Acknowledgements

The project Mascil – Mathematics and Science in Life, http://www.mascil-project.eu – received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 320693.

Giorgos Psycharis is Lecturer in Mathematics Education in the Department of Mathematics at the National and Kapodistrian University of Athens, Greece. His fields of interest include the design of learning environments for mathematics involving the use of digital technologies (emphasis on the role of context and tools in the classroom setting) and teacher education in pre-service and in-service levels.

Received: 15 June 2015
Accepted: 16 June 2015

Author's Response:
The Critical Context of Teacher Attitudes and Beliefs

Karen Brennan

> Upshot • The OPC responses aptly identified numerous factors teachers encounter that can impede changes in pedagogical practice in the classroom. Although some of these factors are external, beyond a teacher's control, I discuss one internal factor – a teacher's attitudes and beliefs about their role and the learners they support – that was raised in the responses.

A tale of two teachers

« 1 » Several years ago, I co-facilitated an introductory Scratch workshop, hosted at a regional technology conference for teachers. After the 20 participants arrived, we showed them three or four projects created by young learners, to give them a sense of what might be possible to create with Scratch. Then, we transitioned to hands-on time for the teachers. The activity was *Pass-It-On*, in which the teachers collaboratively worked on a project connected to the theme of Halloween (which happened to be on the upcoming weekend). We started the activity by modeling – this enabled us to introduce the basic mechanisms of Scratch (e.g., snapping blocks together, running the program), giving participants what we hoped was enough scaffolding to get started. After the modeling, pairs of teachers had 15 minutes to start their stories. After 15 minutes elapsed, each pair stood up, left their computer, and moved to another computer, where they continued the story that they found at the new computer. After another 15 minutes, the pairs rotated again, and then eventually returned to their original computers to see how the other sets of partners had modified their initial creations. Participants were usually surprised and delighted by the evolution of the projects in their absence. (Although some people were sensitive about changes to their original vision.)

« 2 » We asked participants to talk about their experiences with the activity and how such an activity might work in their own classrooms. One teacher expressed doubt about adding the activity into her lessons. "This was great for me, but I couldn't let my students get started this way. I'd need to show them more, right? I couldn't just let them play, right?" She looked around the room at the other teachers for confirmation.

« 3 » A teacher on the other side of the room quickly jumped in:

> "I don't think you need to be so structured. I've been using Scratch for about three years. I started using the Scratch cards with kids because I thought that was a good way to introduce it to them. So I asked them to go through each of the twelve cards before they could start their own project. But that was a big mistake because they got very bored with those cards immediately. Today, what I do with the cards is that I leave them on the table and the kids know the cards are there. They can look for a particular card when they need it. The kids want to be able to just work on their projects and be a little freer."

« 4 » Another teacher, sitting at the back of the room, forcefully raised her arm, while shaking her head:

> "I teach it a different way – I don't let them go and do it, because they just sit there and say, 'I don't know how to make the cat move!' So, I lead them through Scratch step-by-step. It takes me three or four weeks to go through all that. Because if I just ask them to make something, some of the kids – some of them are creative and do produce something – but a lot of them just make something dancing on a screen saying, 'Hi! Hi! Hi! Hi! Oh, you're cool! Hi! Hi!'"

Teacher attitudes and beliefs as context

« 5 » I was reminded of this experience as I read the responses from **Hugh Gash** and **Thomas McCloughlin**, **Carina Girvan**, and **Giorgos Psycharis**. All three responses raised important questions about the significance of context in supporting (or suppressing) constructionist approaches to learning in the classroom. In some cases, these questions focused on external factors – issues and constraints that individual teachers are subjected to as part of their lived contextual experience, but essentially beyond their control. For example, **Girvan** highlighted the constraining function that national assessments can exert on teachers experimenting with new pedagogical practices.

« 6 » Equally important, as the responses argued, a teacher's own attitudes and beliefs play a critical role in directing and shaping their interest, willingness, and ability to include constructionist approaches to learning in the classroom. This is what reminded me of the workshop experience. These two teachers – who were contextually similar, subjected to the same geographic, socioeconomic, grade-level, subject-area, and policy factors – differed primarily in their attitudes and beliefs about their role as teacher and the role and capacities of their students, a type of "internal" context.

« 7 » Too often, professional learning experiences are designed around a facile compliance model – one in which teachers have an experience that they are then expected, without attention or sensitivity to contextual variations, to execute faithfully in the classroom (Lieberman & Pointer Mace 2008). In fact, there is significant complexity in translating professional learning experiences into practice as teachers negotiate external and internal contextual factors (Windschitl 2002). And, although both sets of factors are important, given the limited control that most teachers have over external factors, I argue that it is critically important to engage the internal contextual factors in teachers' professional learning experiences.

« 8 » But what might this engagement look like? In the vision for professional learn-

ing that I described in my article, the teacher learns through experience, an approach aligned with similar endeavors described in the three OPCs and in the broader literature about teacher learning. In the specific case of ScratchEd, in which I study and support teacher professional learning as a means to support constructionism in the classroom, the teacher learning is itself constructionist, emphasizing learning activities of designing, personalizing, sharing, and reflecting. In this approach, the work of surfacing teacher attitudes and beliefs can cut across all four of these activities, but particularly in reflection. Reflection should invite teachers to consider their experiences within the professional learning setting, but, equally importantly, to engage in self-reflective processes, creating opportunities to consider their own preconceptions, attitudes, assumptions, and beliefs. Documentation can serve as a critical component of this self-reflective process – through personal journaling, interviews, or portfolios. These forms of documentation can trace the evolution of attitudes and beliefs over time, making the tacit explicit, and making change possible.

Received: 18 June 2015
Accepted: 26 June 2015

Combined References

Ackermann E. (1996) Perspective-taking and object construction: Two keys to learning. In: Kafai Y. B. & Resnick M. (eds.) Constructionism in practice: Designing, thinking, and learning in a digital world. Lawrence Erlbaum, New Jersey: 25–35.

Alderton E., Brunsell E. & Bariexca D. (2011) The end of isolation. Journal of Online Learning and Teaching 7(3): 1–14.

Alexander R. (2008) pedagogy, curriculum and culture. In: Murphy P., Hall K. & Soler J. (eds.) Pedagogy and practice: Culture and identities. Sage, London: 3–27.

Angeli C. & Valanides N. (2009) Epistemological and methodological issues for the conceptualization, development, and assessment of ICT–TPCK: Advances in technological pedagogical content knowledge (TPCK). Computers and Education 52: 154–168.

Arigue M. & Blomhøj M. (2013) Conceptualizing inquiry-based education in mathematics. ZDM – The International Journal on Mathematics Education 45: 797–810.

Ball D. L. & Cohen D. K. (1999) Developing practice, developing practitioners: Toward a practice-based theory of professional education. In: Sykes G. & Darling-Hammond L. (eds.) Teaching as the learning profession: Handbook of policy and practice. Jossey Bass, San Francisco: 3–32.

Bandura A. (1997) Self-efficacy: The exercise of control. W. H. Freeman, New York.

Barab S. A., Barnett M. & Squire K. (2002) Developing an empirical account of a community of practice: Characterizing the essential tensions. Journal of the Learning Sciences 11(4): 489–542.

Barab S. A., MaKinster J. G. & Scheckler R. (2003) Designing system dualities: Characterizing a web-supported professional development community. The Information Society 19(3): 237–256.

Bertram A. & Waldrip B. (2013) ICT for ICT's sake: Secondary teachers' views on technology as a tool for teaching and learning. Australian Educational Computing 28(1): 61–70.

Borko H. (2004) Professional development and teacher learning: Mapping the terrain. Educational Researcher 33(8): 3–15.

Borko H., Jacobs J. & Koellner K. (2010) Contemporary approaches to teacher professional development. In: Peterson P., Baker E. & McGaw G. (eds.) International encyclopedia of education. Third edition.. Elsevier, Oxford: 548–556.

Boule M. (2011) Mob rule learning: camps, unconferences, and trashing the talking head. Information Today, Medford NJ.

Bransford J., Brown A. L., Cocking R. R., Donovan M. S. & Pellegrino J. W. (2000) How people learn: Brain, mind, experience and school. Revised edition. National Academies Press, Washington.

Brennan K. (2013) Learning computing through creating and connecting. Computer 46(9): 52–59.

Brennan K. (2014) Audience in the service of learning: How kids negotiate attention in an online community of interactive media designers. Learning, Media and Technology: 1–20.

Brennan K. & Resnick M. (2013) Imagining, creating, playing, sharing, reflecting: How online community supports young people as designers of interactive media. In: Lavigne N. & Mouza C. (eds.) Emerging technologies for the classroom: A learning sciences perspective. Springer, New York: 253–268.

Brown A. L. & Campione J. C. (1996) Psychological theory and the design of innovative learning environments: On procedures, principles and systems. In: Schauble L. & Glaser R. (eds.) Innovations in learning: New environments for education. Lawrence Erlbaum, Hillsdale NJ: 234–265.

Brown J. S., Collins A. & Duguid P. (1989) Situated cognition and the culture of learning. Educational Researcher 18(1): 32–42.

Bruckman A. (1998) Community support for constructionist learning. Computer Supported Cooperative Work 7(1–2): 47–86.

Bruckman A. (2006) Learning in online communities. In: Sawyer K. (ed.) Cambridge handbook of the learning sciences. Cambridge University Press, New York: 461–472.

Brunvand S., Fishman B. & Marx R. (2005) Moving professional development online: Meeting the needs and expectations of all teachers. In: Dangel J. R. & Guyton E. (eds.) Research on alternative and non-traditional education. Association of Teacher Educators, Oxford: 205–232.

Buckingham D. (2007) Beyond technology: Children's learning in the age of digital culture. Polity, Malden MA.

Buckingham D. & Willett R. (eds.) (2006) Digital generations: Children, young people, and new media. Routledge, London.

Butler D. (2004) Self-determined teacher learning in a digital context: Fundamental change in thinking and practice. Unpublished doctoral dissertation. Dublin City University, Dublin.

Cherubini M., Gash H. & McCloughlin T. (2008) The DigitalSeed: An interactive toy for investigating plants. Journal of Biological Education 42(3): 123–129.

Cole M. & Wertsch J. V. (1996) Beyond the individual-social antinomy in discussions of Piaget and Vygotsky. Human-Development 39(5): 250–256.

Collins A. (2006) Cognitive apprenticeship. In: Sawyer K. (ed.) Cambridge handbook of the learning sciences. Cambridge University Press, Cambridge: 47–60.

Collins A. & Halverson R. (2009) Rethinking education in the age of technology: The digital revolution and schooling in America. Teachers College Press, New York.

Conneely C., Girvan C., Lawlor J. & Tangney B. (2015) An exploratory case study into the adaption of the Bridge21 model for 21st century learning in Irish classrooms. In: Butler D., Marshall K. & Leahy M. (eds.) Shaping our future: How the lessons of the past can shape educational transformation. Liffey Press, Dublin: 348–381.

Cuban L. (2001) Oversold and underused: Computers in the classroom. Harvard University Press, Cambridge MA.

Daly C., Pachler N. & Pelletier C. (2009) Continuing professional development in ICT for teachers: A literature review. BECTA, London.

de Jong T. & Pieters J. (2006) The design of powerful learning environments. In: Alexander P. A. & Winne P. H. (eds.) Handbook of educational psychology. Second edition. Routledge, Mahwah NJ: 739–754.

Doig B. & Groves S. (2011) Japanese lesson study: Teacher professional development through communities of inquiry. Mathematics Teacher Education & Development 13(1): 77–93.

Dweck C. (2000) Self-theories: Their role in motivation, personality, and development. Psychology Press, Lillington NC.

Farooq U., Schank P., Harris A., Fusco J. & Schlager M. (2007) Sustaining a community computing infrastructure for online teacher professional development: A case study of designing Tapped In. Computer Supported Cooperative Work 16(4–5): 397–429.

Fernandez M. L. (2010) Investigating how and what prospective teachers learn through microteaching lesson study. Teaching and Teacher Education 26(2): 351–362.

Fischer G. (2002) Beyond "couch potatoes": From consumers to designers and active contributors. First Monday 7(12). Available at http://firstmonday.org/article/view/1010/931

Fischer G. & Nakakoji K. (1997) Computational environments supporting creativity in the context of lifelong learning and design. Journal of Knowledge-Based Systems 10(4): 21–28.

Fishman B. J. & Davis E. A. (2006) Teacher learning research and the learning sciences. In: Sawyer K. (ed.) Cambridge handbook of the learning sciences. Cambridge University Press, Cambridge: 535–550.

Fishman B. J., Davis E. A. & Chan C. K. K. (2014) A learning sciences perspective on teacher learning research. In: Sawyer R. K. (ed.) Cambridge handbook of the learning sciences. Second edition. Cambridge University Press, New York: 707–725.

Flavell J. H. (1979) Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry. American Psychologist 34(10): 906–911.

Fulton F., Doerr H. & Britton T. (2010) STEM teachers in professional learning communities: A knowledge synthesis. National Commission on Teaching and America's Future.

Gardner H. (1983) Frames of mind: The theory of multiple intelligences. Basic Books, New York.

Gardner H. (1991) The unschooled mind: How children think and how schools should teach. Basic Books, New York.

Gardner H. (1999) Intelligence reframed: Multiple intelligences for the 21st century. Basic Books, New York.

Gash H. (2014) Constructing constructivism. Constructivist Foundations 9(3): 302–310. Available at http://www.univie.ac.at/constructivism/journal/9/3/302.gash

Gash H. & McCloughlin T. (2010) Primary and secondary school differences in thinking about science. International Journal of Educational Researchers 1(3): 92–102. Available at http://ijer.eab.org.tr/pages/past-issue/2010-volume-1-issue-3.php

Gilligan C. (1982) In a different voice: Psychological theory and women's development. Harvard University Press, Cambridge MA.

Groupe Interuniversitaire Projet Sophia (2009) Formation des enseignants : un exemple de recherche-action: Chypre, France, lrlande, République tchèque, Slovénie. Review Internationale D'Éducation de Sèvres 51: 47–58. Available at https://ries.revues.org/660

Guskey T. R. (2002) Does it make a difference? Evaluating professional development. Educational Leadership 59(6): 45–51. Available at http://www.ascd.org/publications/educational-leadership/mar02/vol59/num06/Does-It-Make-a-Difference¢-Evaluating-Professional-Development.aspx

Harel I. & Papert S. (1990) Software design as a learning environment. Interactive Learning Environments 1(1): 1–32.

Hill H. C. (2007) Teachers' ongoing learning: Evidence from research and practice. The Future of Children 17: 111–128.

Hill H. C., Beisiegel M. & Jacob R. (2013) Professional development research: Consensus, crossroads, and challenges. Educational Researcher 42(9): 476–487.

Hoyles C., Noss R., Kent P. & Bakker A. (2010) Improving mathematics at work: The need for technomathematical literacies. Routledge, London.

Ito M. (2009) Engineering play: A cultural history of children's software. MIT Press, Cambridge MA.

Ito M., Baumer S., Bittanti M., boyd d., Cody R., Herr-Stephenson B., Horst H. A., Lange P. G., Mahendran D., Martínez K. Z., Pascoe C. J., Perkel D., Robinson L., Sims C. & Tripp L. (2009) Hanging out, messing around, geeking out: Living and learning with new media. MIT Press: Cambridge MA.

Jenkins H., Purushotma R., Weigel M., Clinton K. & Robison A. (2006) Confronting the challenges of participatory culture: Media education for the 21st century. MIT Press, Cambridge MA.

Kafai Y. B. (1995) Minds in play: Computer game design as a context for children's learning. Lawrence Erlbaum, Hillsdale NJ.

Kafai Y. B. & Resnick M. (eds.) (1996) Constructionism in practice: Designing, thinking, and learning in a digital world. Lawrence Erlbaum, Hillsdale NJ.

Kimmons R. (2015) Examining TPACK's theoretical future. Journal of Technology and Teacher Education 23(1): 53–77.

Knowles J. G. (1992) Models for understanding pre-service teachers and beginning teachers' biographies. In: Goodson I. F. (ed.) Studying teachers' lives. Routledge, London: 99–152.

Kolodner J., Camp P. J., Crismond D., Fasse B., Gray J., Holbrook J., Puntambekar S. & Ryan M. (2003) Problem-based learning meets case-based reasoning in the middle-school science classroom: Putting Learning by Design into practice. Journal of the Learning Sciences 12(4): 495–547.

Koschmann T., Kelson A., Feltovich P. & Barrows H. (1996) Computer-supported problem-based learning: A principled approach to the use of computers in collaborative learning. In: Koschmann T. (ed.) CSCL: Theory and practice of an emerging paradigm. Lawrence Erlbaum, Hillsdale NJ: 83–124.

Krajcik J. S. & Blumenfeld P. C. (2006) Project-based learning. In: Sawyer K. (ed.) Cambridge handbook of the learning sciences. Cambridge University Press, Cambridge: 317–334.

Lajoie S. P. & Azevedo R. (2006) Teaching and learning in technology-rich environments. In: Alexander P. A. & Winne P. H. (eds.) Handbook of educational psychology Second edition. Routledge, Mahwah NJ: 803–821.

Lave J. & Wenger E. (1991) Situated learning: Legitimate peripheral participation. Cambridge University Press, New York.

Lieberman A. & Pointer Mace D. H. (2008) Teacher learning: The key to educational reform. Journal of Teacher Education 59(3): 226–234.

Liff S. & Shepard A. (2004) An evolving gender digital divide? Oxford Internet Institute Internet Issue Brief 2: 1–10.

Lin H. T. & Fishman B. (2009) Scaffolding teacher adaptation by making design intent explicit. In: Dimitracopoulou A., O'Malley C., Suthers D. D. & Reiman P. (eds.) Proceedings of the 9th international conference on computer supported collaborative learning 2: 159–161.

Mishra P. & Koehler M. J. (2006) Technological pedagogical content knowledge: A framework for teacher knowledge. Teachers College Record 108(6): 1017–1054.

Palfrey J. & Gasser U. (2008) Born digital: Understanding the first generation of digital natives. Basic Books, New York.

Papert S. (1980) Mindstorms: Children, computers, and powerful ideas. Basic Books, New York.

Papert S. (1987) Information technology and education: Computer criticism vs. technocentric thinking. Educational Researcher 16(1): 22–30.

Piaget J. (2007) The child's conception of the world. Rowman & Littlefield, Maryland. Originally published in French as: Piaget J. (1929) Representation du monde chez l'enfant.

Prensky M. (2001) Digital natives, digital immigrants. On the Horizon 9(5): 1–6.

Razzouk R. & Shute V. (2012) What is design thinking and why is it important? Review of Educational Research 82(3): 330–349.

Resnick M., Maloney J., Monroy-Hernandez A., Rusk N., Eastmond E., Brennan K., Millner A., Rosenbaum E., Silver J., Silverman B. & Kafai Y. (2009) Scratch: Programming for all. Communications of the ACM 52(11): 60–67. Available at http://cacm.acm.org/magazines/2009/11/48421-scratch-programming-for-all/fulltext

Riegler A. (2005) Editorial: The constructivist challenge. Constructivist Foundations 1(1): 1–8. Available at http://www.univie.ac.at/constructivism/journal/1/1/001.riegler

Rogoff B. (1994) Developing understanding of the idea of communities of learners. Mind, Culture, and Activity 1(4): 209–229.

Sawyer K. (2006) Explaining creativity: The science of human innovation. Oxford University Press, Oxford.

Scardamalia M. & Bereiter C. (1991) Higher levels of agency for children in knowledge building: A challenge for the design of new knowledge media. Journal of the Learning Sciences 1(1): 37–68.

Schön D. (1983) The reflective practitioner: How professionals think in action. Basic Books, New York.

Seiter E. (2008) Practicing at home: Computers, pianos, and cultural capital. In: McPherson T. (ed.) Digital youth, innovation, and the unexpected. MIT Press, Cambridge MA, 27–52.

Selwyn N. (2009) The digital native: Myth and reality. New Information Perspectives 61(4): 364–379.

Selwyn N. (2011) Education and technology: Key issues and debates. Continuum, New York.

Selwyn N. (2014) Distrusting educational technology: Critical questions for changing times. Routledge, New York.

Sharkey M. (2014) Teachers' beliefs and constructivism. Unpublished masters' thesis. Dublin City University, Dublin.

Swanson K. N. & Leanness A. (2012) Edcamp: A qualitative exploration. Available at http://edcamp.org/wp-content/uploads/2012/07/Edcamp_Whitepaper_Final.pdf

Tapscott D. (2008) Grown up digital: How the net generation is changing your world. McGraw-Hill, New York.

Taylor P. C., Fraser B. J. & Fisher D. L. (1997) Monitoring constructivist classroom learning environments. International Journal of Educational Research 27: 293–302.

Turkle S. & Papert S. (1990) Epistemological pluralism: Styles and voices within the computer culture. Signs 16(1): 128–157.

Vygotsky L. S. (1978) Mind in society: Development of higher psychological processes 14th edition. Harvard University Press, Cambridge MA.

Wake G. (2014) Making sense of and with mathematics: The interface between academic mathematics and mathematics in practice. Educational Studies in Mathematics 86: 271–290.

Watanabe T. (2002) Learning from Japanese lesson study. Educational Leadership 59(6): 36–39.

Webster-Wright A. (2009) Reframing professional development through understanding authentic professional learning. Review of Educational Research 79(2): 702–739.

Wenger E. (1998) Communities of practice: Learning, meaning, and identity. Cambridge University Press, Cambridge.

Wenger E., McDermott R. & Snyder W. M. (2002) Cultivating communities of practice. Harvard Business School Press, Cambridge MA.

Westheimer J. (2008) Learning among colleagues: Teacher community and the shared enterprise of education. In: Cochran-Smith M., Feiman-Nemser S., McIntyre D. J. & Demers K. E. (eds.) Handbook of research on teacher education. Third edition. Routledge, New York: 756–783.

Windschitl M. (2002) Framing constructivism in practice as the negotiation of dilemmas: An analysis of the conceptual, pedagogical, cultural, and political challenges facing teachers. Review of Educational Research 72(2): 131–175.

Wiske M. S., Perkins D. N. & Spicer D. E. (2006) Piaget goes digital: Negotiating accommodation of practice to principles. In: Dede C. (ed.) Online professional development for teachers. Harvard Education Press, Cambridge MA: 9–67.