Teach

DESIGN

Analysis
from
Three
Different
Analytical
Perspectives

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ABSTRACT
Design education encompasses various teaching strategies with classes typically evaluated by students at the end of the term. This evaluation is often perfunctory; in contrast, the observational research presented in this paper examines a variety of design classes as they are taught, then analyzes the observations through three perspectives: across instructor comparisons, comparisons across class activities with regard to student behavior and the relationship between manual skill and reflective practice in studio work. While the study has a limited scope, the methods and analytical perspectives suggest new ways to improve teaching and learning in design programs.

Teaching Design:

Analysis from Three Different Analytical Perspectives

Eric Swanson, Stacie Sabady and Chris Yin

Introduction: A Unique Opportunity

AS PART OF A TEACHING SEMINAR taught at the Institute of Design, IIT, seven students in the master and doctoral programs were given the same assignment: observe a design class, using video observation and a standard framework to be developed in the seminar and write an analytical paper based on their observations. Instructors were selected from the Institute of Design and at the Illinois Institute of Technology. All agreed to be observed during their teaching activities.

Because all seven observers of the classes used the same methods and worked with the same framework, the structure of this assignment lent itself to comparative analyses across all of the instructors:

- All observers had been trained in some form of video ethnography, typically used as a tool for user research in design.
- All observers worked on the frameworks used for logging data from the observations, increasing the cross-observer commonality.
- All observers filled out the same set of worksheets, in the same manner, with one student responsible for ensuring that all students filled out forms for all activities.
- All observers were available to the authors of this paper (who were also observers) to answer questions about their observation data and to ensure validity across responses.

Three authors—three perspectives

THE THREE AUTHORS OF THIS PAPER approached the data from three analytical perspectives, from the broadest to the narrowest:

Perspective 1: Across-Instructor comparison, using the 'Overall Observation' worksheets, some of the data from the more specific 'activity analysis' worksheets, as well as additional information from the prior year's student evaluations of instructors.

Perspective 2: Across-Learning-Activity comparison of overall student experience, primarily using the 'activity analysis' and 'aeiou'worksheets (activity, environment, interaction, object, use), that researchers filled in once during class activity.

Perspective 3: Across-Student comparison within the individual studio learning activity, using protocol analysis of the source video recordings and some data from the 'timeline' worksheets.

Observees

THE INSTRUCTORS REPRESENTED vary in age and teaching experience. Some of these instructors are seasoned professors with many years of experience as teachers and practitioners. Some are adjunct professors teaching on a part-time basis with jobs as consultants or with their own practices. Others are novice teachers, teaching for the first time at the college or graduate level.

All the instructors observed taught some form of design, but the specific topics ranged widely within the design field, including product design studio workshops, systems analysis classes, introductory classes covering design as a topic and human factors classes. The students were mostly graduate students, but they could also be in different levels of their studies. Some of the courses were for the Foundation year students admitted to the program without a prior design background. Other students, who had an undergraduate background in design and a few years of working experience, were in their first and second year of a two-year graduate design program. Ph.D. students and students with six years or more professional experience pursuing a one-year masters degree were less common. Students also came from different cultural, ethnic and academic backgrounds, and varied significantly in their abilities to speak and write in English, in which all classes were taught.

Methods

ALL INSTRUCTORS WERE OBSERVED UNDER CLASS SITUATIONS, with observers taking notes and using video ethnography to allow review of the class sessions afterwards. As mentioned, a set of frameworks ensured that uniform data was captured for analysis. The basic framework included forms to be filled out by the observer that included analysis based on the use of semantic differentials, timelines and questionnaires. The observation focused on the instructor as well as student reactions based on various activities including lectures, presentations and studio activity. The framework provided two levels of analysis: overall analysis of instructor and course, and a more detailed analysis broken down by individual learning activities within the class.

Aspects of instructional delivery included adaptability to events happening during class, adherence to a script and how structured the overall class was. Class preparation and the degree of structure in the use of time and content were also captured along with tools and supporting materials. The student experience was also recorded to reflect student participation in class activity. Interaction among students, attention and engagement in class, enjoyment of the material and whether there was any confusion with the course material was noted.

Instructor Biographies and Course Descriptions

Instructor A (System Evaluation) Instructor A is a professor at the Institute of Design whose emphasis is on teaching design planning and methodology. An expert with significant research and professional experience in the areas of structured planning and development of computer-assisted design support systems, he teaches System Evaluation, a course that introduces methods for evaluating complex systems. Methods are introduced to describe systems generally in terms of the policy requirements they should follow, the functions they should perform and the particular forms they have assumed as instantiations of the models. Techniques for evaluating individual system performance are used to measure performance.

Instructor B (Introduction to Product Design) Instructor B is a Ph.D. candidate at the Institute of Design, teaching students in the Foundation year studies. He worked previously as a furniture designer and has a Master of Arts in Design. The Introduction to Product Design for Foundation-year students, covers basic product design skills such as drawing, prototyping and establishing criteria for design. The course develops product design knowledge, the ability to understand products and the methods by which they are designed.

Instructor C (Design Planning) Instructor C is an adjunct professor at the Institute of Design with a focus on Design Planning and Strategy. He frequently lectures and teaches on innovation and strategy and is president of a consultancy that focuses on innovation strategy. Design Planning develops understanding of the basic ideas, frameworks and capabilities that innovation planning demands and connects ideas ranging from business planning fundamentals, to modern frontiers of design and innovation planning.

Instructor D (Product Design Workshop) Instructor D is an associate professor and head of the Human-Centered Product Design track. With a Master of Science in Design degree and an undergraduate engineering degree, he has over twelve years of experience in product design, user experience research and their implications for business strategy; he also is a partner in a research and development consulting firm. The Product Design Workshop focuses on the use of prototyping within

the context of a design project that includes contextual research, conceptualization, testing and refinement. Students are expected to develop an appreciation for using prototypes throughout the design process to understand, explore and develop a new product.

Instructor E (Introduction to Design) Instructor E is an adjunct professor at the Institute of Design, teaching students in the Foundation studies. Trained as a graphic designer, she has a Master of Design in Design Planning and is a consultant for design firms and major corporations in the Chicago area. The Introduction to Design course helps to establish a context for design for Foundation students. The course surveys design history with emphasis on design movements from the Industrial Revolution up to the present, to establish an understanding of change in professional practices in design as well as learning how to present ideas and work in teams.

Instructor F (Design in Context of a Business) Instructor F is an adjunct professor at the Illinois Institute of Technology teaching students in the undergraduate business program. She works as a design researcher and has a Master of Design degree. Design in the Context of a Business is a course that focuses on the role of design in business. The course is taught with case studies related to both design planning and human-centered design. Students learn how design interacts with other forces including competition, technology, channels of information and distribution. Particular attention is paid to how, within the context of all of these forces, design can benefit and bring value to organizations.

Instructor G (Physical Human Factors) Instructor G is an adjunct professor at the Institute of Design. Instructor G is an interaction designer, human-factors engineer and visiting scholar with a background in mechanical engineering and product design. Physical Human Factors is an overview of physical human factors covering size, work, performance and sensation. The class focuses on hands-on learning with do-it-yourself methods for understanding concepts and issues.

Analytical Perspective 1: Across-Instructor Comparisons

IN GENERAL, FEW DIFFERENCES AMONG INSTRUCTORS EMERGED directly from the numerical data. This supports the correlations

in the next section: among this limited group of instructors, the greatest differences in student experience and instruction technique occurred between types of activities rather than between individual instructors. When analyzed instructor-by-instructor, the values tend to cluster on the same side of average for all instructors.

Structure vs. Engagement

The primary pattern that emerges from the data relates to the instructors as a group. All instructors fall in the "Students Involved/Structured" quadrant, suggesting both that the classes are well-organized and that the students generally engage with, participate in and enjoy the classes *(figure 1)*.

Class Structure	**Composite Student Involvement**
Use of time (average 4.1)	Participation (average 3.9)
Unstructured ○○○●○ Structured	Inactive ○○○●○ Active
Content (average 3.8)	Attention (average 4)
Unstructured ○○○●○ Structured	Not engaged ○○○●○ Engaged
Syllabus (average 3.6)	Enjoyment (average 3.3)
Unstructured ○○○●○ Structured	Unhappy ○○●○○ Happy

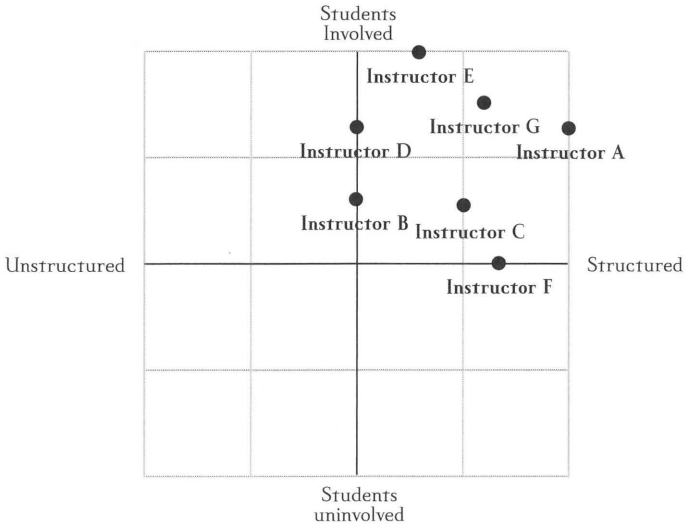

FIGURE 1
Student involvement and class structure

Reflection vs. Concreteness

Here, composite values are averaged for all 'reflective' scales (Class-time, Assignments, and Class objectives), and compared to 'content abstractness.' Once again, instructors fall within a narrow range; all classes involved an above-middle to much above-middle 'Reflective Practice' activities (as described by Schön, 1982). This correlates nicely with the concept of design as a reflective practice *(figure 2)*.

Content Abstractness

This varies significantly. At the 'concrete' extreme, we find classes that are information-rich: Instructor C's class during the observation was discussion of a collection of frameworks; Instructor G's class explored physical factors. At the 'abstract' end, Instructor A's class introduced concepts of system evaluation (still early in the session, Instructor A may have been focusing on concepts), while Instructor D's product design workshop was split between a very concrete tutorial and more abstract one-on-one studio sessions *(figure 2)*.

As in prior diagrams, this tells us more about the institution than the instructors: as a school of design, it deals in reflection; as an analysis-heavy design program, the abstractness of studio activity is contrasted with the concreteness of analytical processes.

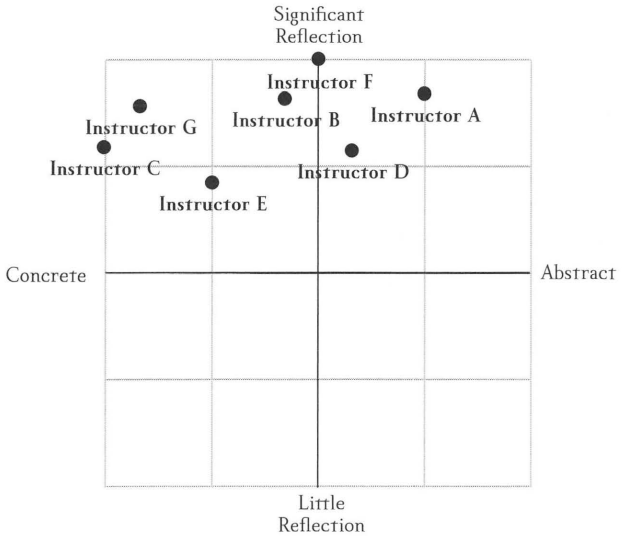

FIGURE 2
Nature of class material and reflective activity

What is a guru? When students within in the school discuss instructors, however, they differentiate sharply between most of the instructors and Instructor C, who is often called a 'guru.' The other instructors with significant experience, Instructors D, G and A are also generally described by students as knowledgeable and skillful, but more different from Instructor C than from each other.

To examine this phenomenon, we turned to another set of quantitative data: teacher evaluation survey results, filled out online by students after the completion of the course. All four long-term instructors taught the same course in the prior semester. We specifically looked at two questions: "The instructor makes students feel free to ask questions" and "The instructor treats students with respect." Three of four instructors differ by less than 0.1 points (out of 10 possible; 1% of the entire scale); Instructor C differs from that group by 1.8 points (18%). Yet, despite this difference, Instructor C still groups with the other instructors on the scale of engagement. The students may not feel as comfortable with Instructor C, but they still pay attention.

Analytical Perspective 2: across activities

Introduction

WHEN ARE STUDENTS PARTICIPATING? WHEN ARE STUDENTS ENGAGED? If we restrict our field of vision to comparisons between instructors, our data tells us that there is very little difference. Instead of looking solely at individual instructors (where the difference was so small it could be entirely based on the differences between observers), we looked at the breakdown of student's experience across different instances of the same teaching activities. The goal was to find patterns that would help us answer these questions and tell us in what situations these positive results were achieved. To understand when and why engagement and participation occurs, we looked at two more questions: Are the students confused? Are they enjoying themselves? This would hopefully show us why the students are, or are not, engaged and participating.

Research Observers were asked to rate the level of Participation, Engagement, Enjoyment, and Confusion the students had during each observed activity. The overall class time was divided into activities by the observers depending on what the instructor was doing. Observers used the criteria below when assigning a rating to a specific activity on a scale of 0-4, where 0 is none and 4 is the highest value *(see tables 1-4)*.

PARTICIPATION

By Class		Avg.
B–Lecture	2	
B–Studio	4	
B–Stu-Present	4	3.3
A–Lecture	4	
A–Stu-Present	2	
A–Team Meetings	3	3
D–Lecture 1	3	
D–Lecture 2	3	3
C–Lecture	1	1
F–Lecture	2	2
G–Lecture	4	
G–Team Activity 1	4	
G–Team Activity 2	4	4
E–Stu-Present	4	
E–Lecture	3	
E–Q&A	3	3.3

By Activity		Avg.
Group-Pres–E	4	4
Lecture 1–D	3	
Lecture 2–D	3	
Lecture–F	2	
Lecture–B	2	
Lecture–A	4	
Lecture–C	1	
Lecture–G	4	
Lecture–E	3	2.8
Q&A–E	3	3
Studio–B	4	4
Stu-Pres–B	4	
Stu-Pres–A	2	3
Team Activity 1–G	4	
Team Activity 2–G	4	4
Team Meetings–A	3	3

By Observer Rating	
4	Group-Pres–E
4	Lecture–A
4	Lecture–B
4	Studio–B
4	Stu-Pres–B
4	Team Activity 1–G
4	Team Activity 2–G
3	Lecture 1–D
3	Lecture 2–D
3	Lecture–E
3	Q&A–E
3	Team Meetings–A
2	Lecture–F
2	Lecture–B
2	Stu-Pres–A
1	Lecture–C

TABLE 1
Scoring for Participation

ENGAGEMENT

By Class		Avg.
B–Lecture	2	
B–Studio	4	
B–Stu-Present	3	3
A–Lecture	3	
A–Stu-Present	2	
A–Team Meetings	3	2.7
D–Lecture 1	3	
D–Lecture 2	4	3.5
C–Lecture	3	3
F–Lecture	3	3
G–Lecture	3	
G–Team Activity 1	4	
G–Team Activity 2	4	3.7
E–Stu-Present	4	
E–Lecture	4	
E–Q&A	2	3.3

By Activity		Avg.
Group-Pres–E	4	4
Lecture 1–D	3	
Lecture 2–D	4	
Lecture–F	3	
Lecture–B	2	
Lecture–A	3	
Lecture–C	3	
Lecture–G	3	
Lecture–E	4	3.1
Q&A–E	2	2
Studio–B	4	4
Stu-Pres–B	3	
Stu-Pres–A	2	2.5
Team Activity 1–G	4	
Team Activity 2–G	4	4
Team Meetings–A	3	3

By Observer Rating	
4	Group-Pres–E
4	Lecture 2–D
4	Lecture–E
4	Studio–B
4	Team Activity 1–G
4	Team Activity 2–G
3	Lecture–F
3	Lecture 1–D
3	Lecture–A
3	Lecture–C
3	Lecture–G
3	Stu-Pres–B
3	Team Meetings–A
2	Lecture–B
2	Q&A–E
2	Stu-Pres–A

TABLE 2
Scoring for Engagement

ENJOYMENT

By Class		Avg.
B–Lecture	3	
B–Studio	0	
B–Stu-Pres	2	1.7
G–Lecture	2	
G–Team Activity 1	1	
G–Team Activity 2	4	2.93
A–Lecture	3	
A–Stu-Press	2	
A–Team Meetings	2	2.3
E–Group-Pres	4	
E–Lecture	4	
E–Q&A	3	3.7
D–Lecture 1	4	
D–Lecture 2	3	3.5
C–Lecture	3	3
F–Lecture	1	1

By Activity		Avg.
Group-Pres–E	4	4
Lecture 1–D	4	
Lecture 2–D	3	
All-Disc–F	1	
Lecture–B	1	
Lecture–A	3	
Lecture–C	3	
Lecture–G	2	
Lecture–E	4	2.6
Q&A–E	3	1.5
Studio–B	2	2
Stu-Pres–B	3	
Stu-Pres–A	2	2.5
Team Activity–G	4	
Team Activity 2–G	4	4
Team Meetings–A	2	2

By Observer Rating	
4	Team Activity–G
4	Team Activity 2–G
4	Group-Pres–E
4	Lecture–E
4	Lecture 1–D
3	Lecture–A
3	Q&A–E
3	Lecture 2–D
3	Lecture–C
2	Studio–B
2	Lecture–G
2	Stu-Pres–A
2	Team Meetings–B
1	Lecture–B
1	Lecture–F

TABLE 3
Scoring for Enjoyment

CONFUSION

By Class		Avg.
B–Lecture	2	
B–Studio	0	
B–Stu-Pres	2	1.9
G–Lecture	3	
G–Team Activity 1	2	
G–Team Activity 2	4	3
E–Group-Pres	4	
E–Lecture	4	
E–Q&A	3	3.7
D–Lecture 1	1	
D–Lecture 2	2	1.5
C–Lecture	1	1
F–Lecture	3	3

By Activity		Avg.
Group-Pres–E	1	1
Lecture 1–D	1	
Lecture 2–D	2	
All-Disc–F	3	
Lecture–B	0	
Lecture–C	1	
Lecture–G	3	
Lecture–E	4	2
Q&A–E	3	3
Studio–B	2	2
Stu-Pres–B	2	2
Team Activity–G	3	
Team Activity 2–G	4	3.5

By Observer Rating	
4	Team Activity 2–G
4	Lecture–E
3	Lecture–G
3	Team Activity–G
3	Q&A–E
3	Lecture–F
2	Stu-Pres–B
2	Studio–B
2	Lecture 2–D
1	Group-Pres–E
1	Lecture 1–D
1	Lecture–C
0	Lecture–B

TABLE 4
Scoring for Confusion

PARTICIPATION
0 Students fail to participate when given the opportunity
4 Students actively participate

ENGAGEMENT
How much do the students seem engaged in the class activity? Were they focused? Did they follow along?
0 Not engaged
4 Highly engaged

ENJOYMENT
Did the students seem to have fun, or were they uncomfortable or unhappy?
0 Students show little enjoyment
4 Students show great enjoyment

CONFUSION
Did they appear confused about the class content, the class process (e.g. assignments), or the teacher's expectations?
0 Students show much confusion
4 Students show little confusion

Assumptions
Before looking at the data, we found we had made some 'common sense' assumptions:

1) If participation is high, engagement will be high as well.
2) Any class with high confusion will also have low enjoyment.
3) Design students will not engage as readily in lectures as in other classroom activities.

Analysis
Observation ratings were compared in the following ways:
Engagement to Participation
Engagement to Enjoyment
Engagement to Confusion
Enjoyment to Confusion
Enjoyment to Participation
Participation to Confusion
Data were grouped in the following ways:
Within each area of interest (e.g., Engagement, Participation), ratings were grouped and ordered by Class, by Activity and by the Observer Rating (the number the observer assigned the activity in regard to area of interest).

Correlations (Behavior)

1) Engagement vs. Participation (=)

The majority of the time, the ratings for these two matched each other. Participation may be a rough measure of engagement, since the physical behavior of participation is more easily observed than engagement. It is much easier to judge if a student is participating (they raise their hand, ask questions, etc.), than if they are engaged. A student may be engaged but look as if they are not paying attention at all, because this is a more personal, and sometimes internal, behavior. So, the pre-analysis assumption that if participation was high, then engagement would be high was correct.

When there were differences in scores, they usually were not very pronounced. There was one instance of an activity (Lecture) where the level of engagement was markedly higher (2 points) than the level of participation. The class was taught by Instructor C who has 'guru' status at the school and in his professional work outside the school. Students want to impress this teacher, and this teacher seeks to impress the students with his knowledge. This can lead to an intimidating situation; by maintaining his status, the instructor can appear unreachable and not at all like a peer. Intimidation, either student or teacher initiated, can reduce the student's comfort to participate even if the engagement level is high.

Engagement vs. Enjoyment (=)

Similar to Engagement vs. Participation, the pattern that arose in this pairing was not that one was higher than the other, but that they mimicked each other. If one was high, then the other would be high. In this situation, however, these two are more alike than in the previous pairing where the existence of one (participation) could indicate the existence of another (engagement). Here, the two behaviors are similar in that if a student exhibits one (enjoyed) then they also exhibit the other (engaged). Yet, it still may be easier to judge if students are enjoying themselves rather than if they are engaged. So enjoyment may, in addition to participation, be a measure of engagement.

In a couple of cases where this pattern was not found, it could be argued that this was due to the nature of the activity itself not being enjoyable. In the first situation where engagement was higher than the level of enjoyment, the activity was Studio time in Instructor B's class. This type of activity is significant and involving for students. They are committed to it and it is very personal

for them. They are not exactly enjoying themselves, but rather their level of engagement overpowers their level of enjoyment because they are concentrating so hard on the task at hand. The second time Engagement and Enjoyment diverged was in Instructor F's Lecture where students 'seemed mostly bored' according to the observer. Since the average enjoyment rating for Lecture was about two points higher than in this particular class, this situation is probably more about the style of the teacher than the nature of the activity, although the topic of the lecture may also have some effect in this case.

Engagement vs. Confusion (e > c)

In most activities, the level of engagement was higher than the level of confusion. This makes sense. So, just as participation and enjoyment may be a measure of engagement, the level of a student's confusion may be as well.

In a few classes, however, the level of engagement equaled the student's confusion. The main activity where this was the case was in Lectures. The average for all Lectures follows the pattern of engagement being higher than confusion. As in the case where engagement is higher than enjoyment in the Lectures, this disparity may be due to either the teacher's style or the lecture topic. For whatever reason, it is positive that some confusion did not cause the students to disengage. As long as the course material was not too far over their heads, a little confusion may be okay for the students and actually keep them interested.

Enjoyment vs. Confusion (e > c + e ? C)

In comparing specific activity types against themselves (Instructor A's Lecture vs. Instructor B's Lecture), enjoyment ratings were higher than confusion ratings. In looking at the enjoyment level and the confusion level within a particular class (Instructor G's Lecture vs. Instructor G's Team Activity), there was less of a consensus. Some classes had a high level of enjoyment and a lower level of confusion whereas other classes had a low level of enjoyment and a higher level of confusion.

In a way, this makes sense. If the level of material matches the comprehension level of the students, enjoyment ratings would presumably be higher than confusion ratings within each activity. However, when considering the class as a whole instead

of in its parts, there is more opportunity for confusion to arise. The change from activity to activity creates an opportunity for confusion to occur regardless of material being taught. It is in this change from activity to activity where real teaching can happen. Moving from activity to activity is like moving from step-to-step in the learning/teaching process. Here it is not the nature of the activity, but rather the inherent nature of teaching and learning that creates the confusion.

So, the second pre-analysis assumption was proved to be incorrect, when comparing activity to activity across different classrooms, but correct when looking at the individual class as a whole. Just as a little confusion might not affect a student's engagement, a little confusion might not hurt their enjoyment.

Enjoyment vs. Participation (e < p)

Most classes had a higher level of participation than enjoyment, but the difference was small. While it is good the students participated, they may not do it very enthusiastically if the level of enjoyment is not there. Quantity may be overtaking quality. When comparing activities, the average level of enjoyment for Lectures was 2.6, and the average level of participation for Lectures was 2.8. This was a surprising and hopeful find, since lectures are sometimes considered a necessary evil. They are a useful tool in relaying information to students, but are not always the most active of methods. In the classes observed, the teachers were doing something right if the students were both participating and enjoying themselves.

The two cases where participation was lower than enjoyment might relate to the personality of the teachers. Spoken highly of within the school, students seem to enjoy Instructor D's way of interacting with them (humorously, gregariously). Instructor C is the 'guru' who students look up to, and who also delivers dynamic lectures. Whether because the students are enjoying the 'show' put on by the teacher, or are intimidated into silence, the students are not participating but they are enjoying themselves. This may not be bad if they are learning something in the process, but since we have suggested that participation may be a measure of engagement, this could be a problem if engagement is the desired behavior.

Participation vs. Confusion (p > c)

Generally the level of participation was higher than the level

of confusion. Again, this is not a surprising find. This can mean a few different things depending on the degree of difference. It could mean that the student level of comprehension was higher than what they were learning, and were participating out of boredom. The material may have been just right for the students, and they were comfortably learning. If the students were really confused because the material was too tough for them, then at least they did not have a problem speaking up.

In both the first and third situations, care should be taken. If a student is bored, then it is unlikely that learning is taking place. Also it is not good if the student is overwhelmed by the material, even if they are participating, because not all students speak up when they are confused. A few students voicing their confusion may represent the entire confused population, but they may just be more vocal than the rest. Either way, the level of participation should be paid attention to as it is a good, if inconsistent and subjective, indicator of confusion.

Position Map (Activities and Correlations)

ACTIVITIES ARE GENERALLY SHORT AND SIMPLE (straightforward one- or two-week assignments) or long and wicked (half- or full-semester long and complex). The exception is the philosophical discussion (Lecture). The philosophical element brings complexity to an otherwise simple problem for the student.

The symbols in Figure 3 (next page) refer to the analysis of the next several pages.

Using average numbers gathered from the findings, the following correlations were made in terms of class activity.

Team Activity

(High Enjoyment, Participation, Confusion, and Engagement)
Due to the game-like nature of the activity, the class taught by Instructor G had high enjoyment, high participation, high confusion and high engagement. In this class, competition between teams was an impetus for learning, rather than a ego-based competition where victors would be declared 'better' than losers. This is a competitive school and Instructor G found a way to get that to work to the advantage of the students. In general, this activity took a little time and presented a relatively simple problem for the students to solve. Specifically, it was highly interactive between students. Students had to come to a consensus intellectually to solve a problem, and also had to

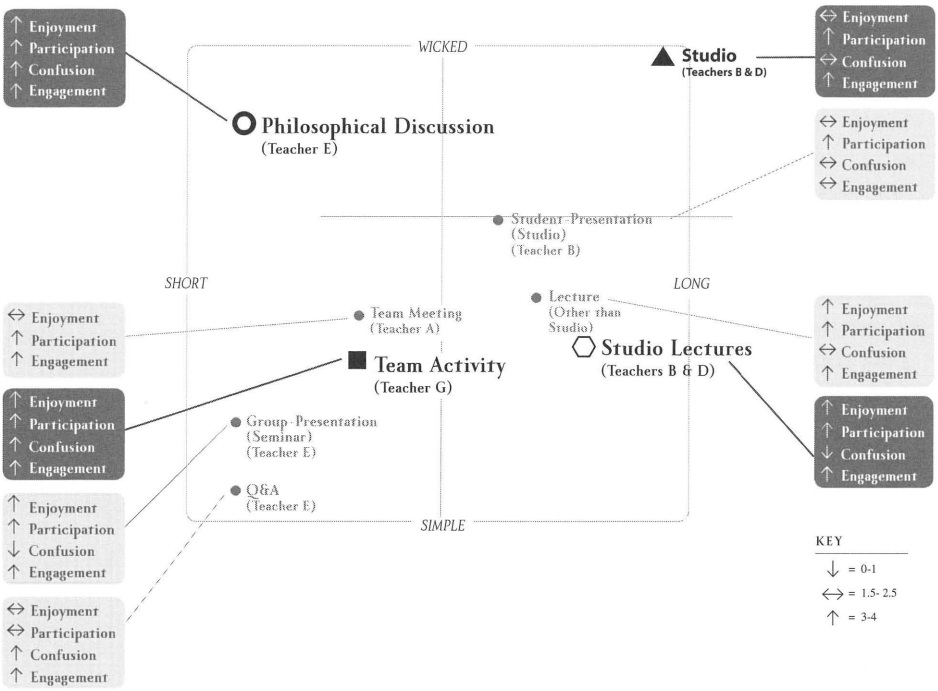

FIGURE 3
Problem complexity vs. length of project
(from student's perspective)

work together physically. This varied work requirement leads to the high level of confusion amongst the students.

Studio Lectures
(High Enjoyment, Participation, Engagement and Low Confusion)
For this activity, the Lectures that took place in the Studio classes were analyzed. They are similar to the Team Activity in three areas. The Studio Lectures given by Instructors B and D had high enjoyment, high participation and high engagement. Students needed to listen and pay attention since this activity relates to the Studio that students take seriously. What makes this different from the Team Activity is the low confusion level. This is because the lectures themselves represent a rather simple problem for students to navigate. The studio lectures address problems that cover longer periods of time than a single week

or class. This may be due to the fact that they are connected to the Studio that is in itself a rather lengthy process.

Studio Time

(High Participation & Engagement, Medium Enjoyment & Confusion)
As has already been mentioned, Studio work is a serious endeavor for the students. This is reflected in the high levels of participation and engagement among students. They need to pay attention if they are to follow along and do what will be asked of them—or even to comprehend what will be asked of them. As with the Studio Lectures, these activities were taught by Instructors B and D.

In the transition from Studio Lectures to Individual Studio Instruction, there is a drop-off in enjoyment for the students and an increase in confusion. This could be because in the Lecture portion of the Studio, the teacher may discuss theory; but in the Studio, the students must put that theory into action. Confusion thus increases because they are learning how to solve the kinds of ambiguous and interrelated problems typical of design. Enjoyment decreases because they are more focused and they are 'doing' instead of more passively (and more publicly) listening. The type of performance anxiety present in Studio is likely to decrease student enjoyment level. In addition, the problems typically last eight or sixteen weeks, so a more serious and thoughtful approach is needed from the students than for the Lecture.

Philosophical Discussion

(High Enjoyment, Participation, Confusion & Engagement)
This activity in Instructor E's class had the same ratings for behavior as the Team Activity. All observed ratings were high. The Team Activity was more physical than this discussion; but both held the interest of the students, as reflected in the high levels of enjoyment, engagement and participation. A possible reason for students finding this activity captivating was the philosophical nature of the discussion.

Many people like to share their opinions. Philosophical debates lend themselves to such opinion giving and, being philosophical, are full of abstraction and ambiguity that brings them closer to the wicked end of the problem spectrum. Also, participants used several modes of communication methods: story telling, argumentation, conversation, summary, questions and humor. This rich environment encourages high levels of enjoyment, participation and engagement. The high confusion level appears additionally to

be partly a result of the situation getting out of Instructor E's control. Enjoyment was also enhanced by the low stakes situation; unlike studio, a philosophical discussion is a challenge lasting merely an hour or two.

Analytical perspective 3: Across Students – How closely tied do the teaching of manual design skills and reflective practice need to be?

WITHIN THE SEVEN OBSERVATIONS are two studio classes: a Foundation level three-dimensional design class taught to students entering the masters program without prior design experience, and a Product Design Workshop consisting of first- and second-year graduate students. Videotaped observations of the student/ instructor studio interactions total five and one half hours, covering twenty different students. Given the small size of the sample, this paper is about presenting provocative ideas.

In the prior sections' analysis, the studio portions of these classes were the only learning activity that did not earn the highest rating for student enjoyment. Also, both studio classes in the observation contained a lecture portion; in both instances, the studio lecture generated frequent laughter. The instructor-student studio work that followed, however, generated little laughter. Studio, it would seem, is serious business. And, the worse a student does, the more serious it becomes. In the words of one of the original observers, "Students [who] perform [poorly] would be discouraged from design activity."

Two very different sets of skills

In an institution that accepts students without a prior design background, studio-based classes serve two purposes *(see table 5)*: 1) to train students to be good designers by engaging them in reflective practice, and 2) to train students to be skillful in design ideation and use of communication tools (once called 'hand skills,' but which now includes abilities in using design visualization software).

Hypotheses

1) Students with poor manual skills will generally be at a disadvantage in learning reflective practice skills as they will have fewer documents or materials to use in student-instructor discussion.
2) Students with poor manual skills may fall into a cycle of

	Displayed little reflective move-making	Displayed multiple reflective moves and evaluations
Displayed poor manual skills	Mark Foundation	Terry Foundation
Displayed notable manual skills	David Foundation	Charlie Foundation

TABLE 5
Manual and Reflective Skills

using their manual skills solely in attempts to produce enough quantity of material to meet class requirements, missing entirely the reflective practice aspects of design.

3) Manual skills and reflective practice skills are different enough that they can be learned somewhat independently of each other.

This paper examines the differences in student's studio experiences based on their observed abilities or inabilities within each skill set. Due to the small sample size, we identified students at the extremes of both skills in various combinations. For assessment of manual skills, we found several instances in which instructors commented on student skills (if the student did not assess themselves).

For reflective skills, we looked for the reflective cycles described by Schön (1982):

In this reflective conversation, the practitioner's effort to solve the reframed problem yields new discoveries which call for new reflection-in-action. The process spirals through stages of appreciation, action and re-appreciation. The unique and uncertain situation comes to be understood through the attempt to change it, and changed through the attempt to understand it. (p. 132)

The practitioners' moves also function as exploratory probes of their situation. Their moves stimulate the situation's backtalk, which causes them to appreciate things in the situation that go beyond their initial perceptions of the problem... In both cases, further, the practitioner's reframing of the problem of the situation carries with it a hypothesis about the situation. He surfaces the model of the phenomena associated with his student's

framing of the problem, which he rejects. He proposes a new problem and with it, a new model of the phenomena, which he proceeds to treat as a hypothesis to be tested. (p. 148)

Based on Schön's descriptions, the elements of reflective practice watched for included: 1) student-generated plans for using design media to experiment; 2) student evaluation of their own work outside of issues of build quality; 3) the use of terms that imply an ongoing process of experimentation, such as 'play with [something].'

Using these criteria, students were identified who fit all four quadrants of the original 2 x 2 grid, although the final quadrant - notable manual skills and strong reflective moves and evaluations - was filled with a Foundation student, so the student's manual skills are relative to other Foundation students. (Of course, names of all the students have been changed.)[1]

Example student	Hand skills	Reflective move-making
Mark Foundation	Poor	None observed

TABLE 6
Observation

1 The data set is small and homogenous.

Observations

Mark struggled mightily with his work, and frequently expressed frustration *(table 6)*.

> Mark: "I tried to [create] this shape... no no I have no idea. I tried to five times but I couldn't figure it out. I can imagine that kind of shape, but when I try to sketch it, I dunno"
>
> *Instructor: "Can you visualize it on paper?"*
>
> Mark: "I dunno some kind of line like image but I can't imagine"
>
> *Instructor: "Sometimes we can imagine some shape, but it's hard to articulate it. ... If you cannot visualize by sketch or computer tools or anything, it's very hard to communicate with other people."*
>
> Mark: "I can visualize it, on this paper, but not to mark it."

The instructor begins to sense the student's frustration and

respond to that - much like the interaction between David (another student who displayed little reflective move-making) and his instructor.

Instructor (later, after examining some of Mark's model-related sketches)
"You need to calm [come?] down. You need to calm down. You got a lot of design... You need to calm down."

Mark is in a very unhappy place. Instead of being able to use his manual skills to explore and experiment with design ideas, his evaluation skills have slipped in to self-criticism. There is no energy in this struggle to evaluate the design hypotheses

Example student	Hand skills	Reflective move-making
Terry Foundation	Good	Observed

TABLE 7
Observation

themselves; instead, Mark's critical and evaluative skills are targeted to the quest of figuring out what is going wrong with his own technique.

Unlike several of the other Foundation students, Terry responded energetically when the instructor asked which of her models she likes best *(table 7)*. She both answers the question and engages in spontaneous evaluation of her own designs. While she is not as articulate in her judgments as Charlie (who appears later), the student with better hand skills who also displayed reflective evaluations, she is able to make qualitative judgments and re-evaluate her own designs once they are in the world.

Terry: "My favorite is this one"

Instructor: "Can you tell me why?"

Terry: "Um I dunno I mean I guess I just sort of like the overall shape. I mean I guess its I like this part of it. I mean, so it does need something. Like looking at it again, it needs something at the bottom."

Instructor: "What about this?"

Terry: "I hate that one."

Instructor: "You hate that one? Why?"

Terry: "I dunno it's just it's like so boring and like I don't know."

While discussing one model, the foam breaks in two in the instructor's hands.

Terry: "Uh oh"

Instructor: (Holding one half of the broken model) "This one might be good. Design by accident."

Terry: "Yeah that one would be a little bit better if my craft was better. That was my experimentation with the wire cutter. Didn't come out so well."

Later, they discuss another model.

Terry: "The thing I don't like about this one, though is it's very like one-sided. And so like outside there's nothing. So but like I wasn't really sure how to reconcile that without sort of ruining what I have."

Instructor: "Because if this model is not precise that's why it's a little you know weird or something."

Terry: "I just feel like that one's so boring. It looks like a monument anyone can make."

Example student	Hand skills	Reflective move-making
David Master of Design	Good	Not well demonstrated

TABLE 8
Observation

One stark contrast stands between Mark, the student with neither the hand skills nor reflective technique, and Terry, who even while struggling with craft, directs her critical thinking to the outcomes of the design moves.

David came to class prepared with a collection of vivid quick sketches, rendered in pencil and marker - the most vivid sketches seen in the videotapes of both studio classes *(table 8)*. However, instead of exploring other alternatives or evaluating his design moves, David spends his time describing his concept

at length, and responds quizzically to the instructor's design process suggestions. (Note: David spoke quietly, so not all of his utterances could be decoded).

Instructor: (after several minutes of discussion about the technology offering behind the design idea). "I want you to stay with the concept – and design it."

(David starts describing the object depicted in the sketches, then returns to describing the technology elements of the solution).

David seems to be responding to the instructor's design practice suggestions by trying to identify specific homework assignments. He takes audible mental notes of any mention of assignments by the instructor.

Instructor: "Can you do a few more versions of this? This idea is that the form is very musical. Is that the idea? ... Can you do a few more language concepts?"

David: "Language concepts. Sure."

Instructor: "Because I think this is definitely one direction, but it's a little too funky... And I don't want you to refine this; I want you to do things like this (gesturing at sketches) in a couple of different. Cause we'll start developing a language. Right now it's a very quick concept, which is great to see... But we really want to more..."

Instructor: "I love the concept."

David: "do more alternatives."

As the instructor talks about what kinds of alternatives to explore, such as the ergonomics for a scanner, David jumps to a quick suggestion for a gun.

Instructor: "Well, you don't want a gun. That's too literal. Right?"

Much like Mark, the other student who did not display much reflective evaluation, David finds himself bewildered and at a loss for how to conceive of what to do next.[2]

David: "There's no criterion. It's just like..."

Instructor: "What do you mean by that? 'There's no criteria.'"

David: "I dunno. Now I pretty much got the idea down I need to know how..."

2 The students who are easiest to study using protocol analysis are the most talkative ones—predominantly American students whose native language is English. Two of the four observed students do not speak English as their native language, but were fluent and talkative during the observation. Unfortunately, both non-native speakers (one from Korea and one from China) fell on the 'reflective practice skills not observed' side of the matrix. No accounting has been made for cultural differences.

Instructor: "Design it. You just have a concept, and you haven't designed it."

David: "What do you mean by design it?"

Instructor: "I mean, not just do a quick—for me this is like a placeholder, right, its like your first draft."

David: "You want like materials and things."

Instructor: "Form, details, relationships among things, a physical model ... it's just doing it at enough depth that it's not at a concept stage."

Instructor: "Either developing that language or other languages. Is what it means to kind of design through a product."

David: "And later how do you choose one?"

Instructor: "You choose by saying 'it should be like this.'"

Instructor: "It's just working through some of the implications of what your concept suggests to see whether it's a viable direction or not. You will have criteria to evaluate. It's not just it's not arbitrary."

Instructor: "You're very good at quick visual sketches, but I want to get deeper."

Example student	Hand skills	Reflective move-making
Charlie Foundation	Above average	Significant demonstration

TABLE 9
Observation

The final quadrant in the grid is occupied by Charlie, whose hand skills were above average within the Foundation class, based on the quality of the models he brought to the discussion with the instructor *(table 9)*. The reflective assessments of his work are particularly dense and descriptive, suggesting that his hand skills have provided him with more to speak about design—or, perhaps, his aesthetic vocabulary has enhanced his ability to engage in craft.

Charlie: "You seem to feel the strongest about that one. I think it probably is the most strong. I was afraid to do it because it

was hard to do. I was pleased with the proportions in terms of the response I get from that."

Charlie: "I think the overall idea of the concept of this stays intact. Sharpening the diamond-shaped object articulating that more. And playing with this possibly to do that on the other ones. I can even see a circle or a button here or just tighten up. Something to" (gesture of closing or tightening)

Discussion

Based on these observations, we can revisit the hypothesis.

1) *Students with poor manual skills will generally be at a disadvantage in learning reflective practice skills as they will have fewer documents or materials to use in student-instructor discussion.*

In the observations, the students who did not engage in reflective activity still had sufficient materials to engage in discussion with their instructors. The missing resource for these students was design-centered evaluation. The student with poor manual skills focused all of his evaluation on his own inabilities, apparently unable to separate evaluation of his design moves from critical personal evaluation of his skills. The student with high-level manual skills did not view design ideation and communication techniques as a way of exploring a design, but rather as a way of precisely representing a specific final idea.

2) *Students with poor manual skills may fall into a cycle of using their manual skills solely in attempts to produce enough quantity of material to meet class requirements, missing entirely the reflective practice aspects of design.*

While the data set is too small to draw firm conclusions, obsession about producing enough 'stuff' - or the correct 'stuff' - appeared only in the two students who did not engage in reflective practice. In the absence of a strategy for making design moves, perhaps these individuals are at a loss as to what kind of moves to make at all.

3) *Manual skills and reflective practice skills are different enough that they can be learned somewhat independently of each other.*

The observations do support this, given that the problems with reflective practice occurred in both the student with the worst manual skills and the student with the best.

The A-student trap There is one speculative, but tantalizing, possible explanation for the struggles of the non-reflective students: they are struggling so much because they are doing everything they know to succeed.

The methods that excellent students use to succeed in non-design programs can turn disastrous when trying to learn reflective practice. One path to excellence is to *1)* understand exactly what the instructor expects for an assignment, and do that precisely; *2)* draft, edit and refine repeatedly; *3)* listen to the instructor's evaluation and use that as a guide for correcting one's work.

This pattern backfires when attempting to become expert at reflective practice. Assignments have deliverables, but the deliverables are an outcome of the strategy of reflective practice. Attempting to create the precise deliverables won't meet the instructor's requirements. The draft-edit-refine metaphor isn't reflective practice, but it looks a bit like it. Both draft-edit-refine and reflective practice involve creating materials that are sketchy, discarding intermediate work products and moving eventually to something refined and final. But draft-edit-refine follows a narrow path to a roughly known solution; reflective practice follows an improvisational path where both solution and problem are explored simultaneously. And, when it comes to using the instructor's evaluation, no matter how hard the student attempts to correct their 'errors,' there are always new ones. The evaluation part of reflective practice looks like criticism.

In struggling, the draft-edit-refine student is likely to work even harder on those techniques that have worked in the past. Unlike in the past, however, working harder doesn't help. This could be quite frightening—at the very worst, they may wonder if they are even fundamentally capable of success.

To become successful reflective practitioners, 'A' students must come to the understanding that student Terry has: evaluation is not criticism, but the core of design. Problems with craft are problems when they interfere with the ability to evaluate.

Suggestions for training reflective practice for students without a design foundation

STUDENTS IN FOUNDATION CLASSES are particularly vulnerable to Mark's predicament: struggling so much with their manual production skills that they are unable to engage in reflective

practice. There are several possible consequences of this struggle:

1) Lacking confidence in their own actions, including work they have completed, the students are reluctant to present work to their instructors.

2) The pace at which they produce deliverables is slowed to the point where they miss the opportunities to discuss the materials.

3) Their lack of opportunity to explore the concepts of design practice may blind them to understanding the purposes of their assignments and class activities, making them seem arbitrary.

4) Their lack of success in producing material can result in an emphasis on production– "what do you want me to do?"–over utilizing the method as part of design practice.

5) The instructor is stuck at cross-purposes when a student is not productive; they need to help the student out of the self-inflicted hole yet resist down-playing the importance of completing assignments on time to an expected quality.

With all these contradictory goals, the Foundation students who most need to spend studio time with the instructor are the ones who look forward to it the least.

Come back, clumsy student

HOW CAN DESIGN STUDIO be made welcoming to the Foundation student whose manual skills are not yet developed? For non-designers, studio is a learning experience much closer to learning in childhood than anything they've faced in their adult lives. For many, it's the first time in years–if ever–that they've been bad at something they're trying to learn. Both manual design production and reflective design practice are new skills that they must learn simultaneously.

Studio materials can be inherently intimidating. There is a tendency to show materials created only by people with significant manual skills–people who have already spent years mastering the craft behind design ideation (sketching, drawing, creating diagrams). After all, the people teaching design have generally been engaged in the craft perhaps decades prior to their work as an instructor. When they create new materials, they create the mate-

rials to their own skill level—a level students may try to mimic, but which is unattainable in a single year of studio work.

What can be done to make studio inviting for the klutz, while still fulfilling the fundamental purpose of developing non-designers into design students?

1) Expressly describe the qualities of a good designer; inform students of what the goal state for 'thinking like a designer' is, even if they cannot yet comprehend what that experience feels like. One of the first things new design students will notice about every good designer they meet will be the production skills those designers have developed over the years.

2) Illustrate reflective practice using materials deliberately selected (or created) for their un-extraordinary hand skills. The work of prior foundation students could be vital.

3) Explicitly separate instruction of reflective practice from manual skills and exaggerate their differences. Make this difference an explicit topic of discussion within early studio classes.

4) Create some assignments that de-emphasize the result over the process of achieving that result. A parallel here is in the teaching of math; instructors will ask students to 'show their work' so they can verify the student's conceptual understanding. For math students who occasionally make simple errors—dropping a minus sign, for example—showing their work lets the teacher grade them on conceptual knowledge rather than the accuracy of their answer.

5) Permit or even challenge students to engage in reflective design activities using poor hand skills.

6) Teach methods to improve a weak manual skill product into one that is good enough to serve a reflective design purpose alongside the skill to produce great design. Would Mark have been so stuck if he knew how to make his stuff a little better even a little bit at a time?

7) Offer a remedial skills path for those who show promise without style.

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