« 11 » This learning method has been used successfully in terms of inferring needs that underlie descriptions of envisioned views on the future (Kaiser, Fordinal & Kragulj 2014; Kragulj 2014) as well as in knowledge-based vision development processes (Kaiser, Feldhusen & Fordinal 2013; Kaiser & Fordinal 2010b; Kaiser & Fordinal 2010a; Kaiser & Feldhusen 2011).

« 12 » In the target article's context of innovation, the tool described might help to anticipate future demands and properties of innovative products or services that have to be met in the future. An illustrative example is given in a recent book on robotics, in which many (technological) demands are derived from a narrative description of a future usage of innovative technology that, under today's technological limitations, cannot be fulfilled (Trappl 2013).

« 13 » To sum up, our method enables people to think "outside the box" (i.e., to transcend today's boundaries mentally); thus, to consider solutions unrealizable today that, however, contain the very essence to pursue today to develop applicable solutions for the future. Within the process framework of the target article (§§48–57), "learning from the envisioned future" might be an alternative tool for the procedure described in §53, i.e., to come up with radically new knowledge leading to innovation.

Constructivist perspective

« 14 » A key feature of this alternative learning strategy is to have subjects embed their wishes, dreams, fears, concerns and so forth in their imagination and to put those "into action." By doing this, people create meaning. Peter Senge argues that…

> "our mental models determine not only how we make sense of the world, but how we take action […] It's therefore crucial to examine one's mental models before planning improvement actions." (Senge 1994: 82)

« 15 » It is clear that those future scenarios are not about an experiencer-independent reality to come, but rely on the agent creating and experiencing them. We emphasize that it is the active construction of the individual that likely helps to guide the selection of actions in the present in order to shape and come closer to the desired state of affairs.

« 16 » Consequently, it is obvious that this future episode remains hypothetical and cannot be judged by the criterion of "truth" in advance. However, in the framework of radical constructivism, the criterion of truth as it is traditionally used by philosophers is rejected (Glasersfeld 1998: 23). Rather, the knowledge derived from imagination should be evaluated in terms of its viability and coherence, which fits our approach:

> "Simply put, the notion of viability means that an action, operation, conceptual structure, or even a theory, is considered 'viable' as long as it is useful in accomplishing a task or in achieving a goal that one has set for oneself." (Glasersfeld 1998: 24)

« 17 » In this sense, the interaction with the individual's imagination can, analogously to Piaget's proposal, "be considered [as] a tool in the organism's adaptation to the world as it is experienced" (in Glasersfeld 2001: 39). The crucial aspect of our learning approach is that the individual adapts according to the experience rooted in an (attractive) imagination rather than according to past experience.

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Authors' Response:
Challenges in Studying and Teaching Innovation: Between Theory and Practice

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> Upshot • This response focuses on the following issues, which summarize the points made by the commentaries: (i) further reflection on and details of the methodological framework that was applied to studying the proposed design of our innovation course, (ii) the issue of generalizability of the findings for teaching innovation (in this context the question of generic or transferable skills will become central), and (iii) finally, more precise explanation of what we mean by "learning from the future as it emerges."

Introduction

« 1 » Studying subjective knowledge construction and intersubjectivity in innovation processes raises several (methodological) issues and questions. How can we deal with the challenges and tensions between radical constructivist theory, research, application, and practice? Is it possible to study the subjective agent in his or her interaction with others systematically, and if so, can these insights be transferred to a more general level of (theoretical) explanations? We will address these questions by discussing the issue of teaching and research, as well as subjectivity and intersubjectivity, within the context of our research design and methods. We argue whether and how empirical results obtained by grounded theory can be generalized.

« 2 » Furthermore, many aspects of the research setting, as well as the didactical setting, and the course content touch upon the issue of generalizability. We will discuss the issues of studying innovation in the context of our course design in comparison to other university courses and their (theoretical) approaches. We will further elaborate on the transference of insights, theories, or skills into other areas apart from (teaching) innovation, as well as transferring radical constructivist approaches to teaching into other institutions and contexts.

Theoretical and methodological tensions in studying processes of subjective knowledge construction

« 3 » Radical constructivism (RC) claims that knowledge is a subjective construction (e.g., Glasersfeld 1995). By attempting both to teach and investigate this subjective knowledge construction, we are challenged by the interplay between the concepts of subjectivity and intersubjectivity. From a theoretical as well as methodological perspective, the study of the socio-epistemological processes cannot be framed by a classical realistic approach, as we cannot directly *observe* these processes *in* the students' minds. **Larry Hatfield** (§10) also addresses this tension, when he discusses the direct, "real-time" investigation of such processes. It is necessary to re-think not only the didactics of teaching, but also how to study it.

« 4 » Results discussed in our target article are part of an extensive long-term study, designed in a way that allows us as researchers to be as open as possible, and follow up new questions and insights in a flexible manner. From a constructivist perspective, innovation as an epistemological process can only be investigated with a multilevel and multiperspective approach, as **Adalira Sáenz-Ludlow** also explicates in her commentary. Our presented results can be understood as starting points for much deeper questions as raised by, e.g., **Sáenz-Ludlow** (§5), addressing a deeper level of understanding of what is going on in the groups, or **Hugh Gash** (§1), addressing effects of the processes on the instructors.

« 5 » In our research, we use Kathy Charmaz's (2006) grounded theory methodology (GTM), which she bases on constructivism. As in all grounded theory approaches, the purpose is not to test hypotheses, but to generate theories about an unknown and yet undiscovered phenomenon, grounded in in-depth observations. This requires an immersion in the research field and closeness to the agents, their actions, assumptions, relations, and the like. In our double role as instructors and researchers, we are part of the process we are observing. As mentioned by **Hatfield** (§8), this of course cannot lead to objective data in the sense of quantifiable results. But, although being a qualitative method, the aim of the GTM is to create generalizable theoretical statements. Therefore it is necessary to analyze actions and events not only on a specific level (individual learning journals), but to relate these insights with contexts and discourses on other levels (Charmaz 2006), such as the group level and course level in our case.

« 6 » Charmaz's approach not only perfectly suits the constructivist framework of the course and research setting, but also provides methods for analyzing varieties of data on different levels. Furthermore, it offers an elaborated coding strategy for elicited texts such as learning journals. As **Hatfield** (§§9f) rightly points out, even analyzing elicited texts is always a second-order construction and can never result in an *objective* account of the epistemic processes of individual learning and knowledge creation (expressed in "realist" terms). Coding in the framework of Charmaz's constructivist GTM does not aim at objectifying data. The different steps and levels of coding help the researcher to deeply immerse in the data and its inner structure, guide analytical processes of research, and make assumptions transparent. "Through studying data, comparing them, and writing memos, we define ideas that best fit and interpret the data as tentative analytical categories" (Charmaz 2006: 3). This is in line with Ernst von Glasersfeld's (1995) notion of viability and his claim to seek *transparency* as an alternative to the realist's concept of *objectivity*.

« 7 » In our research, we look for a coding strategy that enables us to extract out of the data the socio-epistemological processes of innovation we aim to understand, and to learn more about the students' views by comparing data with data. "Through coding, you define what is happening in the data and begin to grapple with what it means" (Charmaz 2006: 46). The coding and initial analysis is a first step to spark ideas and to start a process of crystallizing theoretical concepts and further questions. In the target article, we presented the results of two out of 25 categories that emerged out of the initial coding phase, as they described the relation between learning and teaching innovation as a socio-epistemological process in the specific context of our course design. Of course, these two categories cannot be seen as separate from the others. As **Sáenz-Ludlow** (§§3, 5) also points out, our course and research design is organized on several levels. Additionally to the individual level (learning journals), we also had access to the project platforms and the group reports (group level) and took observation notes during the classes (course level). All the data gathered in this way incorporated the presented results. Furthermore, we are not only instructors, but are researchers at the same time. We are embedded in our own field of research. Therefore, every presented result can never be seen as isolated, but must be understood in relation to its situational context of the whole course and its other levels of observation.[1]

Institutionalizing teaching innovation and constructivist didactics in a contemporary classical university setting

« 8 » **Hugh Gash**'s (§3) question concerning the *sustainability* of the course design presented in our paper is crucial in the context of contemporary university education. As **Gash** (§3) mentions rightly, today's universities are – mostly for practical and financial reasons – primarily oriented towards the classical presentation-repetition model. Of course, this is rather contradictory to the goals and didactics of both the course design we have proposed and a constructivist approach (Glasersfeld 1989a).

« 9 » What is at stake here is the more general question of *generic or transferable skills* (cf. the European Union,[2] and The Lisbon Council and Accenture[3]) and epistemic competency. These skills are domain-

1| By "whole course" we refer to the contextual framework for the research, and include us (the instructors/researchers), the students *and* the three levels of observation/research. In our research design, data cannot be seen as an isolated, separate entity or a decontextualized piece of meaning. It is always contextualized (as we as researchers are too) and interpreted.

2| "Transferability of Skills across Economic Sectors," retrieved on 6 June 2014 from http://csdle.lex.unict.it/docs/labourweb/Transferability-of-Skills-across-Economic-Sectors-Role-and-Importance-for-Employment-at-European-Lev/1737.aspx

3| "Skills for the future," retrieved on 3 July 2014 from http://www.lisboncouncil.net/component/downloads/?id=214

independent and focus on general cognitive and epistemic abilities as well as skills, such as meta-cognition, research, or problem-solving skills, and epistemic attitudes. Our course design partly aimed at training in these kinds of skills. Transferable/generic skills are not only crucial in an academic environment, but also for economic contexts. This becomes apparent when we understand our society and economy as being strongly knowledge- and innovation-driven (Friedman 2006; Levy 1997; Tsoukas 2005, as well as the Department of Trade and Industry (UK),[4] .the European Commission,[5] and UNESCO.[6])

« 10 » As **Gash** (§3) notes, the challenge is how to "teach" such skills in a sustainable and systematic manner, as it is very hard to teach them in a model that is based on classical presentation-repetition only. The following points offer a selection of possible answers and strategies that turned out to be successful in the context of our research and practical work:

- Strong focus on *research based learning/teaching*: Zimmermann, Peschl & Römmer-Nossek (2010) give an example of how such a strong teaching-research nexus (Griffits 2004) can be realized in an interdisciplinary and international cognitive science masters program (MEi:CogSci, http://www.meicogsci.eu).
- *Small cohorts* and/or a good student/teacher ratio: this kind of teaching/learning can only be successful if the groups of students are rather small (max. 25–30 persons), as it is necessary to have a very personal contact between teachers and students for teaching/learning such skills (Cueso 2007).
- *Raising awareness* that generic and epistemic skills, such as reflection, precise observation, dealing with uncertainty, etc., are meta-cognitive foundations for knowledge creation, innovation, and research processes.
- Consistent *curricular integration* of generic skills: teaching, learning, and practicing generic skills have to be part of every curriculum dealing with research, knowledge creation, and innovation.
- Finally, the question of funding and the teaching strategy of a university in general (e.g., by offering a (compulsory) "studium generale" focusing on these skills).

Application and implementation, or how to measure innovation

« 11 » The question of *sustainability* also concerns the degree of innovation/novelty of the outcomes (prototypes) the students produce during the course.[7] Although the whole course setting is open-ended and allows students to go through an endless variety of possibilities regarding their prototypes, in the end the outcomes still need to be assessed and evaluated. The aim of the course is to create an innovative outcome in the sense of "[…] *sustainable* change that is both *fundamentally new* and *organically fits* into existing structures" (target article §6).

« 12 » **John Richards** addresses this issue in his commentary. He rightly notes that innovation requires the application and implementation of the new knowledge (§3) and states: "An innovation includes taking the prototype to the market" (§6). In our course, the students are not limited to an economic understanding of innovation. Coming from a wide range of disciplines, the *thematic fields* (target article §49) that emerge in the early stage of the process can lead to various directions and result in prototypes not only addressing an economic market, but also educational, social, or personal contexts. The applicability of the innovation outcomes in a certain environment or market therefore does not always have to be related to economic measurements and functions such as customer value or success in the marketplace (**Richards** §4).

« 13 » Still, it is crucial to apply an innovation to the context and environment it is produced for, not only for reasons of evaluation. This causes the necessary perturbations that provide "[…] insight into what can be viable […]" (**Richards** §6) in the specific context. Regarding our research sample, we have documented evidence that at least one of the high-performance innovation teams continued their project after the course and could implement their prototype successfully.

« 14 » In our course design, the implementation of the prototypes is intended to occur in the last phase of the process (target article §56). Students present their final prototypes in class after weeks of intense study of, observation of, and interaction with their thematic fields. From a methodological point of view, the whole course setting is seen as the context for the innovation projects. The presentation to the class is therefore similar to an application to a market environment (it is a kind of "pitching situation"). All participants, the students as well as instructors, serve as a systemic context for testing the viability of the prototypes and provide final feedback via live discussions in the class and a final evaluation in the learning journals at the end of the course. In our research, the data gathered in this way is an indicator of the degree of innovation and helps us to identify the high-performance teams.

« 15 » Criteria for evaluating the prototypes are somewhat vague and hard to predefine during the process – both for students and instructors.[8] Nevertheless this reflects actual market situations and the challenges of every innovation project in quite a lifelike manner. This openness on the one hand, and the uncertainty it causes on the other hand, are crucial elements the students – and the instructors – have to deal with.

Enabling – or dealing with – uncertainty and open(-ended)ness

« 16 » Both **Gash** (§4ff) and **Hatfield** (§12) address the issue of uncertainty and openness that our students are exposed to

4| "Creativity, design and business performance," retrieved on 3 July 2014 from http://www.dti.gov.uk/files/file13654.pdf

5| "Innovation management and the knowledge-driven economy," retrieved on 19 June 2012 from ftp://ftp.cordis.europa.eu/pub/innovation-policy/studies/studies_innovation_management_final_report.pdf

6| UNESCO World Report 2005 "Towards knowledge societies. Paris: United Nations Educational, Scientific and Cultural Organization," retrieved on 3 July 2014 from http://unesdoc.unesco.org/images/0014/001418/141843e.pdf

7| Fortunately, we are quite free in our choice of teaching methods as long as the learning outcomes are covered and they are transparent.

8| It should be emphasized that evaluating prototypes is not related to coding. The evaluation of the prototypes is part of the process, on the didactical level as well in results in grades. The coding is our research method for investigating this process.

in such an open-ended learning design. Uncertainty is present in many shades in our design and it has been intentionally fostered:

1 | the constructivist approach encourages students and teachers to leave behind the categories of true and false, in which they are well-trained;
2 | the open-ended design of the course made students (as well as teachers) wonder about the outcome(s): What are the "correct" results?;
3 | the confrontation with novelty itself triggers uncertainty, as one does not know what it will bring about.

« 17 » Partly, this uncertainty is due to the "lack of prescribed learning tasks," as **Gash** (§5) notes. Looking more closely reveals that this is not entirely the case, although it is so on the "content level." However, students are both trained and encouraged to *practice knowledge techniques* that help them create new knowledge on the knowledge/content level. In a similar context, **Hatfield** (§11) shows that another source of uncertainty (both for students and teachers) lies in the constructivist approach itself (and its didactical implications). There is an implicit assumption that direct intervention should be avoided in order to foster the students' construction processes. **Hatfield** himself advocates a more balanced approach integrating explorative, open, and investigating, creative processes with settings focusing on memorizing or rehearsing.

« 18 » This balanced approach is similar to our concept of *enabling* and *Enabling Spaces* (Peschl & Fundneider 2012, 2014). Such processes cannot be determined in a mechanistic or rule-based manner: the goal and challenge is to establish a framework of active and passive constraints that act as enablers for these knowledge processes. These constraints offer "security" in some sense; they do not, however, determine the outcome in a mechanistic manner. They are realized on various levels, as we proposed in our course design: on the level of knowledge processes and techniques, on a social level (e.g., community building and trust), on the level of instructors (e.g., giving theoretical input where necessary, offering coaching, etc.), as well as in the physical domain (e.g., providing specific spatial settings supporting the knowledge processes).

Learning from the future as an innovation strategy

« 19 » In his commentary, **Florian Kragulj** focuses on an approach to innovation that we suggest for our course design – "*learning from the future*" (Scharmer 2001, 2007). It can be characterized as "sensing the future possibilities that want to emerge from a present perspective" (§4). It is opposed to many classical approaches to innovation and learning that are driven mostly by past experiences being extrapolated into the future (e.g., Kolb 1984).

« 20 » In his approach of "interacting with the envisioned future," **Kragulj** (§5) proposes a method for "explicating tacit dreams, wishes, and desires" (§10) that is different from classical scenario techniques. Rather, it is a kind of "mental time traveling" and pre-experiencing a desired and imagined future. In this context, the following question is of interest: how does one detach from one's past experiences in order to be able to be open to the potentially radical new? Although **Kragulj**'s approach follows a similar general strategy to ours, the details are slightly different and lead to different questions.

« 21 » In our target article we suggest letting go, trying to detach from the past completely. The aim here is to enter into an empty space in order to listen to potentials from the future and to what wants to emerge (§50). **Kragulj** starts in the present and envisions a future from an "as-if" perspective. Both approaches have their strengths and open questions. Of course, it is not possible to leave behind one's past completely and enter into a completely "empty space." This empty space is rather a semi-structured sparse space in the sense of an Enabling Space. In other words, it represents a minimally structured space that is traveled through by a process triggering and modulating the cognitive/knowledge dynamics in an enabling manner. **Kragulj**'s question is how to avoid being determined by the past in his envisioning processes. By quoting Peter Senge in §14, **Kragulj** makes this problem clear: it is not sufficient to examine one's mental models, but – and this is crucial for fundamental/radical innovation – one has to be able to change and transcend them in order to open up to the future and its potentials. It is not entirely clear how **Kragulj** supports this process in detail. Synthesizing these approaches, a more complete procedure emerges, both on the level of methods and conceptually. On the one hand, it is necessary to start the process in the present and to have a deep understanding of the present potentials. But on the other hand, it is necessary to be "pulled" by the future in the sense of an Aristotelian *causa finalis* in order to give the present potentials some direction. Taking this complementarity into account, such an integrated approach can be used for achieving even more successful results.

« 22 » **Richards** (§3) notes that innovation requires an implementation of the new knowledge and states (e.g., a prototype) to the market. In a way, the necessity to apply and implement an innovation into an environment is a challenge of envisioning a *future* market. We (in our target article) understand by an innovation a "*sustainable* change that is both *fundamentally new* and *organically fits* into existing structures" (target article §6). **Kragulj** on the other hand discussed an approach of envisioning the future. Understanding sustainable change – in terms of innovation – as originally fitting into existing as well as potential future structures could turn out to be an interesting and promising strategy.

Conclusion

« 23 » Teaching and studying innovation processes in a radical constructivist framework challenges researchers working in such an area of tension. As von Glasersfeld (2010) points out, RC is an uncomfortable position, as it forces us as teachers to admit that students take responsibility for their own construction of knowledge; and it forces us as researchers to take responsibility for our knowledge constructions (research processes and results). Being both teacher and researcher, following a theory-based didactical design while doing empirical research, as well as dealing with issues arising in ongoing research processes and the practical application of results for further studies, is quite challenging. So how can we bridge this gap between theory and practice and generate generalizable results? By discussing our research design and methods and the course design, on both a content-related and a theoretical level, we illustrated how insights regarding subjective knowledge creation in innovation can possibly be transferred to a variety of other contexts and

fields of application. We contrasted our theoretical, empirical, and teaching approach with those of others and showed how insights regarding our study and course design can be transferred to other (educational) institutions, or business and market contexts. The inspiring inputs and comments of our colleagues perturbated (sensu Glasersfeld 1980) and facilitated a re-thinking of our research methods and results, and will possibly lead to new and promising research questions and insights.

« 24 » Inspired by the commentaries, we intend to focus in the next research phase on the nurturing and hindering dynamics in the groups, trying to grasp what makes the high-performance teams successful, but also what could be improved in the low-performance teams. Furthermore, we will focus more strongly on the role of the instructors and their influence, as well as on how they are influenced by the process themselves. Finally, we also see our research as part of a broader discourse on RC in educational research and our presented results and theoretical considerations as a contribution to it, especially regarding the tensions between theory and practice of RC in education.

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