

Cross-Cohort Development in ISAT

By Morgan C. Benton, July 2017

What is Intentional Cross-Cohort Development?

Every year a new group of students joins the ISAT major. Although there will be transfers, and some people switching into the major, the members of this group remains relatively stable. These students take courses together, work on team projects together, work together on capstones, and will graduate together. They form close relationships that will last for their entire lifetime. There is no doubt that the members of one's cohort play an enormous role in learning and achievement. Individuals within the cohort develop reputations for being extraordinarily talented in one subject or another. Some become known for being fantastic report writers, or the moral anchor to a team project. Less positively, if someone is a less-than-reliable team member, the word gets around. Regardless of one's role or reputation, the cohort is a tremendously important element of the ISAT experience.

While it's clear that each cohort develops a strong group identity, the bonds between cohorts are less strong. Students at different stages of the program have fewer classes together and are focused on different things. There aren't as many opportunities for students to get to know each other and learn to rely upon each other across cohorts. Currently, there are very few points throughout the ISAT program where faculty have sought intentionally to strengthen the ties between cohorts. As a result, ISAT has failed to take advantage of some significant, systemic opportunities to make the program more efficient and more effective.

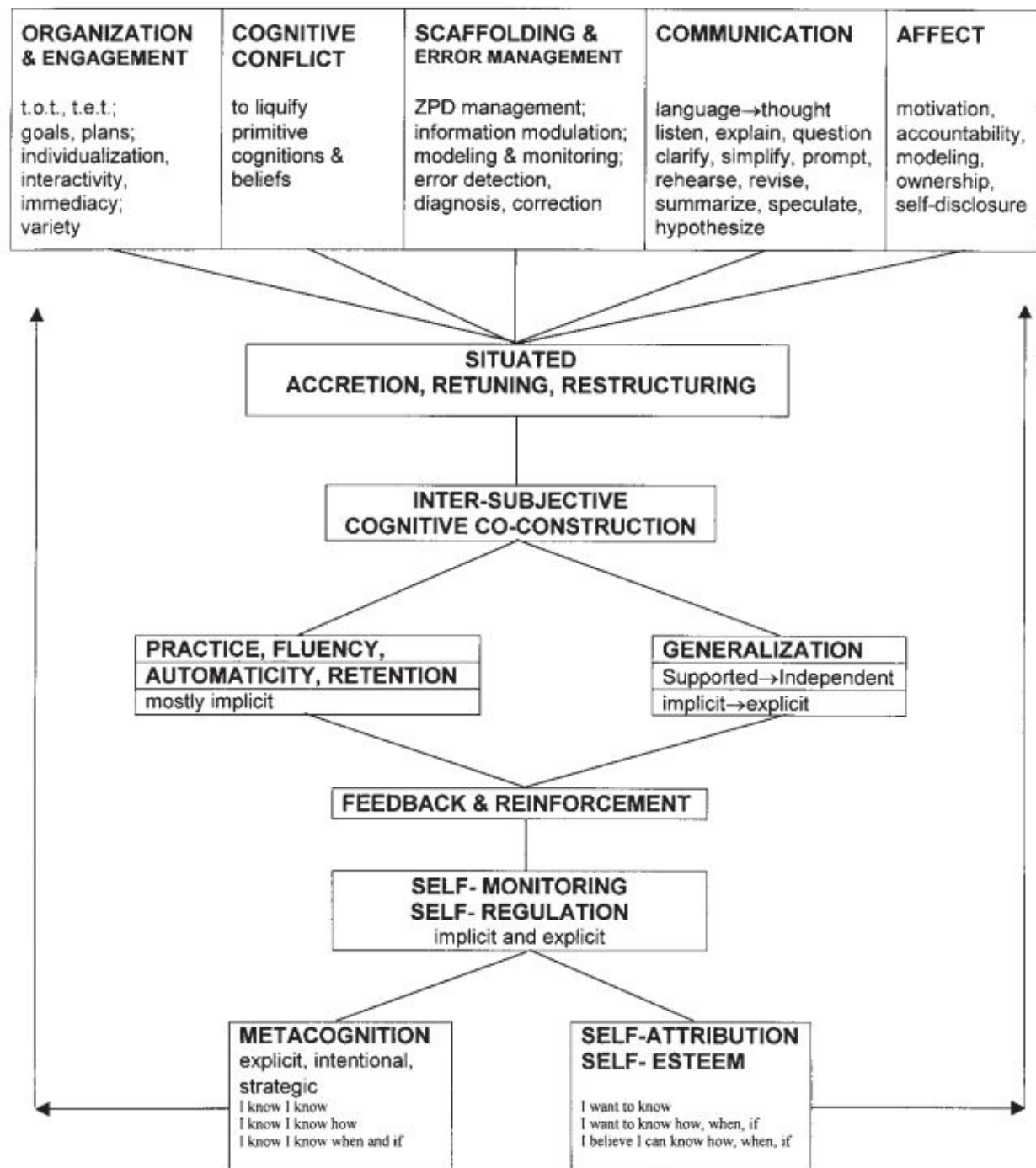
Intentional cross-cohort development (ICCD) means creating a systematic, well-defined set of fixtures within the ISAT major to foster strong relationships between students in different cohorts. The rest of this whitepaper will explain the potential benefits, theoretical underpinnings, and challenges entailed in fostering ICCD in ISAT.

History and Theory of Peer Learning

Peer teaching has a **very** long history. While peer teaching has probably existed for as long as there have been formal settings for teaching and learning, one of the first written accounts of a successful, intentional implementation of peer teaching was in 1798, according to Goldschmid's (1976) review of the literature. While periodically, there are newer reviews of the literature (see Topping, 1996 and Topping 2005), the theoretical underpinnings and empirical evidence for the effectiveness of peer teaching have only emerged in the last fifteen years (see Topping & Ehly, 2001 and Leung, 2015). The empirical findings support the intuitions of hundreds of years of practitioners--peer teaching is an effective, low-cost way to improve learning.

Topping and Ehly (2001) created perhaps the first integrative framework for the benefits of implementing peer teaching:

Groups of Processes Influencing Effectiveness:



In iterative cycles: Surface → Strategic → Deep Declarative → Procedural → Conditional

Figure 1: Framework for Peer Teaching from Topping and Ehly (2001)

According to this framework, there are five groups of processes that benefit from peer teaching:

- **Organization and Engagement:** refers to the increased time-on-task and immediacy/individuation of feedback that comes from small group or 1-on-1 tutoring
- **Cognitive Conflict:** constructivist learning theory (Vygotskian) posits that learning happens in the wake of cognitive dissonance, which can be catalyzed with peer teaching
- **Error Management:** with a peer teacher, learners are likely to spot more errors, to spot them more quickly, and to recover from them more quickly
- **Communication:** both tutor and learner are forced to practice communicating complex ideas to one another which in turn forces resolution of cognitive conflicts
- **Affect:** peer teaching can increase motivation and can encourage learners to see themselves as future teachers, i.e. giving back to the community that supported them

A key contribution of Topping and Ehly (2001) was to identify thirteen dimensions of variability that would allow researchers to examine exactly under what conditions peer teaching might be effective. These dimensions have been explored in hundreds of empirical studies. Leung (2015) synthesizes the findings of the empirical literature in a meta-analysis that covers seventy-two such studies. Rather than examining all thirteen of the dimensions from Topping and Ehly's framework, we'll focus on the key dimensions that are relevant to ISAT and which have empirical support according to Leung's analysis.

Before going on to look at the individual dimensions, it is worth taking a moment to give a general overview of Leung's (2015) findings. The 72 studies examined were culled from over 15,000 in the original search space. Notably **ALL** of the studies reported a positive effect of peer teaching on learning, even when publication bias (i.e. resulting from the tendency for researchers only to publish their work successfully when it shows a positive result) is taken into account, and regardless of whether the measure of learning was a standardized test, or one devised by the researcher. Of the 72 studies about ten of them focus specifically on higher education; most of them focus on elementary or secondary school. The effect sizes discussed in these papers primarily concern cognitive gains--there is much less literature on other benefits of peer teaching, such as socialization, motivation, and self-esteem.

Key Dimensions of Peer Teaching

If ISAT were to implement a program-wide effort to create systematic opportunities for students to teach and learn from each other, here are the key factors we would want to pay attention to, according to the literature.

Structure, Training, and Socialization

Effect sizes for structured implementation of peer teaching tend to be larger than for unstructured implementations. In other words, if we were to throw students together randomly,

cross our fingers, and hope that learning gains would magically appear, that is not likely to happen. Rather, it is important that we provide at least minimal training to would-be tutors, and manage the expectations of all students involved, so that people don't go in with unrealistic beliefs about what might come of tutoring. In addition, another way that ISAT could provide structure is to set aside physical space specifically dedicated to student interaction for the purpose of studying.

Tutor training should cover, at least four elements: explicit goal-setting, guidance on what kinds of things to look for in their tutees, how to provide effective feedback, and guidelines for maintaining positive interaction with tutees. When students meet each other for the purpose of tutoring, they should have a specific and well-defined plans for what topics they will cover in their session. Rather than meeting to "go over programming," they should specify that the session will explicitly cover a specific topic, e.g. how to implement for-loops in JavaScript. Tutors should be trained to look for misconceptions, i.e. inaccurate/ineffective beliefs about the world, and present their tutees with information that will cause a cognitive dissonance. Tutees should follow the "USA" feedback model, i.e. provide feedback that is:

- **Understandable** to the tutee,
- **Specifically** addresses a flaw in reasoning or execution, and
- is **Actionable**, i.e. has a concrete avenue towards improvement.

Finally, tutors should be trained to monitor the frustration level of tutees, to provide positive reinforcement when it will be helpful, to believe in the capability of all tutees, and to offer encouragement. Conversely, tutees should never be shamed or made to feel stupid. Both tutors and tutees should get some training that will help them recognize when there is an incompatibility between the two people, and how to part on good terms.

An open question for ISAT is how we should approach the role of gender in peer teaching situations. The research clearly indicates that effect sizes are **much** smaller for male-female dyads than for same-sex dyads ($d=0.41$ vs. $d=0.80$) and attributes it to the interference of gender role stereotyping. That being said, recommending to students that they only seek tutoring from a same-sex peer feels like we are perhaps shirking our responsibility to teach our students to recognize and combat gender-bias in themselves and others. Particularly given the fact that males are over-represented in ISAT, and that we would like to reach gender parity in the program, we should discuss and come up with an explicit way to approach this subject.

All ISAT students should be socialized to expect that they will seek and provide tutoring from and to their peers on a regular basis. (As one of my mentors used to say, "There is nothing very 'high' about higher education if it doesn't give something back to the community from which it was taken.") We should build a culture that includes frequent, intentional interaction between students at different levels designed to be mutually supportive. This is preferable to making it a requirement and paying students--either with credit or money--to be good citizens.

In summary, we should have a large room dedicated to academic interactions between peers. All of our students should receive explicit training on how to make the most of these interactions. We should work hard to make this mutually-supportive ethic a defining feature of the ISAT culture.

Matching

Another key element of successful peer teaching is deciding who helps whom? The greatest effect sizes are derived from one-on-one tutoring, but small groups can be effective too if they are able to stay on task. With dyads, the gender of the participants deserves consideration (see above). However, perhaps the most significant predictor of the effects of peer teaching may be the ability levels of the participants.

Perhaps counterintuitively, the greatest learning gains occur when the tutor is of “low” or “average” ability level. This runs against our tendency to believe that our highest performing students will make the best tutors or teaching assistants. There are a couple of reasons for this phenomenon. One is that tutoring is more cognitively challenging for low or medium ability students, and so they are most motivated by the challenge and also make the greatest learning gains as a result of tutoring. Conversely, high ability students may be bored by the act of tutoring and not feel challenged or like they have anything to gain from the experience. Research indicates that while tutees may make smaller gains when tutored by peers with “low” or “average” ability, the overall learning gains, i.e. the total of the tutor+tutee, are more significant in this situation.

The important thing to learn here is that nobody should be counted “out” as either a tutor or tutee. Even a student who didn’t do all that well as a calculus student can be a very effective calculus tutor, and stands to gain a lot more in reinforcing their knowledge as a result of tutoring. It’s key to realize that **everyone** has something valuable to contribute. A piece of go-to advice for everyone in ISAT is that if you don’t feel confident about your ability in some area, seek out the opportunity to teach it to someone.

In ISAT, we may want to identify pairs, or even sequences of courses that lend themselves well to having their students matched. For example, since calculus is an integral part (no pun intended!) of thermofluid science, it would make sense if thermo students devoted some time during the semester to work with calculus students just beginning the program. As a result, we could greatly reduce the degree to which students go directly to a professor for help, and at the same time magnify the amount of help being received by our students.

Other Things to Avoid or Consider

The research has identified a number of factors that may or may not be important to the effectiveness of tutoring. Tutoring tends to be **more** effective when sessions are limited to one or two a week. More than two sessions a week for a particular tutor/tutee pair yielded smaller

learning gains. If tutors spend too much time tutoring, they receive increasingly diminishing returns on the investment of their time and energy, and also risk burnout. Students should perhaps be cautioned about tutoring too much. Furthermore, marathon study sessions prove to be less effective than shorter ones on the order of 45 minutes or less. One or two 45 minute sessions a week appears to be the right formula for success. Knowing that might make the whole enterprise seem like a much more manageable commitment to students.

Another finding of the research is that it is important to avoid competition. Teams or dyads of students engaged in tutoring should not be forced to compete. There are a number of ways that competition increases anxiety and stress in negative ways, and failing to “win” any sort of competition can be demotivating. Likewise it should be noted that rewards should be avoided, whether they are tangible or something like points or extra credit. The “reward” should be the learning itself, and the feeling of accomplishment. If students are only participating in tutoring to earn points in a class, they will be less motivated to be helpful, and the tutoring will be less effective. As such, as we work to create a culture of supportiveness, it’s important that we not try to bribe our students in to participation.

Summary of Key Dimensions

In summary, if we decide to implement some sort of peer teaching system within ISAT, we’ll want to make sure that we pay attention to a number of key dimensions. It needs to have an explicit structure, and students need some minimal training before participating. We should avoid forcing students to participate, and instead work hard to make it a feature of the program’s culture that students naturally devote a significant amount of time tutoring their peers. Everyone needs to know that their contribution is valuable--to themselves as well as to others. It’s not a competition, and everyone can benefit in significant ways.

Non-Cognitive Impacts

While more effective teaching of content is generally the primary goal of peer teaching, ICCD has broader goals that expand to include social and affective dimensions. While it is important for faculty members to convey the importance and significance of the ISAT content to students, it is frequently much more effective if that expression comes from peers. For example, there’s a big difference between an instructor telling students in a calculus class that it is an important foundation for understanding the more advanced concepts in the major, and having an upper-class peer talk about how important understanding calculus has become in the thermofluid science class that they’re now taking. More experienced students can be very effective at passing on wisdom about the best sequence for courses, or how and when to choose a capstone. Fostering cross-cohort connections will also likely have a longer-term impact which is much more complex and robust alumni networks. We are likely to be able to avoid many of the complaints that ISAT seniors report in their senior exit interviews regarding

unfulfilled expectations with the program if they have strong relationships with older colleagues who tell them about the “real deal.”

An Example

What would ICCD look like if implemented? One of the most successful assignments in ISAT 190 is having the students interview faculty members. I envision additional assignments that encourage students at the lowest levels of ISAT to create relationships with their more-experienced peers. Perhaps 190 students could be “interns” on capstone projects. Or ISAT 151 students could be advised to seek out students in upper-level classes that require calculus for tutoring, and likewise the students in those classes could be encouraged to offer such tutoring and taught about the benefits of tutoring to one’s own understanding.

If implemented thoroughly and effectively, a course like ISAT 251 (intro stats), or ISAT 252 (intro programming) could have 50+ students per section with a single instructor. Instructors of those courses would be able to rely upon our more senior students to provide support to the students in those classes and alleviate the need for the instructor to be the sole provider of assistance to students in the class.

Pros and Cons for ISAT

Pros

- Relatively cheap to implement
- Heavily supported by the empirical research literature
- Has benefits that extend beyond cognitive learning, e.g. senior students feel the need to be good role models to the younger students
- Could potentially halve the number of sections of a number of foundations courses by increasing the number of students a single instructor could handle to 50+

Cons

- May take a few years to ramp up
- May be difficult to get administration to allocate and provision the physical space for a tutoring center
- Requires faculty members at different levels in the program to collaborate in encouraging their students to get involved on both sides of the equation

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