whether the product is "well-constructed, fit-for-purpose, and delightful" (Glanville 2009: 176). What the latter does is based on what he already knows but that is not necessarily specific to the targeted activity since it constitutes precisely what learning consists of. If, in an open-ended task, "designers are typically more interested in the viability of the outcomes of their doing than in descriptions or justifications for their doing" (§1), it is only partially the case for the learners, for whom feasibility is the field of constraints also partially supported by themselves.

Constraints and language

« 15 » A word or phrase can proscribe only if it is significant. Yet must it be equally significant for both the trainer and the learner. This is a stipulation in order that the device favours certain fields of activities over others.

« 16 » In the analysed case by Herr, the language of instruction is a foreign language for the students, within a context containing numerous significant cultural differences. That is why the author emphasizes that "[s]uch activities transcend limitations of linguistic communication and loose" (§8). But this indeterminacy is not specific to that context.

« 17 » Von Glasersfeld states that language "does not convey knowledge but can very well constrain and orient the receiver's conceptual constructing" (Glasersfeld 1995: 182). This constraint is far from absolute. The artifacts restricting the space of the possible must be meaningful to the learner. In the case of the use of language, this constraint will only become effective if consensuality has been established between the various actors.

« 18 » In the case of the design studio device, the field of restraint also constitutes a learning challenge. The doodling/sketching process is at the heart of the design job and rests on specific knowledge. What follows is that the challenge resides in learners' capacity to question their understanding of the system in which they work (Schön 1988). This aspect deserves further specification. It is, however, through an evaluation making use of the comparing of examples. Moreover, students need to not only focus on the outcome but also work on the process that has enabled them to act within the design studio device. This also highlights an important issue, namely, that of the difference between viable knowledge and viable activity; in other words, considering learning as both a drift (Maturana & Varela 1987) and as a search for consensuality.

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Interdisciplinary Connections between Radical Constructivist Approaches in Mathematical Problem Solving and Structural Design in Architecture

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> Upshot • In the target article, Christiane Herr offers an insightful characterization of how von Glasersfeld's radical constructivism can be implemented in structural design education in architecture. In this commentary, I articulate possible connections between research on problem solving and problem posing in mathematics education and design processes in structural design education as described in the target article.

« 1 » In her target article, Christiane Herr provides a detailed description of a radical constructivist teaching approach in structural design education in architecture. Despite challenges such as large class size, cultural expectations about learning and teaching, and limited instructional personnel, Herr convincingly articulates how feedback and multiple learning and teaching modes can promote intrinsic motivation, meaningful engagement, and increased understanding of structures in architecture. Her illustration of the radical constructivist pedagogy involves a curricular module on structures and materials in the context of large cohort of students in an undergraduate program at a Chinese university.

« 2 » To promote and support intrinsic motivation, self-generated activity, and increasingly viable organization of experience, Herr offers her students multiple modes of learning and teaching, which integrate design processes that are subjective, generative, iterative, and cyclic in nature. In so doing, Herr challenges and extends conventional structural design education practices and creates a form of actual architectural design practice in the classroom that involves substantial amounts of trial-and-error and reflection in action (Schön 1983). The multiple modes of learning and teaching include lectures with rich examples and imagery, model building activity in small teams, drawing-based design exercises, construction site visits, and self-reflective papers.

« 3 » Perhaps the most significant value of Herr's radical constructivist approach to teaching structural design is that, in her large classroom, she provides a cohort of around 190 students with open-ended design tasks that do not involve recipe-style answers: "A typical design task involves some form of ambiguity, paradox or even impossibility that challenges students to find his or her own way of addressing the task" (§12). Herr's detailed descriptions of the various course activities provide convincing evidence of increased student engagement and reflection. However, as noted in the conclusion (§31), more research is needed in order to further explicate the processes that support individual construction of structural design knowledge. Due to the nature of the open-ended design problems, students need to spend increased time formulating both the problem conditions and the goals that they seek to achieve. This is a form of problem posing. In the iterative and cyclic design activities, I believe that Herr's students frequently use the results of their problem solving actions to re-formulate problem conditions and individual goals. After developing their initial designs, through feedback and further reflection via problem solving and problem posing they advance their understandings of structures and create more formal design models by the end of the course. In this way, problem posing and problem solving co-evolve. Victor Cifarelli & Volkan Sevim (in press) have examined this dynamic process in the field of mathematics education.

« 4 » One possible line of research, then, that could provide insight into how students might develop personal goals and understandings within the design-based open-ended tasks is the examination of how problem solving and problem posing co-evolve (Cifarelli & Sevim in press). Edward Silver (1994) has referred to *within-solution* problem posing as "problem formulation or re-formulation [that] occurs within the process of problem solving" (Silver 1994: 19). In this way, we may refer to the solver's problem formulation or re-formulation as the development of a set of goals and purposes that he or she is trying to achieve at any point in time. As problem solving progresses, the solver may continue to re-formulate the problem based on his or her interpretations of the results of his or her actions. Thus, problem posing could be viewed as a form of sense-making that helps to organize the solver's on-going creation of goals and purposes throughout problem solving.

« 5 » For example, in the target article Herr clearly illustrates how design-based drawing exercises present opportunities for individual exploration and self-directed learning (§12). According to Herr, the presented design-based pedagogy differs from that of conventional statics, where teachers often give their students formulas and structural elements as problems that can be solved correctly (§2). In contrast, the employed design-based exercises resemble the experiences of architects, in which an architect is challenged to develop individual solutions to problems in an on-going fashion using existing knowledge. Central to this problem solving and problem posing activity is the solver's experiences of a problematic situation. According to Gordon Pask (1985), these situations are phenomena within which individuals actively formulate particular problems they see fit to address and solve. The solver may assimilate situations using existing concepts and establish particular goals, but the solver may be yet to construct solution paths to reach the goals (Steffe & Cobb 1988). Thus, on-going creation of (sub) goals and purposes throughout problem solving ensue, and the solver progressively makes better sense of the problem and its possible solution (Cifarelli & Sevim in press). As demonstrated in the target article, requiring students to develop a visualization, express it by means of a drawing, and annotate the drawing with individual thoughts and explanations offer valuable opportunities for reflection. Herr notes that in-class case studies and reviews, and immediate feedback on initial drawings, help students to make further revisions and thus make progress in their problem solving. Examination of the co-evolution of problem posing and problem solving within individual students' drawing activities can further provide insight into their reflections about structures and materials.

« 6 » Above, I offered a possible lens for examining students' activity and learning in order to refine teaching interventions that promote and support intrinsic motivation, self-generated activity, and increasingly viable organizations of experience. Such focus on students' individual goals and problem formulations is closely linked to Ernst von Glasersfeld's radical constructivist epistemology, in that knowing is viewed exclusively as an ordering and organization of one's world constituted by experience (Glasersfeld 1984). Self-generated questions (during problem solving) can help students to place the current problem in a broader perspective and thus expand its scope. This expansion of scope can further help students engage in unexpected generalizing activity that is rooted in students' own goals and purposes (Cifarelli & Sevim in press). Thus, the presented line of research within the target paper could be extended by examining how individual students' goal-directed activities evolve in the context of problem solving within design tasks and transform their understanding of structures.

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Forging a Constructivist Pedagogy: Focus on Teacher Decision-Making

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> Upshot • In this comment, I take Herr's proposition for a constructivist-informed pedagogy for structural design education to extract initial ideas for a framework for a constructivist pedagogy, a framework focused on the decision-making of a constructivist teacher. I enhance this initial framework with initial findings of a study I conducted with a constructivist mathematics teacher.

« 1 » In taking up the challenge to teach the professional knowledge characterizing the field of structural design, Christiane Herr examined in her target article how a pedagogical approach that may emerge from a radical constructivist theory of knowing and learning may improve personal and active attitudes toward what was learned. Herr reports a schism between how the technical and creative knowledge used in structural design are taught: the first following an instructionist pedagogy (Herr names this a science-based approach, or a transactional view of learning), versus a more personalized and applied mode of learning in the latter, which she suggests to be a constructivist pedagogy. I found this paper surprisingly relevant to my field as a mathematics educator, in particular with regard to efforts to theorize a constructivist pedagogy for the schooling environment, which val-