teachers' own experiences with these kind of activities (as in Story 1), their reflections of – and motivation by – the unforeseen situations they have themselves the opportunity to delve into; the observation and reflection of students' experiences (as in Story 2); and their involvement in designing a similar MbL activity (Story 3); all of which enriches the learning and professional development process for teachers. Papademetri-Kachrimani describes the reflective process as one that

> "begins with a new problem / challenge that drives towards a new cycle of collecting observations and making representations [leading] the learner to construct gradually a deeper understanding of the phenomenon / structure / concept under study." (§33)

« 4 » One thing that I find particularly important in this process is the role of representations, and the articulation between the ways in which the solutions are represented: e.g., as graphical representations and as equations. I very much appreciate that teachers are "encouraged to go backwards and forwards between what they actually saw and how they counted the circles in the shape and their representation(s)" (§14) in order to gain better understandings. Representations, either graphical, algebraic or in any form, are the produced shareable products that make this learning process constructionist. Furthermore, articulating and constructing links between representations is a fundamental component of developing meanings and understandings; part of what Richard Noss and Celia Hoyles (1996) refer to as webbing.

« 5 » In conclusion, I consider that Papademetri-Kachrimani's article is a helpful and interesting example of how teachers can experience valuable professional development experiences for future MbL / constructionism implementations in their practice. Furthermore, it includes a profound analysis of the processes and the role of representations that can lead to the development of understandings in teachers, students and also researchers. A further possible step in terms of the specific activities presented could be to ask participants (whether teachers or students) to write some kind of computer program that puts into action the rules and strategies for counting that they described during the activities (i.e., to program the model created).

Ana Isabel Sacristán has been a researcher, since 1989, at the Department of Mathematics Education of the Centre for Research and Advanced Studies (Cinvestav-IPN) in Mexico City. Her main area of research is the teaching and learning of mathematics through digital infrastructures, as well as the professional development of teachers in that area. In particular, she is an advocate of computer programming in mathematical education. Other interests include advanced mathematical thinking and the articulation of representations. Homepage: http://www.matedu.cinvestav.mx/~asacristan

Received: 8 June 2015
Accepted: 19 June 2015

Elements of Surprise in Teaching and Learning

Nikoleta Yiannoutsou
Educational Technology Lab,
NKUA, Greece
nyiannoutsou/at/ppp.uoa.gr

> Upshot • In my commentary, I focus on the concept of surprise underlying the design of the learning experience presented in Papademetri-Kachrimani's target article. I treat surprise as a concept that integrates the creative, open and non-predictable characteristics of constructionist teaching and learning. In my analysis, I show that current technological and societal developments have made these ideas of constructionism more relevant than ever. Within this rendering, it becomes clear that there is a need to revisit the position of constructionism in education.

« 1 » In her target article, Chrystalla Papademetri-Kachrimani mentions the element of surprise as a principle that underlines the design of the learning experiences described. Furthermore, surprise in this article is not just a design choice. Instead, it is presented as a core element of a pedagogy that is not guided by a strictly defined curriculum (objectives, learning scenarios) and that places more emphasis on the rich, complex, dynamic and non-predictable nature of teaching and learning.

« 2 » In this sense I find "surprise" relevant to the constructionist and to the constructivist approach to education. Both, by postulating *that knowledge is actively constructed through the child's interaction with the world*, emphasize teaching not just as a process of directing learning towards a strict known end but as a process of *offering opportunities to kids to engage in hands on explorations that fuel the constructive process* (Ackermann 2004: 18). In constructionism, the constructive process of learning evolves around constructions with personal meaning for the learner (Papert 1980b), and is mediated by digital tools that empower learners to shape, express and share their inner ideas *in and through* their constructions (Ackermann 2004).

« 3 » Constructions – *being sand castles or theories about the universe* (ibid) – as public entities to be shared and discussed, integrate elements of art that relate not only to the end product (i.e., the construction) but also to the process: the art of learning how to learn (ibid). Teaching and learning as art of course can refer to and make use of a framework (a set of goals, objectives and directions) but it also creates a space for surprise, for creativity and for freedom.

« 4 » In Papademetri-Kachrimani's article and in this analysis, a set of core ideas of constructivism and of constructionism have been highlighted: learning as an active process as opposed to passive consumption of information; empowering learners to shape (internalization of actions) and express their inner ideas; focusing on learner-generated constructions that have the status of public artefacts in the sense that they are situated in a social space where they can be shared, discussed and re-shaped. These ideas, although not directly related to constructionism, have become prominent today in the world of technology, where tools with new characteristics are gaining ground.

« 5 » The current technological landscape is populated with tools that empower end-users to design, modify, extend, evolve and share their artefacts. Many examples are encountered in, but not limited to, the field

of digital games.[1] Around these empowering technologies a new culture emerged in which user activity incrementally shifts from consumption to participation and in which the distinction between users and designers is blurred (Fisher 2009). This shift takes place through a technologically mediated transformation of the user from a passive consumer of finished goods designed by some to be consumed by many to an empowered individual equipped with the means to participate actively in the produced culture. Such constructionist tools, along with innovations such as 3D printing, democratize production by lending users the power to produce high-quality goods (physical or digital).

« 6 » An important point to note here is that the use of tools oriented towards construction (from now on "constructionist tools") is situated in the powerful social space of virtual communities. Virtual communities are not just the space where members share and discuss their products. Instead, they constitute a learning environment that offers the support and the collective intelligence necessary for individuals (as opposed to companies or experts) to deal with the demanding process of constructing high-quality end products. Characteristic examples are, to name a few, the "Do It With Others Communities" (an evolution of the "Do It Yourself" communities), the communities that develop and live around popular sandbox games (such as Minecraft) or around tools such as Scratch, the communities that organize events around technology and culture such as museomix (http://museomixuk.tumblr.com), etc.

« 7 » The characteristics of constructionist tools designed to empower end users, new materials and innovations (3D printing and automation), by democratizing production, have empowered communities to such a degree that a new direction in the design and production process is identified. This new direction involves shifting the orientation of design as a top-down process of producing rigid closed products to a process that entails the…

> "activation of open systems, tools that shape society by enabling self-organization platforms of collaboration independent of the capitalist model of competition, and empowering networks of production."[2]

This new approach, built around tools, self-organized communities and constructionist culture, is related to the third industrial revolution and the concept of adhocracy (ibid).

« 8 » My reference to the broader technological and societal landscape aimed to show how relevant the ideas of constructionism have become today, which is partially explained by the wide availability of tools with affordances that empower end users towards constructions. This realization is particularly interesting if we consider that the current trend in educational research is guided towards:

- micro-learning: i.e., focusing on more effective consumption of content – due to the growing amount of content available; and
- big data, data analytics, personalized and affective computing: i.e., focusing on over-structuring the teaching and learning process by recording and modeling as many aspects of student activity as possible.

In this context, quite often we see the use of sensors to capture biometric data (breathing rate variability, skin temperature, blood oxygen saturation, etc.) mobile data, mood data, social activity data (for an overview see Ferguson 2012). These data are labeled to model student behavior; the constructed models are used by technology to regulate student behavior towards other desired modeled behaviors or towards specific learning objectives; then new data are produced by the students feeding back into the "vicious" cycle.

> "Out of the maelstrom of happenings we abstract certain bits to attend to. We snapshot these bits by naming them. Then we begin responding to the names as if they are the bits that we have named, thus obscuring the effects of change. The names we use tend to 'fix' that which is named […]" (Postman & Weingartner 1969: 105)

« 9 » Neil Postman and Charles Weingartner are not referring to data analytics and adaptive-personalized learning. They are referring to language and how it shapes or – one could say – narrows down our view of the world, which is also a way to see the process of modeling the teaching and learning process described earlier. Our purpose here is not to dismiss the important role of personalization and adaptive computing in various educational settings (i.e., such as in the massive online open courses, distance learning, e-learning, etc.) but instead to rule out a simplistic view that learning and teaching are the models and the structures that can be created through data. Learning and teaching also involves, as shown in Papademetri-Kachrimani's target article, what cannot be modeled and predicted ahead of time and *what makes students tick, what keeps them intellectually alive, willingly pursuing knowledge and growth* (Rudduck 1995: 8). Our analysis of the relevance of constructionist ideas in the society today shows that these aspects of teaching and learning mentioned above need to attract again the interest of the educational community.

Nikoleta Yiannoutsou is a Senior Researcher at the Educational Technology Lab at the National and Kapodistrian University of Athens (NKUA), she holds a doctorate in educational technology, a bachelor's degree in psychology from the NKUA and a master's degree in intelligent tutoring systems from the University of Nottingham in UK. Her research focuses on the design of digital tools (mobile, desktop, tangible) so that they empower learners and teachers. She is also involved in the learning design of mobile and desktop games.

Received: 6 June 2015
Accepted: 17 June 2015

1| For a list see http://lifehacker.com/the-best-free-tools-for-making-your-own-video-games-1689905461

2| "Adhocracy" by Joseph Grima, M+ Matters, December 2012, http://www.mplusmatters.hk/asiandesign/paper_topic3.php