CONFESSIONS OF A CONSTRUCTIONIST: FIFTEEN YEARS OF UNDERGRADUATE INTERACTIONS – FOR BETTER OR FOR WORSE

James Clayson, Department of International Business Administration
and Department of Mathematics and Computer Science,
American University of Paris, France

To come to grips with the big ideas of statistics, students must often abandon certain ideas about how math works and how the world is constructed. They must accept ambiguity and uncertainty as givens and abandon the notion that there is such a thing as right or wrong answers independent of context. This leads to tremendous emotional stress because it requires more than technical facility. It implies a whole conceptual shakeup that can strike at deeply held beliefs about how we make sense of the world. I use a constructionist approach to help students develop a new perspective on problem-solving in a postmodern environment. As the paper shows, I have had mixed success.

SCENE OF THE CRIME

The work that I am describing takes place in a rather unusual institution – the American University of Paris (AUP) – a small, four-year, American-style liberal arts college located in Paris. The students at AUP come from 90 different countries, from diverse religions and cultural traditions and, typically, speak three or more languages. Despite their great diversity of backgrounds, however, all seem to share the same convictions about the physical world. For them, this world is highly stable, operating according to simple laws of cause and effect, and these laws are about formulas and pat answers rather than about exploration and hypothesis building. Despite evidence to the contrary, these students cling fervently to the modernist view that rules and procedures lead us inexorably to a correct answer.

When I first started teaching basic statistics, it never even occurred to me that my world view would be totally at odds with my students'. It certainly never occurred to me that a world view could even be relevant to learning a discipline. So when I entered my classroom at AUP I was totally unprepared either emotionally or intellectually for the drama that unfolded.

LATE BLOOMER

For one thing I entered teaching late; I was forty when I began in earnest. For another, because I came to AUP from a career in operational research and consulting, I thought the strengths of statistics for exploring real-world situations would be self evident

to students and all I had to do was to share my enthusiasm. I was also naive about teaching philosophies: I didn't realize there was such a thing. I certainly had no idea that my own approach carried the grand label of "constructionism". I came upon it – almost by accident – when I devised a course called "Visual Thinking" for the Parsons School of Design in Paris – in conjunction with AUP.

This experimental course mixed business and economics students from AUP with art and design students from Parsons. It was built around a series of design explorations using computer models based on the work of MIT constructionist Seymour Papert. In one project we looked at various ways of portraying depth on a flat surface by using different "spatial systems". We built models that simulated renaissance perspective and Japanese prints. We talked a lot about the process.

Art students are, by their very nature, curious. For example, given the task of drawing from a nude, the student will walk around, sketch a bit, walk around some more – in effect, looking at the exercise from a variety of angles. For the artist, too, a drawing is never quite finished. It is always in process, an exploration of one point of view within a vast field of possibilities. On the other hand, business and economics students are less open to exploration; their goal is to move ahead quickly to the "right" answer in a linear fashion. They tend to believe there is only one answer so they stop whenever they get one. But in this experimental class it was not a problem. Both groups learned from the other and we had a good time. Little did I realize – given the success of this experimental class in visual modeling – that these differences in outlook and expectations would prove fatal when I wanted to transfer a constructionist pedagogical approach to a statistics class.

LOST INNOCENCE

I believe the central goal of statistics education is to introduce students to the idea of manipulating uncertainty in a formal way. In this sense, it is not about right or wrong answers – but about navigating in an uncertain space. Not only was this unfamiliar territory to my liberal arts students but, as I began to realize as I relentlessly pursued my own constructionist approach, it turned out to be very emotionally threatening. Why should this be so?

I have found that most students arriving into the basic course in statistics are dyed-in-the-wool modernists: they use rules and procedures to solve problems that have been given them on the authority of a teacher and a textbook. They expect problems in statistics

to be like any other math problems. Math education for these students is only a question of accessing tools without any consideration for relations and contexts . The teacher is judged on how well the tools are transmitted.

According to this view, a tool is deemed useful only if it can be understood within the immediate class period. Unfortunately – or fortunately depending upon your point of view – my statistics classes do not follow this model. For, as I have already confessed, I am an unreconstructed postmodern constructionist. The tools we use must be crafted by the students themselves. They are almost never useful or usable within a single class period. We work together throughout the whole semester to construct a reality based on shared experience. We create our own textbook as we go along. That's the ideal, anyway.

STATISTICS IS FAR WEIRDER TO STUDENTS THAN WE IMAGINE

In reality, however, I must confess that my classroom is charged with emotion and conflict. The constructionist approach is much more stressful than the traditional way. I had always underestimated the importance of this factor, but now after 15 years, I am beginning to see that working through the stress – talking about it and acknowledging its reality – is at least as important as statistics itself. Indeed, until the stress is dealt with, there can be no breakthrough to the paradigm shift that allows students to make sense of statistics.

We forget, I think, just how weird statistics is to most undergraduates, certainly to the non-science ones. The modernist student expects to be given non-ambiguous rules and procedures to resolve complexity. These students want to eliminate uncertainty and ambiguity and they seem to believe that that is the purpose of science and math. Most of them know nothing of 20th century science paradigms. Points – not distributions – are what they want. The counterfactual world of hypothesis testing is unfamiliar to them and when asked to use words to help formulate notions of uncertainty, they think this is a waste of time. They do not see the connection between grammar that distinguishes conditional and subjunctive tenses, and degrees of probability and uncertainty. Consequently, they fail to appreciate that the ability to talk about a notion is a first step in constructing a model.

How often have we heard the universal student complaint when using some statistical software: "it doesn't work" ?. For me this is the crux of the matter. It reveals

the student's unwavering belief that ambiguity is merely a technical bug that can be "fixed", rather than a fact of life.

Unless students experience a personal paradigm shift away from this instrumental, rule-based, modernist mode of quick fixes and pat answers – to a more open-ended relational postmodern one where ambiguity is enriching – they won't grasp the big ideas of statistics. There must be a shift within the student's head.

MAKING A PARADIGM SHIFT: 7 LESSONS

For this to happen, students must be "enticed" to confront a problem they cannot "solve" using the modernist approach – but which might yield to insights gained through a more relational approach. Until they discover it for themselves – that statistics is about ideas, metaphors, imaginary worlds and more – they won't believe it. How can we make this paradigm shift easier?

1. A constructionist classroom must be structured around individuals. It is not a class for the lecture hall. 25 people in a class is the most I can handle.
2. A teacher cannot make the change for the student – it is a personal journey. But, the teacher can enrich the language, expand options and broaden the modeling space.
3. We need to introduce open ended approaches as soon as possible so that multiple viewpoints become familiar features of the landscape and, therefore, less threatening.
4. Since a change in paradigms only happens through problem solving, the teacher must encourage students to work on problems that are personally meaningful.
5. Constructionist ideas need a constructionist workspace. Students and teachers must be free to move from one area to another – from computer to blackboard to projector to desk – as in a real workshop. The learning environment should allow for free association.
6. A final project rather than a final examination is often the surest way of demonstrating to students that they are capable of making sense of a large, complicated data set. And best of all, their feeling of accomplishment at constructing their own model makes the stress and confusion worthwhile. In my

experience, students who build their own “solutions” are more likely to retain what they have learned.

7. Finally, the hardest lesson: the constructionist teacher needs to listen to his students and appreciate that the same words may be construed differently by the student and teacher.

GRID ANALYSIS OF CLASSROOM DYNAMICS

I would like to elaborate on this last point about language differences. I used George Kelly’s repertory grid theory to conduct an experiment that proved to be a real eye opener in understanding the stress in my classroom. Using repertory grid programs, I had four students elicit from their classmates the constructs they used to compare different teachers. Each student interviewed 10 other students using a fixed list of teachers and encouraged them to come up with at least six bipolar constructs (e.g. funny/serious, passive/active, hard/easy, organized/disorganized) Getting six was always hard going. All of the 40 students were in business, they were evenly divided between men and woman and between American and European. The results were very surprising.

1. There was a surprising poverty in the construct language of individual students. While the constructs varied from student to student, each individual’s constructs were highly correlated.
2. None of the student constructs corresponded with the constructs used by faculty. In other words, it was as if there were no shared experiences.
3. There were some gender differences. Men had a tendency to include more constructs that described grading methods, policies, severity and fairness. Women seemed more concerned about the quality of the materials used, the approachability of the professor, how they feel in the classroom and the recommendability of the class. 75% of women’s favorite teachers were woman professors while among the men 75% of their favorites were men.
4. The only difference across nationalities seemed to be a tendency for the European students to be more concerned with grades than their American classmates.

5. None of the constructs allowed for alternative teaching and learning styles. All seemed geared to the modernist approach and judged teachers according to that one standard.

Let's look at one example of why listening is paramount.

GALINA'S GRID: THE STRESS OF "ALWAYS STARTING FROM BASICS"

This are Galina's constructs, using a five point scale to evaluate my classroom style.

Pole 1	Pole 5	My score
Useful	Not useful	5
Natural	Bullshit	5
Relaxed	Tense	5
Neat	Slob	5
Structured	Unstructured	5
Book	No book	5
Likes students	Hates students	1
Motivating	Off putting	1
Knowledgeable	Not knowledgeable	1
Recommended	Not recommended	1

"Galina," I asked, "how on earth do you know how *useful* a class will be before you have even left the classroom? Well", she said, "of course I know because I try to use what you say immediately then and there in the classroom. If I can use it, understand it right off, you know, then it is useful.... Often I can't understand what is being said and when I try to join the conversation, you know that's what is needed in this kind of class, I can't really say anything natural since I don't understand so I just garble a bit, talking bullshit, I guess. Yeah, I have to talk bullshit when I don't really understand what is going on and that makes me real tense. I have to concentrate a lot...."

According to Galina, it was a problem of not having a class textbook. As she put it, "I don't have a vocabulary for the course. Without the right words I have real trouble asking questions.... I don't know what to say, what words to use because I don't find a natural voice. I need to know the right words for the course. I don't like speaking in a

voice that is not mine. I'd rather have a book and use that to help me listen to lectures. That way I can understand the stuff fast and get through the lecture without feeling as tense as I do."

The notion of structure always comes up, too. She went on to say that most other classes are structured, the teacher even puts up what is to be discussed and then does it. That this makes it pretty easy to take notes; that every thing makes sense. "But, you seem to want us to help all the time and that is real hard. It is real stressful since we know that you like us and love what you are doing so we feel even more embarrassed sometimes when we can't help you do what you want us to be doing. Always starting from scratch.... It is so much easier when we know what the teacher wants. We just do it and get on with it. Yeah I know the material is important and I'll recommend the class, but it is real tense doing what you want us to do. Always starting from basics."

As this experiment shows, it is very easy to misunderstand each other, especially where language is concerned. Despite many years' experience, I totally missed the point and so did the students. This caused great amounts of stress which could have been minimized if only I had realized earlier what was really going on. But that is exactly why it is so important to talk and to keep talking about the learning experience so that over time we build a common vocabulary. At least by building a common vocabulary we are anchored in one kind of reality even as we move about exploring others.

REFERENCES

James C. (1989). *Visual Modeling with Logo: A Structured Approach to Seeing*, MIT Press, Cambridge..

Harel, I., and Papert, S. (1991). *Constructionism: Research Reports and Essays, 1985-1990, by the Epistomology and learning Group, The media Laboratory, MIT*, Ablex Publishing Corp., Norwood, NJ.

Kelly, G. A. (1963). *A Theory of Personality: The Psychology of Personal Constructs*, Norton, New York.

Shaw, M. L. G. (1980). On Becoming a Personal Scientist: Interactive Computer elicitation of personal models of the world, Academic press, New York.