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Decentralizing the Classroom: Utilizing network theory, collaborative teaching, and agile development to create a soft-structured learning environment

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Abstract
Graphic Design is increasingly becoming an interdisciplinary practice where designers in the industry can expect to work on a variety of projects, some of which may require an array of disparate skill sets and tools. Given the difficulty of making fundamental changes to existing design curriculums, and the fact that programs cannot educate students to be 'experts' in every discipline they will encounter in professional practice, what changes can individual instructors make within their courses to address this situation? In response to this challenge the authors of this paper implemented a number of structural changes to two distinct courses in their graphic design curriculum in an attempt to decrease the 'silo-effect' between subjects and to provide students with situated learning experiences in a simulated interdisciplinary setting. These structural changes include creating conduits between courses as a way to decrease the 'silo-effect', implementing a 'soft-structured' group dynamic within one of the courses, and utilizing a generationally tiered project progression as a way to diffuse and share large amount of knowledge from multiple branches of study simultaneously. In this article the authors explain the models they implemented, examine those models based on existing theoretical frameworks, and review the effects these models had on the student experience, cooperation, and knowledge retention in relation to previous courses.

Keyword : graphic design pedagogy, multidisciplinary design, collaborative teaching, decentralized classroom, interactive design, interface design, systems design, dynamic critique models, cross-course registration

Introduction

This case study reviews the author's experiences in abandoning an instructor-centered classroom structure by applying a new model to two existing courses in their Graphic Design curriculum.

These changes were implemented in response to problems that arose in previous 'Interactive 1' courses, primarily having to do with a silo-effect in which students struggled to apply their knowledge from the 'Interactive 1' course to projects from other courses within the graphic design curriculum. Secondarily, changes were made in response to the steep learning curve often encountered in advanced or specialized design courses. We noticed that in several interactive, interface, motion and technology-based design courses, students struggled to absorb and correctly apply knowledge without heavily relying on faculty for validation.

Our intent was to create a dynamic classroom experience where small groups of students could deeply examine a topic, while at the same time share information with other groups in the class throughout the lifespan of the project, instead of only sharing information in a final critique (figure 1). We posited that this scenario would yield greater efficiency in time spent during class critiques as well as expand both the breadth and depth of knowledge covered within a given class. In addition, we intended to decrease the 'silo-effect' by bridging courses and course projects to allow for a natural migration of ideas to occur (figure 2).

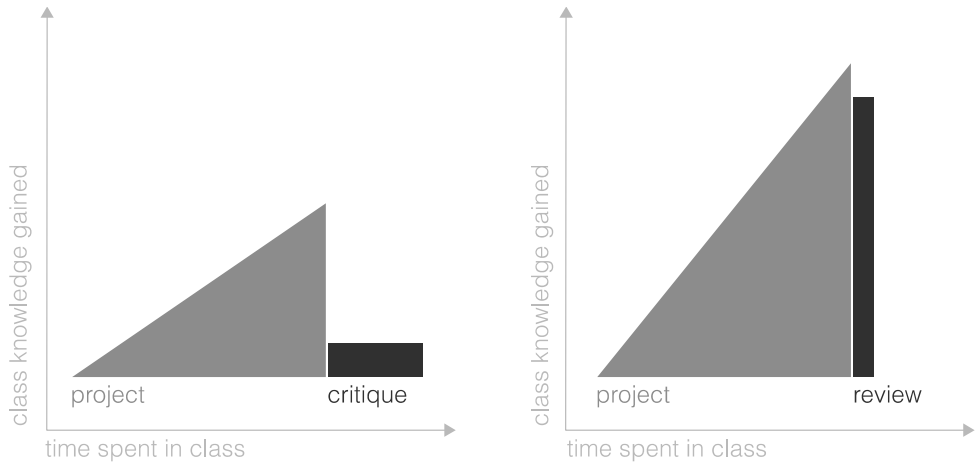


Figure 1.

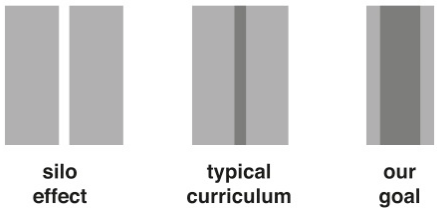


Figure 2.

Due to the difficulty of making fundamental changes to the Graphic Design curriculum, we chose to focus our energy on making principle changes to two of our classes: Interaction 1 and Systems in Design. The primary impetus for this change was to test the effectiveness of alternate classroom models in reducing the silo effect between courses, mitigating the problems associated with the instructor centered classroom model, and increasing the amount of content in each course.

Literature review

Issues with instructor centered teaching

In reviewing the relevant literature there is significant consensus that the traditional 'Instructor-centered' teaching model has a number of negative effects on student learning.

The evidence suggests that the classroom model of instructor as knowledge-giver leads to the memorization of facts and doesn't allow students to connect new knowledge to their prior conceptions (McCray, DeHaan, & Schuck, 2003, p. 26). Another report utilizing active learning strategies (Handelsman et al., 2004) states that courses which rely on "transmission-of-information" lectures and "cookbook" exercises are not highly effective in fostering conceptual understanding. This is also supported by Harris & Harvey (2000, p. 29) who state that the use of models where "students are recipients of knowledge from an authority and expected to regurgitate the information on a test, does not expand their use of critical thinking skills, nor does it help them encounter their own power to construct knowledge, either on their own or with others."

It is not difficult to see how a model that doesn't allow students to connect new knowledge to their prior conceptions (McCray, et al. 2003, p.26) can lead to an increased 'silo-effect' where students are unable to easily connect the learning from the subject area in one course to that of a different course.

Moving forward

McCray (2003, p.27) proposes some general suggestions for improvement: "the lecture format can be improved by allowing learners to grapple with an issue on their own before they are provided with answers." He goes on to state that "inquiry-based instruction and problem-solving strategies…assist students in assimilating new information through interaction with their prior concepts and knowledge of the world outside the classroom."

In developing an alternate classroom model that would fit the needs of the design studio and those of our students, we looked to 3 different areas: working models from the design industry, existing academic models, and organizational models from the sciences.

Learning from the design industry

There are a number of organizational models utilized in the design industry. But if we limit our scope to look at studios that utilize interdisciplinary design teams, and are highly innovative, we see that the primary model is the agile development process (Meyer, & Marion, 2010).

An important element of an agile development process, perhaps the most important, is fluidity (Meyer, et al. 2010, p. 25). Meyer speaks of fluidity in the design concepts and prototypes themselves. But fluidity is also an integral structural component of the design team where team members shift between roles and responsibilities even taking on multiple roles, often with little organizational. In describing the design process Bill Moggridge (2007, p. 649) states that "The most productive approach is often apparently unstructured, where members of the design team may suddenly dive into a prototype, renew some research activity, look at people afresh, reexamine some of the constraints, or create new alternative concepts. The process does not look like a linear system diagram, nor a revolving wheel of iterations, but is more like playing with a pinball machine, where one bounces rapidly in unexpected directions."

Learning from alternative class models

We can draw parallels between successful team-based practices in the industry and existing classroom models such as the Jigsaw Classroom, which utilizes the organizational concept of assigning students to specific 'tasks', and has been used extensively in many areas of education (Reese, 2009; The Jigsaw Classroom, 2000). Central to the Jigsaw model is the practice of dividing a subject into parts and assigning each to different students who are then responsible for learning only that part. When the students develop a solid understanding of their area of investigation they are responsible for reporting back, and thus educating the rest of the class (Reese, 2009).

Specific to design education, a classroom model utilizing student 'specialization' has been used with much success by educator Charlie Cannon in his award winning 'Innovation Studio' course. In an interview with Dwell magazine, Cannon describes using a class structure that explores a wide range of design possibilities and technologies by having individual students focus on and becoming 'experts' in different subjects, before forming 'interdisciplinary' groups to conduct research and engage in the "real design work" (Chu, 2009). When asked if the details and "minutiae" of technology and engineering concepts are lost in a classroom model that tries to cover so much breadth, Cannon answers "yes", but emphasizes the value of generating a range of solutions by "covering such a wide base of study at different scales" (Chu, 2009).

Another classroom model that allows students to be exposed to a greater amount of knowledge compared with single instructor classrooms is the 'Interactive team teaching' model (Helms & Alvis, 2005). This model is characterized by two professors being present and active in the classroom simultaneously. Team teaching has been shown to promote creative thinking and reduce the 'silo effect' of learning by presenting students with contrasting views on a topic (from two instructors), allowing students to explore alternative positions and generate their own conclusions (Harris & Harvey, 2000; Helms & Alvis. 2005; Vogler & Long, 2003.).

Learning from other disciplines

In addition to reviewing existing research on organizational models from the design industry and education, we can also look to the sciences for descriptions of specific organizational patterns and structures, which may prove useful in an educational setting. A relatively new area of scientific study, complexity theory, has been promoted by some as a potential framework that could provide insight and innovation to educational models (Haggis, 2008; Kuhn, 2008) and design education in particular (Wang, 2010).

One aspect of complexity theory which is particularly applicable to the classroom is network theory. Network theory is described as "focusing on relationships between entities rather than the entities themselves." (Mitchell, 2009, 52%) And is concerned with the study of how information flows within complex networks. The applicability of this to the classroom is relatively easy to see if we view the classroom as a network of discrete entities that are engaged in the transmission and processing of information.

Educational researcher Lesley Kuhn (2008) warns against utilizing complexity theory as prescriptive in educational research, emphasizing the fact that the theory is used in a primarily descriptive way in the scientific community. While we agree that many theories that fall under the umbrella of 'complexity theory' describe the way phenomenon actually work rather than how they 'should' work; there are cases where descriptive theories can be useful as prescriptive models. We would argue that there is a fundamental difference between design and nature in the sense that natural (or emergent) systems exist as they are (changing and adapting naturally of course), whereas designed systems are created

and iterated based on previous systems by the express will of designers themselves. A 'descriptive' theory that explains the way a natural or emergent system works can thus be used as a prescriptive model in cases where the systems in question are not 'natural' systems, but 'designed' systems. This can be viewed as a sort of 'bio-mimicry' (which is an accepted design approach), a way to make the designed system in question more efficient based on observations of systems in nature. We can look at a specific example from the work of Melanie Mitchell, a well respected complexity theorist, who utilized a design process in which she took direct inspiration from research findings in complexity theory to develop the ‘Copycat’ software program, which was able solve complex analogy problems (A is to B as C is to D) that are normally quite easy for humans but incredibly difficult for computational machines (Mitchell 2009, 43%).

Applying alternative classroom models

Teaching at VCUQatar is a unique experience. Qatar is one of several countries in the Middle East involved in rapid growth of infrastructure, industry, culture and education. In order to stay relevant, education must adapt to meet the needs of this changing context. Students hoping to be successful designers in this region will need to be agile, adaptable, capable to make connections, share knowledge and anticipate the changing circumstances of an emerging industry.

With a limited design culture in the region, our students must be able to learn from the global design industry, while at the same time developing skills and a conceptual understanding of a wide variety of media.

Due to the factors outlined above, as well as insights we have gained from our combined seven years of experience as professors in Doha, we decided to investigate new teaching methodologies that could result in learning outcomes that would better fit the context of Qatar. Based on observations of previous courses we set out to design new course structures and teaching methods that could prompt an increase in the sharing of knowledge between students and classes, and an expansion of design solutions.

Building on our past observations and existing research we developed a teaching strategy that involved ‘decentralizing the classroom’, a ‘generational project progression’, and the ‘creation of connections’ between individual students, groups of students and different courses.

Decentralizing the classroom

In testing a decentralized approach to teaching we focused on the class structure of the ‘Systems in design’ course. We began with the problem/project-based model which is typical of design studio classrooms (Moggridge, 2007; Wang, 2009), and quite familiar in our graphic design curriculum at VCUQatar. The single problem we built the class around was the development of design solutions for a hypothetical metro system for the city of Doha. Typically in a design studio course the instructor might assign a series of fixed projects (e.g. design a logo, a map, then a schedule, etc.) that every student would investigate (e.g. if the class has 20 students, the result would be 20 logos, 20 maps and 20 schedules) and present in a critique format at the end of the project. Instead, we conducted an in-class workshop on the first day of class where students developed a list of design related projects that would need to be completed for a new metro system. The class was then divided into four distinct categories (Wayfinding, Data visualization, Identity systems, Marketing).

Generational project progression

We designed a generational project progression to facilitate the exchange of information between the different groups. Our implementation involved three distinct phases, each longer and more involved than the previous phase (figure 3). The outcomes of the three phases paralleled a typical design process. In phase one students had to present research only, phase two they presented visual directions (sketches), phase three they presented detailed and consolidated visual design solutions.

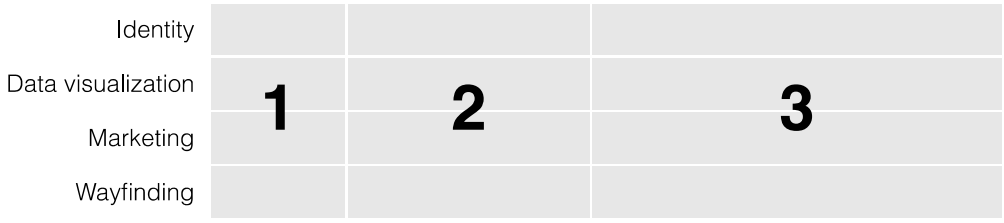


Figure 3.

Timeline of generational project progression within the systems in design course.

The implementation of a generational project progression within our course was based on design studio practice, where designers are often required to move fluidly between different roles, engage in a variety of solutions for one project, and continue work initiated by previous designers. We intended to mirror a design practice by creating situated learning experiences in our classroom, influenced by the agile development model.

Dividing the semester into 3 distinct phases also allowed us to apply the Design-based research methodology (Kali & Dori, 2009; Sandoval & Bell, 2004; The Design-Based Research Collective, 2003) as a way to iteratively refine our model after each phase, based on our observations of its effectiveness up to that point.

To begin each phase, students submitted proposals to work within a particular category. Each proposal needed to demonstrate problem-seeking, posit design thinking and rank their level of interest in each of the four categories. Based on the proposals we facilitated the formation of groups around the four categories to ensure numerical balance and the potential for exploring a range of material.

The start of each of the three phases began with a similar proposal process in which students were required (or highly encouraged) to apply for new category. The intent for dividing the class in this manner was to increase the diversity of projects, consequently increasing topics discussed in class and leading to more shared knowledge among the students. In principle, this single course, Systems in Design, became four mini-courses relative to one topic (systems thinking in graphic design) and one design problem (the Doha metro).

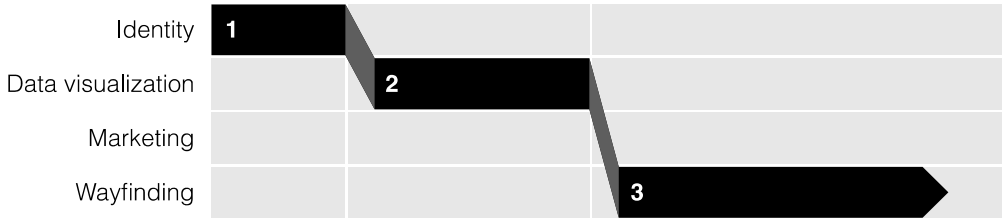


Figure 4.

Example of an individual student progression within the timeline of the systems in design course.

Within each group, students still created individual projects, but could use group members for support, to exchange ideas, share knowledge or even share content. Based on the proposals, each student was responsible for particular projects and outcomes within their category. The result of each category would produce a limited range of

diverse projects related to each other. And the result of each phase would produce a wide range of possibilities, each relative to one of the four categories (figure 5).

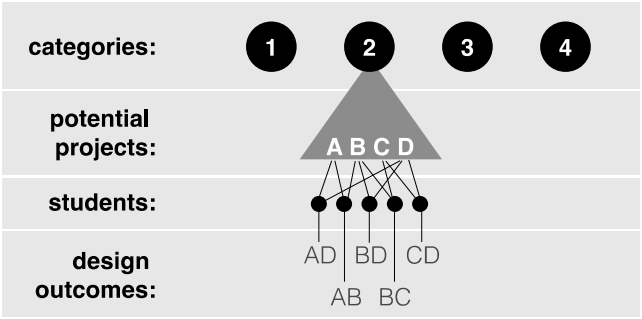


Figure 5.

This chart demonstrates the range of possible outcomes

Creating connections

As a way to weave the knowledge generated by individual teams back into the fabric of the class, we implemented a decentralized structure of peer to peer communication and evaluation, with the assumption that a central approach would prove overwhelming from the perspective of available class time and cognitive load. Using the concept of connected nodes, we created conduits for the exchange of information at three different scales: between individuals within a given group, between groups in the class, and between two different classes (Systems in design and Interactive 1) within the graphic design curriculum.

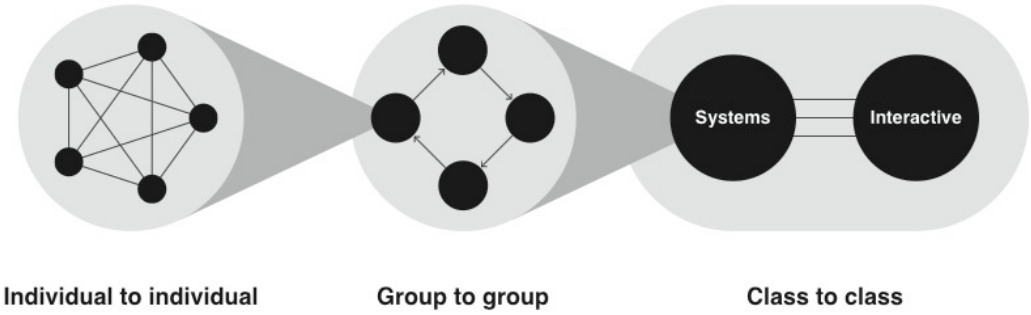


Figure 6.

Diagram of connections at different scales within the class structure.

Individual level

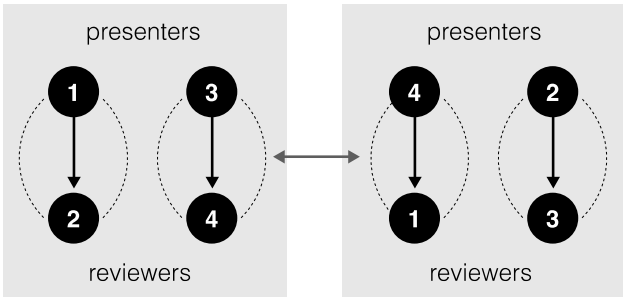
At the level of individual connections the group dynamic within the ‘Systems in Design’ course utilized a flexible soft-structure in the sense that students conducted work individually and were not required to work together. The groups functioned as advisory, and as a way to organize the transfer of information in-class, during workshops, critiques, and meetings with the instructors. (figure 6, figure 9).

Group level

At the group level the structure we implemented is similar to the Jigsaw classroom but with some key differences. In the Jigsaw model, students are responsible for learning a particular aspect of the overall subject and reporting their findings back to the entire class (Reese, 2009; The Jigsaw Classroom, 2000). The problem with a centralized approach such as this is that it takes a significant amount of class time to allow each student to report, one at a time. In our model we had student groups report only to other specific student groups. This allowed pairs of groups to report in parallel rather than one at a time, with the goal of reducing the amount of in-class time required for the transfer of information (figure 7). The only drawback to this approach was that not every student in

the class was directly exposed to the knowledge generated by a particular group. But by creating connections at different scales across the classroom our hypothesis was that through diffusion, all relevant information would eventually work its way through the network of students and groups within the class. (figure 9).

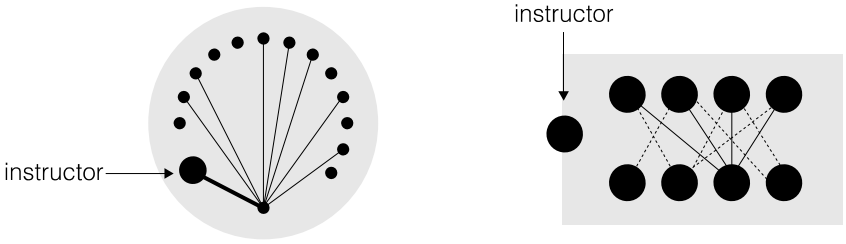
To further promote the diffusion of information in the class, we established unique critique models for reviewing and sharing information. In one model, the critique session was comprised of one project group and one review group. The project group was made up of all the students working within one category (e.g. wayfinding). The review group was made up of students who had submitted proposals to be in the next 'wayfinding' category. This essentially meant the review group was composed of students previously from the other three groups. This process was repeated for each group resulting in each student having to be both presenter and reviewer at different points. This rotation also supported the sharing of knowledge as we moved from one phase to the next (figure 7).



parallel / switch critique & review session

Figure 7.

Parallel group presentations and review sessions



individual critique **group review**

Figure 8.

Individual critique model and feedback vs. group review and an exchange of ideas

The flow of information at different scales (individuals to other individuals, groups to other groups, and classes to other classes) across the network of a classroom can be understood through the framework of network theory. Of particular interest is the 'small world' network principle which has been utilized to understand organizational relationships and complex networks in a range of disciplines from science to the humanities (Mitchell 2009). The principle describes systems which are highly clustered with small average path lengths (links between nodes) containing 'few' connections which span long distances between separate clusters (Mitchell 2009; Watts & Stogatz, 1998) (see fig. 9). This principle has been shown to be an integral feature in the success and efficiency of a range of complex networks from a variety of areas and scales, from the brains of certain animals to the power grid of the western United States (Mitchell 2009; Watts & Stogatz, 1998). The utility of this principle applied to our classroom model is in its emphasis on the importance of the 'few' long distance connections as the feature that determines the efficiency of non-centralized networks in terms of the transfer and spread of information.

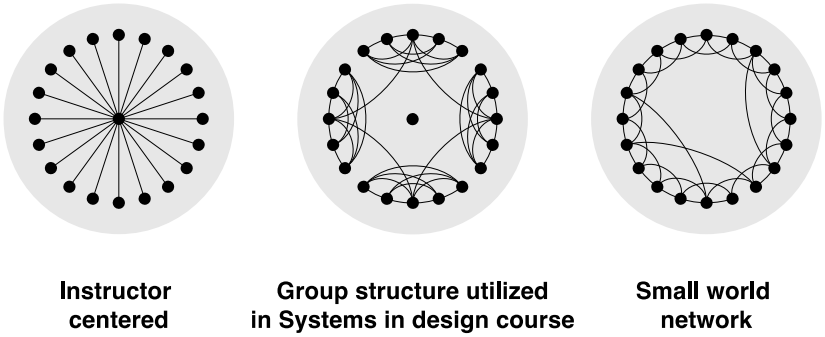


Figure 9.

Diagram showing conduits through which information can travel between nodes in three different network configurations.

Class level

At the course level, we intersected two distinct classes, Systems in Design and Interactive 1. We scheduled the two courses to share students and instructors, while maintaining distinct projects and outcomes, and retaining separate meeting times for each class (Sunday and Thursday).

Our intent for connecting the two classes was to decrease the 'silo-effect' (mentioned previously) and investigate alternative teaching methods and new course projects. The Interactive course focuses on interface design, user experience, qualitative and quantitative research, persona development, information architecture, rapid prototyping and the investigation emerging technology to design and develop conceptual products. Although all of these areas are distinctly different to topics in the Systems in Design course, there are several areas of overlap (e.g. wayfinding requires user experience testing, students used rapid prototyping as a method to create transit maps, students developed persona's to understand who would be riding the metro, the use of new technology for sign systems, developing concept-based apps to access metro information on a mobile device, etc.). In addition, the final project in Interactive 1 is to design a working prototype for a touch screen kiosk to purchase transit tickets for a metro system.

Instructor as facilitator

Within a de-centralized model such as the one we have implemented, the instructor no longer plays the role of explicit knowledge giver, but rather facilitates student investigation, providing guidance, vocabulary, and feedback at appropriate times during the course. As co-instructors, we became participants in the learning, while at the same time, we were able to play various roles (client, city planner, design director, technologist, community member) to simulate a situated learning experience.

Observed differences with instructor centered courses.

In both courses, we used the artifacts generated by the students as a primary data source for this study (Kali & Dori, 2009). By comparing artifacts from previous courses that referenced the same course content, but taught in an instructor-centered classroom, we were able identify areas of change in student performance.

Our secondary source of information came from direct observations of in-class student performance and participation within both courses. We were able to compare the observations from the course using our new teaching model to that of previous teaching models through post-class discussion and by referencing notes that transcribed in-class events. We do not present the results below as specific evidence of the success or failure

of the course changes we implemented and outlined above. Where we have observed potential cause and effect situations we have highlighted the relationship. But on the whole, we present the following results as observations of how these two courses differed in practice compared to similar courses we have taught in the past, against the context of the structural changes we made to the courses.

We were able to see that the primary differences we measured and observed in the implementation of the two courses at the center of this case study compared to previous courses fall into 4 primary categories. We have outlined and expanded on each below.

Silo effect

We observed a definite reduction in the silo-effect between the Systems in Design course and the Interactive 1 course, compared to previous sections of Interaction design. During the meeting times for the systems class we observed students utilizing tools we had taught in the interactive class to solve the problems they were engaged with in the systems class, notable among these were tools such as personas, rapid prototyping, and vocabulary terms such as ‘usability’.

We have experimented with merging courses with Interaction 1 in the past, to create an exchange of ideas between courses, but have always done so in a way that combines the courses together so tightly that from the perspective of the students, the multidisciplinary subject matter becomes too integrated and many students have the perception that they are only engaged in one course. In the past this has resulted in a failure to reduce the 'silo effect' in any measurable or observable way among the students. In one extreme case where we had joined two design courses, Interactive 1 and Visual Narrative 1, a student was asked by another faculty member what she had learned the previous semester in interactive 1, the student replied “I only had Narrative 1 not Interactive”. In relation to this issue, we observed that in this case study, students were better able to articulate the differences between Interaction 1 and Systems in design compared to previous instances where we had merged two courses, presumably due to the clear divide that we engineered between the courses.

Increase in information / content covered

Utilizing a decentralized classroom model, the courses in this case study were clearly able to deliver a wider sampling and larger quantity of information compared to our experience with instructor-centered courses. Compared to previous courses, students in our study still conducted a similar amount of work per credit hour. But due to the de-centralized model, students were exposed to a greater variety of subject matter, not from their instructor, but from their peers.

Based on our observation during critiques we hypothesis that a significant amount of new information was being transmitted between students, much greater than in a ‘teacher-to -student’ teaching model or an ‘individual-to-class’ critique model. Essentially, the critique sessions transformed from the ‘the solo-artist defending their work’ to a fruitful discussion with critical feedback and an exchange of ideas (figure 8).

More efficient use of class time

By utilizing group structures that only had direct contact with one other group at any given time, the critique, workshop, and reporting activities in the class became much more efficient in terms of time spent. Each student was able get the same amount of feedback that they would in a centralized structure (based on prior observations that approximately 30-40% of students do not fully engage in critique scenarios in classes with more than 16 students), except they had the added benefit of more discussion time due to the small

group sizes, were able to engage in more critical feedback without the fear of an entire class responding negatively, and they still had the opportunity to receive direct feedback from instructors acting as mediators. We found that the critique/workshop experiences utilizing a decentralized model took approximately 75% less class time due to group size, parallel group structures and more efficient dialog. Through in-class discussion with our students, they have confirmed that the decentralized classroom model and group critique structure produced more useful feedback, a broader understanding of possible outcomes and a deeper understanding the design solutions.

In addition, instructor preparation for the course on a week-to-week basis was lowered. With the students taking on the active role of research and knowledge seekers, less emphasis was place on the instructors having to deliver a significant amount of knowledge through lecture and specific assignments. However, more emphasis was placed on the instructors to engage with students within group discussions, and the instructors had to be prepared to accept that the students may present new information outside of the instructor's knowledge base. Instructors needed to be equally agile to be able to assert knowledge and be willing to learn simultaneously.

Student engagement with material

During critique activities where one group was responsible for presenting the work they had done to the subsequent newly formed group, we noticed 2 distinct changes in the attitudes of the presenting students and the receiving students. Compared to instructor centered critique models we had used in previous classes, the group critiquing the work became highly attentive to the material being presented and highly critical of the material. We hypothesize that this increase in engagement was due to the fact that the group conducting the critique had a real stake in the work being presented and communicated, because in the next phase they would be directly responsible for carrying that work forward, and would have to fill in any gaps if the previous group failed to conduct the necessary research or design the required components. This is consistent with findings from the jigsaw classroom (Reese, 2009; The Jigsaw Classroom, 2000). This in turn appeared to lead to an increase in the enthusiasm of the presenting students. We observed this most notably during critiques, where students presented work and defended their outcomes more critically and passionately. In several cases, this lead to more thoughtful group discussions and a greater exchange of ideas, however, in some cases it simply caused students to baselessly defend work with personal assertions.

Another aspect worthy of discussion is the way in which this model differs from a model where all of the students are engaged in the same subject area. Because students worked on unique subject areas (data visualization vs. identity for example) and did not have regular class wide critiques where their work would be shared with all the other students, a situation emerged where there was a clear imbalance of knowledge in the sense that the critiquing group had little idea about what would be presented, while the presenting group who had been working with the material for weeks were 'experts' in comparison. This imbalance of knowledge appeared to directly promote an increased sense of 'discovery' in the students critiquing the work presented, in that we observed a greater number of students who were attentive, constructive, and genuinely enlightened by the material and work being presented.

Problems

In one case a subsequent generation failed to adopt and learn from the previous generation. Out of the total of 12 group/subject generations (3 generations x 4 groups each) we observed one group (2nd generation marketing) who produced work that was clearly inferior to the work presented directly to them by the previous generation. By the end of the 2nd generation it was clear that the group in question had failed to learn from and build upon the work completed by the previous group.

We also noticed no change in the work ethic of students who had shown motivational issues in previous courses. In the courses which utilized a de-centralized model, the same students had trouble engaging with the course material and participating in the class except in situations where in-class group work was required, and monitored by the instructors.

Conclusion

The de-centralized model shows promise in creating a classroom where students are able to engage in a wider sampling of work within a particular subject area, while at the same time have the ability to go deeper into a distinct area of interest. The model also shows promise in fostering a more dynamic classroom experience where students share information, engage in critical discussion and work collaboratively, without being specifically assigned a 'group' project. Students who prefer to work individually can do so, but still engage in a collaborative experience. Likewise, because each student is responsible for an individual outcome, the instructors can evaluate each student's performance aside from the group.

We learned that 'soft-merging' courses has potential to expand the classroom experience and decrease the 'silo-effect'. Students seemed to have a greater ability to interconnect concepts learned in different courses and apply that knowledge to projects. Through this process, the range of projects produced in a class increased. However, students still had difficulty separating the learning outcomes and projects from each distinct course. We believe there is potential to 'soft-merging' courses, but have not arrived at a definitive answer.

Integrating new models for critique structures is an important factor when using the de-centralized classroom model. Normal critique models that place significant emphasis on an individual student confronting an entire class with the instructor guiding the critique will deter the exchange of knowledge. We tested various models for critique that seemed to be successful to a greater or lesser degree. We will continue to test new methods to critically review work and share learning, we suggest other instructors who employ a de-centralized classroom model to do so as well.

Teaching courses in a design curriculum is never easy. The speed of contemporary culture and the integration of technology is expanding the field rapidly. In the past, a design course could spend an entire semester focusing on two or three key areas, but now the practice of design has become more expansive, multidisciplinary and collaborative, and students today are versed in multi-tasking and sharing information (e.g. social media). In order for academia to remain current, we need to explore new classroom models and reinvent in-class structures to create new environments for learning, complex problem solving and design thinking.

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