The Journey to One: Teachers’ Transformation in Multidisciplinary Cooperation on Engineering Education

Dr. Mei-Mei Song, Tamkang University

Mei-Mei Song is an Assistant Professor in the Graduate Institute of Futures Studies and the Director of the Center for Futures Intelligence and Research (C-FAR) at Tamkang University in Taiwan. Dr. Song’s teaching and research interests are in futures thinking, futures education, and engineering education. She earned her M.A. and Ed.D. from Teachers College, Columbia University and is a fellow of World Futures Studies Federation (WFSF).

Prof. Shang-Hsien Hsieh, National Taiwan University

Dr. Hsieh is a Professor and Chairman in Department of Civil Engineering at National Taiwan University (NTU), Taipei, Taiwan. He is currently serving as Director of the Research Center for Building & Infrastructure Information Modeling and Management in NTU’s Department of Civil Engineering. He is a member of Board of Directors of the International Society for Computing in Civil and Building Engineering Since 1999 and served as the society’s President from 2006 to 2008. He has a wide range of research interests, including engineering & construction simulations, engineering information & knowledge management systems, engineering education, parallel and distributed engineering computing, earthquake engineering and structural dynamics, and object-oriented software development.

Dr. Hsieh received his B.S. in Civil Engineering in 1985 from NTU, and his M.S. and Ph.D. in Civil and Environmental Engineering from Cornell University, U.S.A. in 1990 and 1993, respectively. From 1993 to 1995, he worked as a Postdoctoral Research Associate in the School of Civil Engineering at Purdue University, U.S.A. He joined the Department of Civil Engineering at NTU in 1995 and had since served NTU as the Chief of Extracurricular Activities Section in Office of Student Affairs, Vice-Chairman of Department of Civil Engineering, and Deputy Dean for Office of International Affairs.

Dr. Shih-Yao Lai, National Taiwan University, Graduate Institute of Building and Planning

Assistant Professor
Abstract

In this age when interdisciplinary education is highly valued and strongly emphasized in engineering education, the experiences of teachers working in multidisciplinary teams deserve closer examination, as teachers are essential players in leading curriculum changes towards multidisciplinary cooperation. What motivates teachers to take the first step out of their professional comfort zones to reach out to and work with others? What might be the difficulties, struggles, or even frustrations along the way? What constitutes the moments of glory and/or offers real rewards to them? Do disciplinary boundaries play a role in the process of student cooperation? If yes, how? These issues need to be further understood in order to expand the impacts of multidisciplinary education.

This study presents the 3-year experience of a multidisciplinary teaching team working together to co-teach Capstone courses aimed to enhance students’ capacity for solving multidisciplinary problems by providing real-world issues and conditions as well as multidisciplinary team experiences. Students from four departments—civil engineering, building and urban planning, mechanical engineering, and futures studies—worked together to propose revitalization plans and design for a 50-plus-year-old, run-down community that is in the prime area of a city but is mostly occupied by disadvantaged groups in the society. Data were collected through meeting discussion logs over the period of time (2013-2016). They were thereafter transcribed and analyzed using qualitative research methodology and the computer software NVivo. Results from the analysis are presented in order to portray the teaching team’s transformation in multiple dimensions over the three years.

Keywords: Multidisciplinary education, engineering education, teacher experience

Introduction

In a globalized world where issues and problems are becoming pressingly complicated, universities are expected to take the lead by developing interdisciplinary curriculums in order to equip students with skills to cope with the new era. It is essential for students in this day and age to develop the ability to understand other disciplines and connect their own disciplinary knowledge with that of others, even for students from professional schools. Various initiatives have been attempted with various degrees of success, and students can benefit from interacting with peers from other disciplines in interdisciplinary courses.

---

This study is supported by the “Development of Interdisciplinary Engineering Curriculum for Innovative Design,” sponsored by the Ministry of Science and Technology (formerly National Science Council), Taiwan, under Grant no. NSC 102-2511-S-002-011-MY3.
Teachers engaging in interdisciplinary curriculum are often freed from isolation, allowed to actively take on multiple roles in teaching, and supported in reconstructing their roles and views on their profession. On the other hand, some kind of mechanism—either institutional or social—also needs to be in place in order to foster interdisciplinary cooperation among teachers in the long run.

In December 2013, three university teachers from civil engineering (CE), building and planning (B&P), and futures studies (FS) embarked on a 3-year journey with the support of a research project aimed to foster multidisciplinary, innovative curriculum in engineering. The initial philosophy of bridging the three seemingly unrelated disciplines was that the tools and methods developed in FS for futures thinking might be able to enhance the design capacity of CE students. At the same time, as a discipline that bridges architecture and social sciences, B&P was the perfect agent between CE and FS.

The collaboration has been quite fruitful, with the three teachers moving increasingly closer year by year in terms of disciplinary overlap and having continued to do so after the end of the three-year project. As we are attempting to venture forward with even deeper integration of our disciplines towards interdisciplinary cooperation in the next phase, which is a long way from the initial state three years ago when we were not quite familiar with one another’s areas of expertise, it would be worthwhile to share our reflections on the journey with other teachers.

Context

Over the course of 3-year-cooperation (from December 2013 to November 2016), three curricular experiments were conducted consecutively in the Spring Semesters (i.e., February to June) from 2014 to 2016 at National Taiwan University (NTU) in Taiwan. The first experiment was meant to be an initial try-out, embedding two 8-hour sessions of futures thinking curriculum in an existing selective advanced CE course, with the purpose of familiarizing engineering teachers with futures thinking. Based on their understanding of the other disciplines at the time, the teachers then co-designed the second- and third-year curricular experiments. In essence, the second-year design was the original prototype of the experiment, and the third-year one was the improved version, based on the experiences of the previous year. The second- and third-year courses were project-based and addressed real community issues. The multidisciplinary teams of students were asked to propose community revitalization plans for an old run-down district in Taipei.

Although each year’s curricular experiment was co-taught by the three teachers during the class time, different course titles were utilized for the sake of alignment with the curricular arrangements in each teacher’s affiliation (see Table 1 for details). The common class time was three hours per week, with an additional 3 hours for B&P students on a separate day of the week, led by the B&P teacher, to make up for the difference in credit hours and instruction time. CE students also had two hours of extended class time regularly on a different day as needed, led by the CE teacher, to ensure a commonly available time for all CE students to convene for training, discussions, collaboration, or experience sharing among project groups.
Totals of 10, 22, and 22 students took the courses in the first, second, and third years, respectively. Students were mainly recruited from the three teachers’ affiliated departments, with a fourth teacher from mechanical engineering (ME) sending students to the class and mentoring students on their professional knowledge associated with ME without participating in the course design or teaching. It should be noted that while courses offered in B&P and FS were offered only to graduate students due to the natures of the two graduate programs, all courses provided by the CE and ME departments in this project were open to both upper-

Table 1
Description of courses utilized in the curricular experiments.

<table>
<thead>
<tr>
<th>Year</th>
<th>Course Title</th>
<th>Credit Hour</th>
<th>Attribute</th>
<th>Department/Institute</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BIM Implementation Practice</td>
<td>3</td>
<td>Elective; for advanced undergrad and graduate levels</td>
<td>Civil Engineering, NTU</td>
</tr>
<tr>
<td></td>
<td>Practice of Emerging AEC Technologies</td>
<td>3</td>
<td>Elective; for advanced undergrad and graduate levels</td>
<td>Civil Engineering, NTU</td>
</tr>
<tr>
<td></td>
<td>Workshop on environmental Planning and Design</td>
<td>6</td>
<td>Required with elective projects; graduate level</td>
<td>Building and Planning, NTU</td>
</tr>
<tr>
<td>2</td>
<td>Internship in Futures Studies</td>
<td>0</td>
<td>Required with elective projects; graduate level</td>
<td>Futures Studies, TKU</td>
</tr>
<tr>
<td></td>
<td>Principle of Air-Conditioning and Refrigeration</td>
<td>3</td>
<td>Elective; for advanced undergrad and graduate levels</td>
<td>Mechanical Engineering, NTU</td>
</tr>
<tr>
<td>3</td>
<td>Civil Engineering Capstone Challenge</td>
<td>3</td>
<td>Elective; for advanced undergrad</td>
<td>Civil Engineering, NTU</td>
</tr>
<tr>
<td></td>
<td>Workshop of Environmental Planning and Design</td>
<td>6</td>
<td>Required with elective projects; graduate level</td>
<td>Building and Planning, NTU</td>
</tr>
<tr>
<td></td>
<td>Principles of Air-Conditioning and Refrigeration</td>
<td>3</td>
<td>Elective; for advanced undergrad and graduate levels</td>
<td>Mechanical Engineering, NTU</td>
</tr>
</tbody>
</table>
Table 2
Numbers of Students and Demographics.

<table>
<thead>
<tr>
<th>Year</th>
<th>Total No. of Stud.</th>
<th>Female</th>
<th>International</th>
<th>Major</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Civil Engineering</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(BS) (MS) (PhD)</td>
</tr>
<tr>
<td>1</td>
<td>10</td>
<td>4</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>22</td>
<td>9</td>
<td>2(^a)</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>22</td>
<td>7</td>
<td>2(^c)</td>
<td>12</td>
</tr>
</tbody>
</table>

\(^a\) One international student with no Mandarin proficiency, the language of instruction and discussion; the other with high proficiency.

\(^b\) One undergraduate student from Bioenvironmental Systems Eng., NTU; 1 graduate student from CE, TKU.

\(^c\) Both with high proficiency in Mandarin.

Class and graduate-level students. As indicated in Table 2, the diversity in student demographics was highest in the second year, with a group of FS students from Tamkang University (TKU), an international student with no proficiency in the primary language of instruction, and more students from the graduate level. The proportions of female students throughout the three years are about the same.

**Method**

Qualitative research seeks to derive meanings and insights from unstructured data. During the process of analysis, researchers examine raw data sentence-by-sentence and assign nodes to each data unit according to the nature of the content. Nodes with similar natures are subsequently grouped together in order to formulate concepts and then categories, which may serve as the basis of new theory.\(^1\)

The data for this paper were derived from transcripts of all the collective meetings and discussions among the teachers throughout the three years. In some cases, the meeting participants also included research/teaching assistants and other colleagues. With the qualitative analysis software tool NVivo 11, the data were carefully examined and coded. The researchers then regrouped the nodes into different concepts to search for themes and subthemes in the data. Nodes associated with teachers’ experiences were identified and selected for the purpose of this paper. The internal qualities of teachers and external mechanisms contributing to the successful multidisciplinary cooperation in this case were also identified. The results and discussions of the findings are presented in the following section.

It should be noted that since the curricular experiments were conducted in a non-English speaking environment, all data were collected in the primary language of instruction and discussion. Excerpts used in this paper were then translated into English.
Result

Fundamental question on multidisciplinary learning

A question that continually emerged, especially in the first two years of the discussion, was “What kind of multidisciplinary course do we want to create?” Consequently, questions such as “What constitutes a true interdisciplinary course experience?”, “What is a good or successful multidisciplinary course that is meaningful to us?”, and “What kinds of elements do we want to include in the course in order to make it good or successful?” were recurrently raised in discussions.

To date, we, the authors (also the teachers in this study), still do not believe there is an across-the-board formula for creating successful multidisciplinary experiences. Repeatedly raising the fundamental questions and keeping the answers open, however, were helpful to our discussion in designing the course. Some of the questions included:

What is a good interdisciplinary learning environment? We can’t call it interdisciplinary learning simply because we have people from different disciplines in the same room and learn. You have to have something that’s truly interdisciplinary. Teacher A

Do we simply create an environment for students to cross the disciplinary boundary? Or do teachers need to do it first? Teacher C

Is our goal to create an environment for students to have multidisciplinary experiences? Or to (aggressively) enhance students’ capacities in multidisciplinary cooperation? These two are not quite the same. Teacher C

It is easier to simply put students from different disciplines in one class or in one group…But if we want them to understand the methodology of another discipline, we might have to put in more effort. Teacher B

In addition, the threshold for crossing the boundaries might be different among students. In this case, in retrospect, the teachers expected engineering students to be able to cross over to areas in the social sciences but did not expect the same level of crossing over for social sciences students to engineering knowledge. Is this difference in expectations acceptable to the teachers? Will it be acceptable if we enlarge the scale of the course and expand the participation to students from all disciplines?

Another interesting question that emerged from the curricular experiments was how to define which discipline a student comes from. Can we really label a student according to his or her major? Students’ self-selection might complicate the traditionally-defined disciplinary boundary, especially because the courses from CE and ME were selective. As Teacher A stated:

Some students might have come for a course with B&P because they possessed qualities that were closer to B&P. We might have attracted CE students with those qualities and they (therefore) fit in better. They might have taken courses in B&P and might feel even more comfortable there. They challenged our definition of “crossing”
When we form the team, how do we identify (a student’s) level of cross-discipline? He or she might have two or even three sides. Teacher A

Such challenge also applied to other students with different undergraduate and graduate majors, such as a ME graduate student with an undergraduate CE major, as well as many students from the graduate institutes of B&P and FS.

The teachers’ multidisciplinary experiences

Dealing with Uncertainty. Compared with other curricular designs that we developed, the curriculum experiments in this project comprised much higher degrees of uncertainty, as we had to rely on the other two colleagues to co-create the course work. In other words, each of us held some pieces of the puzzle, but we were not sure how the assembled image was going to turn out. It was very different from experiences we had had with other courses, which we could design alone and for which we were the sole expert authorities in the entire process. Although the teachers needed to have the courage to face and step into many unknown territories in teaching, they co-created a rare space for students from different disciplines, who were used to different cultures, to work together and learn from each other through intense interactions. The following are some views from the teachers:

The biggest challenge to me is the uncertainty and (whether) the training we give students (is good enough). I’m not very sure how the students will absorb and apply the knowledge. . . . There are many uncertain factors in this course. It feels that the stringency is lower. Teacher A

Let alone the students, even the teachers didn’t understand every part (of the curriculum) but dared to teach it . . . Even we couldn’t predict the results. Teacher A

You may say it is not responsible (to know everything when designing the course). But we were willing to try, despite the uncertain variables. And we had the confidence and ability to know how to keep the risks and uncertainty below a certain level instead of allowing them to completely run wild. Teacher A

Dealing with “culture shock.” Part of the beauty in multidisciplinary learning is the opportunity to learn about other disciplinary cultures; i.e., other ways of thinking and doing, which ironically also adds extra burden to teachers, as students might be distressed by “culture shock” when working with students from other backgrounds. Even in the fields of CE and B&P, which are seemingly closer in terms of disciplinary boundaries, the cultures of thinking and doing are still quite different:

The pattern of discussion in that group was that engineering students hoped to see clearly-defined task objectives and NOT have the discussion willy-nilly prior to that. They wanted to get things solved quickly. Teacher B

TA1: In fact, that’s what we do every Tuesday [Note: the meeting time for only B&P students]. We spend three hours discussing each other’s complaints or what to improve on.
Teacher A: But that’s for B&P students. . . . We (in CE) don’t have the culture for that kind of (interaction). Students don’t have that kind of habit either.

Different ways of doing may also mean increased opportunities for conflicts and misunderstanding within the group, which happened in two of the three groups in the second year of our project, when the student grouping was the most diverse of the three-year period in terms of academic background, age, and language. The teaching team therefore had to take extra care to identify problems in the students’ group dynamics and sometimes provide intervention to help students to resolve issues:

I’ve observed that the cultures in the (four) departments are different. . . . That is part of the reason why we are seeing these issues. For this round (of the curriculum arrangement), we apparently are following the ways of doing defined by B&P. . . . This is what we were hoping students would see—Oh, that’s how people in other disciplines do it. . . . It is better that they are experiencing this here in school than at work. Teacher C

I feel in the future, we’ll have to learn to take care of students’ emotions and expectations at this stage. . . . The question now is how to help students put the (distress) behind and move forward. Teacher A

On top of the different ways of doing, an added dimension to our challenge in dealing with students’ culture shock was the different ways of thinking. As Teacher A indicated:

(The core of) futures studies tackles (social) values, but we don’t really talk about values in engineering. The courses in (engineering) teach students how to solve problems, which are already defined. . . . We need to contemplate on how to pull engineering (students) from concrete thinking to abstract thinking… and teach them to examine their own value systems. Teacher A

In other words, FS was brought into this project with the aims of expanding the students’ horizons and stretching their thinking capacities. Unlike joint courses between two disciplines that are rather similar to each other in nature, multidisciplinary learning across the engineering/social sciences or concrete/abstract boundaries adds further challenges in teaching.

Differences in culture not only existed among the students but also among the teachers. The fact that individual teachers have different expectations about classroom behavior, group performance, and assignments for individual courses is widely accepted by students. But when three teachers were present in the same classroom and provided advice to students in groups during project time throughout the semester, incoherence in attitudes and advice became an issue because students were used to the teacher in one course being one entity. Additional meeting time for B&P and CE students with their respective teachers outside the common class time created further misalignments among teachers:

(The students) expected a traditional kind of teacher-led course, where everyone listens to the teacher. They had never had to deal with these random issues before because whatever the teacher said was the rule. It was really a big shock to them in this course. Three or four teachers might not say the same thing, and people from
different disciplines have very different ways of doing. So they were very shocked. I think it’s a very good thing. Teacher C

…I would suggest that we (teachers) have to be extra careful with our roles in the class; otherwise, the students will be confused. . . . We have to be aligned. Teacher C

Qualities of teachers

A multidisciplinary curricular design needs to ensure good development in three parts, as Teacher C pointed out:

In our cooperation…there’s a very interesting phenomenon. I see three things mutating: teachers, students, and curriculum. It seems that all these three things are mutating (at the same time in terms of multidisciplinary development). Teacher C

Teachers are inevitably the most essential part among the three, as they are the designers of the curriculum and of the multidisciplinary learning experience for students. In our multidisciplinary classroom, the teachers were even symbols of students’ professional identities. In other words, CE students looked up to the CE professor as a representative of their field, as did students from other departments. That was probably a contributing factor in why ME students, whose teacher was absent in the classroom teaching, seemed to be less oriented in our classes than did the rest of their peers.

The self-challenge and learning of the teachers were quite self-evident:

During the process (of our experiments), teachers have to learn from each other in order to form a team. Teacher A

Teachers all have teaching styles and models that they are accustomed to. So we have been trying them out during the first two years. Teacher A

Right now, we teachers are working hard to expand ourselves, looking for coherence in order to create a (good) learning environment. Teacher A

The next question was, “What qualities of the teachers involved in multidisciplinary cooperation might affect their willingness to participate in such ventures as well as their levels of involvement in the collaboration efforts?”

If we dig deeper into it, we might be able to identify what kinds of teachers are more suitable for doing this kind of (multidisciplinary cooperation). One’s resources, one’s maturity…professional maturity, one’s multidisciplinary experiences, one’s commitment, etc. The composition of the teaching team is very important. If the teachers don’t get along, then it all falls apart. . . . So it needs to take time to match (teachers) and build the team. Teacher A

Though prior experience in multidisciplinary collaboration might not be the dictating element for successful cooperation of this kind, the three teachers in this project had all engaged in
multi- or even interdisciplinary learning and teaching prior to this collaboration. To a certain degree, the academic fields in which the three teachers were professionally trained (i.e. civil engineering, architecture, and educational organization and leadership, respectively) deal with various disciplines by nature. Teacher A’s professional training traverses the disciplines of civil engineering and information technology. He was also engaged in various co-teaching activities with professors from other fields in the same discipline, from architecture, and from electrical engineering, though the levels and forms of co-teaching varied. Teacher B also had 2 semesters of teaching experience working with civil engineering professors before this project. Teacher C’s entire career was mostly built on crossing different academic boundaries—from education to cultural studies to futures studies. To all three teachers, the leap between disciplines seemed to be the greatest this time. However, it was not a completely foreign experience to any of them.

The other quality of teachers that surfaced from the data was the maturity in their professional fields. As of January 2014, when the project first launched, the three teachers had 19, 3.5, and 8 years of full-time teaching experience and 0, 6, and 1.5 years of part-time experience, respectively. Maturity in one’s teaching and academic profession allows sufficient teaching dexterity to deal with new challenges and uncertainties in multidisciplinary teaching.

Maybe some engineering professors need to mature to a certain level in order to appreciate the importance of (teaching) social values (in engineering). When you are in your 20s, for example…you might feel it’s something for someone else to know, but not for you. Teacher C

In addition, a bolder challenge, such as multidisciplinary collaboration, can be very rewarding to experienced teachers, as it brings fresh perspectives and new learning that take them outside their comfort zone but are still reachable.

Supporting mechanism for multidisciplinary cooperation

From the data, four major elements for enhancing and eventually sustaining and deepening our multidisciplinary cooperation were identified: (1) the research grant, (2) the experience to interact in serious but informal occasions, (3) established format of delivery, and (4) the leap of faith.

The effect of the 3-year research grant on sustaining curricular experiments like this is quite self-explanatory. As with any other research projects, our efforts also needed a large amount of support in terms of materials and human resources, without which it would have been hard to devote the teachers’ time and energy to such endeavors.

The experience of working together in various workshops and conferences, especially in the beginning stage of the cooperation, was vastly helpful. Working, thinking, and professionally growing together at close range in these serious yet relaxing settings allowed the teachers to become familiar with one another’s work, thinking styles, and personalities in quick and meaningful ways. In addition, the teachers’ continuous participation in these events and in the even less-formal self-organized gatherings with colleagues from other disciplines provided common knowledge and experiences that were often beneficial and applicable to
the project. In essence, the teachers were able to create a small learning community within other learning communities and to keep developing it.

I actually have laid out our process of cooperation. In fact, I think the (futures) workshop at the beginning of the project was very important. It gave us a chance to work together. Then the (futures) workshop we held ourselves. Even the TRIZ workshop...it gave me a chance to work with (Teacher B). I think it was helpful for me to understand what kinds of people the others were and which ways work with them.

Teacher C

Another helpful element was the established format of delivery in futures thinking, which was the major part of futures studies that we attempted to bring into the engineering curriculum. In order to assist people from different disciplines and sectors to envision the future, futurists have already established a 2-to-3-day participatory workshop format, called Six Pillars of Futures Studies.³ Professors A and B, therefore, were quickly able to familiarize themselves with the core operation of futures thinking:

I was thinking...you could quickly understand what futures thinking was because there happened to be a set of (delivery format) here. If not, (would it have been more difficult to start the cooperation)?...For example, could you quickly tell me the fundamentals of civil engineering in two days? Teacher C

The fourth element that emerged from the data was the leap of faith, which played an essential part in the initial stage of the cooperation:

I put it down to “blind faith.” I think there was fundamental trust (in here). When I think back to half a year ago, when you (i.e., Teacher A) initiated (the collaboration of the project), I feel that it was based on blind faith (on my part). To a certain degree, I felt I should be able to do it, so I gave it a try...And I think it was very interesting that I called it blind faith. I completely didn’t know what would happen, but I just jumped in. Then I came into this field. Then I started to realize there were many, many fun things here. Teacher C

Though seemingly intangible, “faith” was actually a good metaphor for our state of mind in the initial stage of cooperation—faith in the judgment of the project PI, faith in the self-efficacy of teaching to take on the challenge, and faith in one’s own competence to traverse successfully the disciplinary boundaries. Although the faith might have seemed initially “blind,” it was in fact clear in an obscure manner in our minds. As stated earlier, none of the teachers had a completely full picture of what the curricular experiment was going to lay out at first. However, the trust in each other made up for the missing certainty that we were accustomed to having in other projects, and that trust eventually allowed us to take the leap of faith to join the venture.

Lessons Learned from the Experience

Multidisciplinary cooperation is an organic process. With many more variables, such as teachers and students of different backgrounds, than single discipline curricular experiments, multidisciplinary cooperation evolves more rapidly and drastically. Crossing disciplinary boundaries means more new questions and new ideas
emerging throughout the process. It is, in our opinion, the beauty of the multidisciplinary cooperation experience.

*Teachers need to handle added uncertainty and complexity in curricular planning and execution.*

Complexity often arises in students’ reactions towards multiple teachers from various backgrounds with different ways of thinking and doing. In addition to regular classroom management, teachers also have to pay extra attention to issues such as helping students deal with “culture shock,” aligning with each other to lessen students’ confusion, dealing with students’ professional identities (attached to individual teachers), etc.

*Disciplinary boundaries are “unequal in width.”*

Crossing the disciplinary boundaries of engineering and social sciences is an interesting challenge, as students from these two backgrounds often have disparate ways of thinking. Students accustomed to concrete or abstract thinking often find it difficult to communicate with those from “the other side.” On the other hand, as increasing numbers of students are crossing the boundaries in their own ways, stereotyped images of what an engineering student is like or what he or she knows (or does not know) about other disciplines need to be re-examined.

*Multidisciplinary cooperation needs support.*

It was our experience, in retrospect, that multidisciplinary understanding really takes time. Mutual understanding is the foundation of multidisciplinary cooperation but often yields few tangible results in the beginning. In addition, teachers need time and opportunities—perhaps outside the professional arena—for their own team building in order to develop understanding of and trust in one another. Teachers also need support for professional development, since they ought to equip themselves with new tools and methods for addressing new questions raised during the cooperation. Funding from research grants naturally helps to sustain such cooperation.

*The composition of the teaching team is essential.*

Though we are not attempting to develop a formula for a successful team in multidisciplinary cooperation, we did find some qualities of the teachers in our project that might have contributed to our positive experience. They included multidisciplinary experiences in one’s own background, experiences in teaching, professional maturity in one’s field, and open-mindedness.

**Conclusion**

This study is based on data collected through meeting discussions in a 3-year journey of a multidisciplinary teaching team working together to co-teach courses for enhancing students’ capacity to work on teams to solve real-world multidisciplinary problems. With the assistance of a qualitative research tool, the researchers combed through the raw data and derived insights. The key findings from qualitative analysis of the data are summarized as follows:

- Although there is no across-the-board formula for creating successful multidisciplinary experiences, it is helpful for the teaching team to repeatedly
discuss the fundamental questions on the purpose, content, and assessment of the course and to keep the answers open.

- Teachers getting into multidisciplinary cooperation on engineering education need to have the courage at all times to step out of their comfort zones, face unknown challenges, and deal with uncertainty in teaching. In return, they are rewarded by learning new ways of thinking and doing from other disciplines, thereby enhancing their interdisciplinary capacities. Also, they may co-create a great learning environment for students to develop similar courage in learning and to cultivate different ways of thinking and doing through the “culture shock” of working with their fellow students from different disciplines.

- The teachers for a successful multidisciplinary teaching team may possess the following qualities: (1) previous experience in multidisciplinary cooperation, and (2) good maturity in their own professional fields.

- There are four major elements for supporting the multidisciplinary cooperation reported in this study: (1) the research grant, (2) the experience and abilities of the teachers to interact in serious but informal occasions, (3) the established format of delivery in FS, and (4) the leap of faith among the teachers.

The curriculum development (including the design and implementation) of a multidisciplinary course is itself a multidisciplinary project for the teaching team. The process of curriculum development is also an inter-disciplinary learning for the teachers of different disciplines, and it is critical for the success of the course. If the teachers can get along well, establish a format of delivery for helping each other to learn ways of thinking and doing from different disciplines, and develop faith in one another, there is a very good chance of executing a successful course on multidisciplinary education. In addition, building a successful team of teachers for multidisciplinary education requires both strong funding support and a good environment to provide opportunities for teachers with multidisciplinary experiences and mature professional development to interact in serious but informal occasions, especially in the early stage of team building.

Bibliography


