students see themselves through the eyes of their colleagues and reflect upon disparities with their own perception of themselves |