Examining the Roles of Feedback and Models of Student Thinking in Pursuing Instructional Goals Inspired by Radical Constructivism

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> Upshot • Herr's thought-provoking approach to structural design education targets goals that include fostering the development of students' intrinsic motivation and shifting the instructor's role from one of dispensing knowledge to one of guiding students' conceptual organization of their experiences. This commentary is intended to start a dialogue regarding the affordances and constraints of particular approaches to achieving these goals. In particular, opportunities for self-generated feedback within the context of students' productive activity and the use of models of individual student thinking to guide instructional planning are presented as promising possibilities.

> *"As I have often said, constructivism cannot tell teachers new things to do, but it may suggest why certain attitudes and procedures are fruitless or counterproductive; and it may point out opportunities for teachers to use their own spontaneous imagination."*
> *(Glasersfeld 1995: 177)*

« 1 » As a theory of knowing and learning, Ernst von Glasersfeld's words remind us that radical constructivism does not prescribe a particular teaching method. Rather, the theory can provide a basis for judging certain strategies and approaches as unproductive. However, implicit in the assertion that radical constructivism can provide the negative half of an instructional design (i.e., what not to do) is that the instructor's goals figure prominently in any assessment of potential productivity or usefulness. It is against the backdrop of an instructor's goals that I wish to situate my commentary on the target article.

« 2 » Christiane Herr's target article describes several goals, informed by the theories of radical constructivism and second order cybernetics, that motivated her efforts to redesign the *Structures and Materials* module of the architecture program. I infer that these goals include helping novice learners better relate to the field of structural design and teaching in ways that are more closely connected to how architects actually utilize structural design principles in their architectural practice. The author also describes wanting to foster students' development of intrinsic motivation to pursue deeper understanding through an inquisitive approach towards learning. Additionally, the approach involves a goal of shifting the instructor's role towards guiding the students' conceptual organization of their experiences.

Intrinsic motivation and opportunities for feedback

« 3 » In pursuit of these goals, Herr characterizes learning as "…an ongoing conversation held between the learner and the world she/he is trying to make sense of" (§13). In addition, the author includes feedback as an essential component of the constructive learning process that helps to keep the conversation going. Herr's changes to the instructional design of the *Structures and Materials* module create opportunities for students to receive feedback in multiple ways. I would like to compare two of these types of feedback as a way of considering the design of instructional activities in relation to the goal of fostering intrinsic motivation.

« 4 » In the drawing-based exercises (§§19–23), after completing the design activity, the students receive feedback from the instructor in the form of categorized assessments of quality with general suggestions for improvement in each category. In the model building project (§§24–27), after completing their designs and building their cardboard structures, the students have the opportunity to experience the intended users testing and using their products. This opportunity to meet with kindergarten children affords the students an opportunity to observe their structures being used in both expected and unexpected ways. I consider these types of experiences to be a form of feedback in the sense that they provide an experiential basis from which the students can self-assess the quality and efficacy of various aspects of their designs.

« 5 » Comparing these two projects, while in both design-based activities the students receive feedback, I see a significant difference in the nature of the feedback available in each. In the drawing-based activities, the feedback comes from students' interactions with the course instructor after the design experience is completed. This both separates the feedback from the students' experiences in designing and entails external assessment of the results. However, the feedback in the model building project arises within the students' interaction with the design and introduces novelties that support self-assessment that is more instructive than simply being told to consider those things. This difference is significant when considered with respect to intrinsic motivation. According to von Glasersfeld (1983: 15), "It makes no sense to assume that any powerful cognitive satisfaction springs from simply being told that one has done something right, as long as 'rightness' is assessed by someone else." Thus, while the author emphasizes that attempting to foster intrinsic motivation is an important aspect of her approach, the manner of providing feedback in the drawing-based exercises contradicts this goal. Alternatively, by planning the model building project to include opportunities for the students to make their own self-assessments of the quality and efficacy of their designs, the feedback mechanism of the model building activity seems better suited to fostering intrinsic motivation.

« 6 » In presenting this contrast I do not mean to suggest that the incorporation of drawing-based activities and providing instructor feedback are un-productive modifications to traditional approaches to structural design education. In fact, with respect to the author's goal of providing students with opportunities to engage in structural designing that is more closely connected to the actual practice of architectural designing, both activities seem to be significant improvements over the traditional structural design instruction described by the author. Rather, my point is that differences in how one incorporates feedback into instructional activities can impact their potential for fostering students' development of intrinsic

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motivation to pursue further learning and deeper understanding.

« 7 » Further, I raise the issue as a way of starting a dialogue regarding ways to design instructional approaches and activities with potential to support intrinsic motivation. While no teacher or instructional activity can provide intrinsic motivation to students directly, analyzing the affordances and constraints each activity places upon the students' experiences can better position instructors to foster intrinsic motivation. For instance, if the model building project had not included testing the structures with the kindergarten children, then the opportunities for students to self-evaluate their expectations using feedback from within the context of their design experiences would be lost. Thus, including this component into the model building project afforded the students opportunities for experiences more conducive to intrinsic motivation. Considering the drawing-based exercises, are there ways to modify the activity to incorporate feedback opportunities within the context of the design process that students could use to test their expectations and self-assess the quality of their designs? For a point of comparison, consider the context of students learning about geometric relationships in mathematics. Dynamic geometry programs provide an environment in which students can construct, manipulate, and measure various aspects of geometric objects. This dynamic environment affords the opportunity for students to generate and test hypotheses within the context of their mathematical activity and without the need for external assessment from an instructor. Perhaps there exists a computer program or some other avenue that students could use to experiment and test their expectations and hypotheses regarding structural design and materials in the context of the drawing-based activities before receiving feedback from the instructor.

« 8 » Speaking more generally, I believe this notion of considering how feedback opportunities are incorporated into instructional activities has implications for instructors regardless of whether one is considering teaching structural design, mathematics, or some other domain. Even among instructional approaches that introduce non-routine problem solving in which more than one correct solution strategy exists, those that include opportunities for students to receive self-generated feedback within the context of their productive activity seem more likely to support the development of intrinsic motivation.

Models of student learning and possibilities for future directions

« 9 » In addition to using feedback to promote extended conversations between students and their instructors and between students and their design experiences, Herr's approach to structural design education also recasts the teacher's role as one of guiding students in their conceptual organization of particular types of experiences. However, appropriately guiding students' conceptual organization requires models of students' current understandings as well as models of the understandings one hopes that students will construct. According to von Glasersfeld (1983:16), "A conceptual model of the formation of the structures and the operations that constitute mathematical competence is essential because it, alone, could indicate the direction in which the student is to be guided." Applied to this case, conceptual models of what constitutes structural materials and design competence are critical for guiding the attempt to develop an educational approach based upon radical constructivism.

« 10 » However, by focusing on models of the entire cohort's learning rather than the learning of individual students (§9), the author's approach to reimagining structural design education currently lacks the types of models von Glasersfeld deems so essential for guiding instructors' efforts. Recognizing the need for models of individual learning, the author concludes by describing her intention of conducting detailed analysis of individual students' learning (§31). Drawing upon my experiences in conducting mathematics education research, I wish to begin a dialogue regarding what these models of student learning might consist of and what role such models of individual learning could play in helping instructors to guide the learning experiences of large cohorts.

« 11 » My research in mathematics education focuses on using teaching experiment methodology (Steffe & Thompson 2000) to investigate how students construct operative understandings of intensive quantities such as density and rates of change. I approach this research with a goal of constructing second-order models (Steffe 2007) consisting of conceptual schemes and operations that can account for the observed actions and language of the students with whom I work. In doing so, I have found that variations in students' distributive reasoning play an important role in their efforts to construct intensive quantities. In particular, this effort to model student thinking resulted in three distinct distributive reasoning schemes that characterize my understanding of the students' ways of operating.[1] Further, it is important to note that these models are distinct from adult conceptions of the distributive property and different than standards that outline expert understandings of the property. Instead, they are abstracted from the researcher's experiences in interpreting the constraints and affordances of the students' mathematical activity. As such, they characterize the students' ways of operating and making sense of their experiences.

« 12 » I see these types of models as powerful because more than simply documenting three ways of operating by students, these models provide insight into a possible direction along which students' understanding might progress. In addition, this information could be a valuable asset to a teacher attempting to design instructional activities for large groups of students. First, having these types of models available provides a way of interpreting the current understandings of the students. Rather than attempting to construct individual models for each of 200 students, an instructor could compare the students' ways of operating to just three models to develop a clearer understanding of the current ways of operating of the students in the cohort. Secondly, this understanding would enable the instructor to adjust the sequencing or nature of the planned tasks in ways that are sensitive to the instructors' assessment of the students' current ways of operating and that the instructors believe will support the students' efforts to construct more sophisticated understandings.

1| I presented elaborations of these three distributive schemes as part of a research symposium at the 2014 Research Conference of the Annual Meeting of the National Council of Teachers of Mathematics in New Orleans, USA.

« 13 » Returning to target article, I wonder if there are similar ways in which models of student thinking could be developed and utilized in structural design education. For instance, what understandings and ways of operating and reasoning might prove critical to the actual practice of structural designing in a way similar to how distributive reasoning proves critical to constructing intensive quantities? How might the interviews with individual students be designed to provide evidence of how students think about these topics and how that thinking becomes more sophisticated over time? How might these models support the instructors' efforts to plan instructional activities and guide the students' conceptual organization of their experiences?

Conclusion

« 14 » In my experiences, I have found that trying to understand a student's goals is a crucial component of attempting to understand and build models of his/her ways of operating. Thus, when reflecting upon the target article, I have chosen to consider the author's efforts to reimagine structural design education in terms of the goals I inferred from her approach. In particular, incorporating opportunities for self-generated feedback within the context of students' productive activity and developing and utilizing models of individual student learning to guide instruction of large cohorts represent potentially productive directions for achieving these goals. Ultimately, I hope this commentary will begin a dialogue regarding specific aspects of instructional approaches, activities, and orientations that advance efforts to design instructional environments inspired by Ernst von Glasersfeld's radical constructivism.

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The Device Design Studio: Proscribe in Order to Promote New Knowledge

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> Upshot • The concept of proscription enables certain characteristics of the design studio to be highlighted and some of the difficulties mentioned by Herr to be understood, and it raises the question: What does "open-ended" mean in a formal learning context?

« 1 » In my commentary on Christiane Herr's target article, I focus on the concept of proscription. It endeavours to highlight the interest evoked by the design studio in architectural education, while questioning the possibility of implementing certain features of this device in the training context within a radical constructivist perspective.

« 2 » An essential feature of the activity of designers is doodling and sketching. Designers produce a sketch then proceed to change role in order to analyse the quality of their work and thus improve their sketch. The sketch highlights characteristics of a designer's own work and so enables insights and ways of seeing that are initially foreign to the designer. That is why designers learn to switch between the roles of viewer and drawer. They therefore work iteratively, without seeking a predefined goal, but taking advantage of the characteristics progressively defined during the iterative process (Glanville 2006a, 2009). This activity is part of a working device: the design studio. Herr analyses the implementation of such a device in architectural education. In this context, it would enable one to characterize the task put before the students as open-ended: the students are not meant to adhere as closely as possible to predefined knowledge presumed to be true, but rather to explore a possible area and thus bring about viable knowledge. As stated by Herr:

> "from a constructivist perspective, students should be motivated through awareness of the reasons why particular ways of thinking and acting are considered desirable instead of the authority of a claim to objective truth […]. The teaching approach presented here aims to support students in developing a personal relationship of interest and awareness towards a field of study" (§5).

« 3 » The concept of proscription enables specification of certain characteristics of this device, better understanding of some of the difficulties mentioned by the author and better enquiry into what the term "open-ended" means in a formal learning context. The process initiated in a design studio in an educational context (what I name a "design studio device") does not refer to a qualified designer looking for new solutions, but to students who are constructing new knowledge that is then shared within this profession. In other words, the question is: Under what conditions can a working device be a training device? One way to ask this question in a radical constructivist approach is to analyse this device using the concept of proscription in order to highlight its possibilities and limitations.

Proposal: Adopting an activity approach

« 4 » The interest of the target article is to analyse the design studio as a teaching device that "encourages students' individual learning while negotiating constraints deriving from large cohorts" (Structured Abstract). It thus opens up relevant paths necessary to cope with the constraints of mass higher education.

« 5 » The very characteristics of this device make its comprehension possible within an activity approach (Barbier & Durand 2003): it is not about the acquisition of additional knowledge for its future utilization but rather about the promotion of a viable activity. More specifically, the activity approach stipulates that

> "Trainers[2] must be able to design environments that help transform trainees' activity of learning/

2| In the French tradition, the domain of "adult education" has settled within "education science." The concept of "adult educator" is close to the term "teacher" as opposed to "instructor/ trainer" if we follow von Glasersfeld's (1995) reasoning. This concept is at the heart of the problem between articulating/ developing the power