



HAL
open science

Tensions between resource perspectives and trends in the design and dissemination of digital resources

Zenon Borys, Jeffrey Choppin

► **To cite this version:**

Zenon Borys, Jeffrey Choppin. Tensions between resource perspectives and trends in the design and dissemination of digital resources. CERME 10, Feb 2017, Dublin, Ireland. hal-01950512

HAL Id: hal-01950512

<https://hal.science/hal-01950512>

Submitted on 10 Dec 2018

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Tensions between resource perspectives and trends in the design and dissemination of digital resources

Zenon Borys¹ and Jeffrey Choppin¹

¹University of Rochester; zenon.borys@gmail.com

¹University of Rochester; jchoppin@warner.rochester.edu

Teachers are increasingly using digital resources to design lessons. We describe three perspectives for describing teachers' interactions with digital resources, perspectives that denote different assumptions with respect to teacher agency and the connections between capacity development and resource use. This paper examines the tensions between these conceptions of teachers' interactions with digital resources and the ways other actors – including policy makers, curriculum developers, and purveyors of online content – frame the purpose for and development of digital resources. Our analysis suggests that the assumed role of the teacher differs across different sets of actors and different visions related to the design and development of digital curriculum resources. The implications relate to the opportunities for teachers to transform digital resources to suit their purposes and to develop and grow professionally as a result.

Keywords: Digital curriculum, teacher practices, curricular resources.

Teaching is design work: Teachers actively interpret and mobilize resources to attain pedagogic and curricular goals. Moreover, teachers increasingly use, and are expected to use, digital resources to design lessons. However, there are tensions between education technology discourses, curriculum design trends, education policies, and the work teachers do with digital resources. As a case in point, in Sweden a public/private partnership endeavor created a repository of resources and lessons for teachers that was little used because the design of the repository did not take into account how teachers actually take up digital resources, illustrating the lack of alignment between teachers' professional practices, education policy, and the design of instructional resources (CERI, 2009). As Remillard (2012) notes, teachers do not simply interpret authors' intentions as they engage with curriculum resources, they engage with the artifact itself (p. 114). Given that teachers' work with resources can promote teachers' professional development and meaningful experiences for students, it is important to understand how tensions between teachers' practices and the assumptions about teaching and teachers embedded in digital resources potentially constrain teachers' opportunities to develop design capacity.

To illustrate how digital resource design and dissemination limit teachers' agency – and thus their roles as designers – we examined tensions between conceptions of teachers' interactions with digital resources and the ways other actors – including policy makers, curriculum developers, and purveyors of online content (commercial publishers, large philanthropies) – frame the purpose for and development of digital resources. These actors constitute the largest source of resources and information regarding digital resources and thus their influence merits attention from the research community. The ways digital resources are framed and promoted by policy makers and other actors may be at odds with the actual work teachers do and the needs of their students.

Conceptualizations of teachers' work with digital curriculum resources

The meaning of the term resources depends on the perspective of the researcher and what is being researched (Ruthven, 2013). Researchers frame the relationship between teachers and their use of resources in three ways: resources function as tools that mediate the act of teaching; resources function as artifacts (instruments) that signify outcomes of processes; and resources function as objects whose creation is a key component of teachers' professional work (Remillard, 2013). These are elaborated in more detail below.

The most common framing in teachers' design work is that resources are tools that mediate teachers' work, in line with sociocultural notions of tool mediation (e.g., Wertsch, 1998). The resource's function is primarily to help/aid/assist teachers in the work of teaching. Teachers' use of resources allows them to improve practices they already engaged in or, sometimes, to engage in new practices altogether. Often, the affordance or benefit of the resource is located within the resource and teachers perceive the affordance or benefit and apply it to their local context. Kasten and Sinclair (2009), for example, showed that teachers selected digital applets to help present topics in new ways. Also, Duncan (2010) demonstrated that teachers made their classroom practices more student-centered because the resources they were using automatically provided students feedback and gave students more agency over their interactions with content. These teachers crafted lessons that capitalized on this shift in the student-content relationship. In these two examples, the benefits or affordances were thought of as residing in the resource.

Considering resources as an artifact – rather than as a tool – connotes place and time: teachers' use of resources is inseparable from when they are used and teachers' purposes for using resources. The theory of instrumental genesis (Rabardel, 2002) considers three factors: the impact of the design of tools on how they are used (instrumentation); the users and their previous experiences with using the tool (instrumentalization); and the purposes and goals users assign to tool use (schemes of utilization). Acknowledging the different factors that impact how teachers take up tools makes the processes associated with using the tool rather than the tool itself the object of study. Rabardel defined an *instrument* as an artifact coupled with the schemes of utilization users assign to it. It is important to note that the theory of instrumental genesis is focused on the resource *in use*, not the resource itself. The use of the term instrument emphasizes a process of transformation where the focus is on how teachers use resources to attain goals, not some innate quality of the resources. This is especially important when considering teachers' work with resources because teachers increasingly draw from a variety of sources when crafting instruction and use resources differently over time according to their context (e.g. Gueudet, Bueno-Ravel, & Poisard, 2014).

The third conceptualization is framing resources as objects, where a key component of teaching is to create resources. Document genesis (Gueudet & Trouche, 2009) is a theory focused on teachers' creation of resources for teaching. Stemming from the instrumental approach, document genesis explains how, in the creation of resources, teachers develop schemes of utilization that are comprised of teachers' knowledge and processes for using resources. Document genesis offers a window into teachers' evolution of practices with their resources. Since teachers often reuse resources from previous years, the documents from one year become resources for the next year and are embedded with teachers' experiences and modifications (Gueudet & Trouche, 2009). Often, when resources are considered tools, teachers are not producers: their work is of application and applies to one instance

of enactment without connection to future use. However, when treated as objects of design, the focus is on how teachers create resources to meet their local contextual challenges and on how the teachers' understanding and use of resources evolves over time.

In a complex landscape where teachers weave together various resources in the design of lessons, treating resources as an object of teachers' design work provides researchers with a theoretical grounding to make sense of and explain interactions in online spaces, such as resource repositories. The resources being downloaded and shared by teachers are not solely resources (tools) to mediate teaching: their creation and transmission constitute important facets of teaching. For example, Trglaova and Jahn (2013) examined how teachers improved resources posted to a repository based on the feedback they received from other teachers. Also, this framing allows researchers to situate teachers in broader collectives and to determine how the impact of belonging to and participating in collectives has on teachers' practices (Guedet & Trouche, 2012).

These perspectives on resources suggest different roles for the teacher with respect to how digital resources get taken up. In the first, resource as tool, the resource is considered to have innate qualities that teachers can employ to varying degrees in their lessons but not substantially revise. The latter two perspectives outline a more active role for the teacher, suggesting not simply a mediating role between resource and student, but a transformative role for the teacher with respect to the design and use of the resource. More generally, thinking about teachers' design processes positions teacher capacity as an important goal in the design and use of digital resources; consequently, perspectives on digital resources that minimize teachers' role have potential impact in terms of agency and ultimately the development of teacher capacity. Below, we explore how trends in the design and dissemination of digital resources may be in tension with conceptualizations of active roles for teachers with respect to the design and use of digital curriculum resources. We consider how different actors influence the design and dissemination of digital curriculum resources, and that these efforts may neglect the role of the teacher. An aim is to show that there are potentially conflicting values between perspectives focused on teaching as design and perspectives that promote characteristics of digital resources that constrain teachers' roles and their ability to be responsive to their local context.

Trends in the design and dissemination of digital resources

In this section, we articulate broad trends in the design and dissemination of digital curriculum materials and then connect those trends to the perspectives that emphasize the design role of teachers. We characterize these trends by focusing on the actors who emphasize particular perspectives – and exercise considerable influence – related to the design and dissemination of digital resources. We focus on the following three broad sets of actors because of the considerable influence they exercise over the design and dissemination of digital curriculum materials: designers, policy makers, and purveyors of online content (e.g., commercial publishers, for-profit educational websites, large philanthropic or corporate organizations). Included in the group of corporate entities are philanthropies and corporations not previously engaged in educational publishing (e.g., the Gates Foundation, Amazon, Mark Zuckerberg's funding efforts), who strive to influence both content as well as delivery mechanisms for that content, especially in the U.S.

These groups make a number of claims about the potential transformative features of digital curriculum materials. We focus on three features to highlight the roles of the sets of actors identified above:

- Content can be more relevant and interactive;
- High quality content can be inexpensive and widely accessible; and
- Content can be customized to meet the needs of individual students.

We selected these features because they are the primary focus of the design, dissemination, and publicity efforts of the actors described above. Below, we describe how these features are emphasized by the various actors and how they are in tension with the perspectives on resource use, with implications for how teachers get positioned as active designers who can develop increasing capacity to design and enact curriculum materials.

Content can be more relevant and interactive

Advocates claim that content in digital materials has the potential to be more interactive and relevant, as it can be updated and revised to fit the local context. In terms of interactivity, digital texts can be flexible with respect to navigation (e.g., hyperlinks) and with respect to creating documents with resources and materials from a range of sources, including the web (Zhao et al., 2010). Other kinds of interactivity include the use of sliders or buttons to manipulate parameters in a model to investigate problems or phenomena (Dede, 2000). More powerful forms of interactivity involve the use of tools with flexible purposes in open working environments, such as curriculum programs developed in Israel and Korea (cf. Lew, 2016; Yerushalmy, 2016). In general, interactivity can be conceived in terms of the choices users can make to influence their engagement with the content.

We focus on the set of actors we call *designers* to highlight how interactive features are incorporated into digital resources. We refer to designers as those who conceptualize features of digital materials based on research on learning and learning systems. Of the sets of actors described above, the curriculum resources designed and disseminated by designers are the most aligned with teaching as design perspective. These resources offer the greatest flexibility in terms of adaptation by teachers and in terms of generating interactions with students that provide opportunities to understand how student thinking develops. Designers emphasize learning experiences that augment or enhance what is possible in paper curricula. Moreover, designers emphasize the development of tool-rich workspaces that enhance interaction, communication, and exploration. Designers incorporate ubiquitous access to tools that allow for dynamically linked representations and the ability to record and curate work (Confrey, 2016; Lew, 2016; Yerushalmy, 2016). Confrey, Lew, and Yerushalmy emphasize that workspaces should provide access to a suite of tools that learners strategically select as they engage in complex problems. These workspaces facilitate the use and manipulation of multiple representations, including symbols, in ways that are intuitive and that communicate increasingly formal inscriptions of the mathematics. Furthermore, these workspaces should allow students to store and curate their work, for future reference for themselves and external audiences.

In terms of developing teachers' design capacity, and thus align with the artifact and documentation perspectives described above, designers emphasize more complicated and idiosyncratic learning paths for students in terms of deviating from a rigid demarcation and flow of mathematical activity (Confrey, 2016). Curriculum materials differ from open tools, such as Sketchpad, Cabri, or

Mathematica, in that they are intended to provide structure by bounding and sequencing mathematical activity. Integrating rich problems and work spaces provides opportunities for the kind of complex activity that involves non-linear processes (unproductive approaches may precede more productive approaches), complex interactions of tools and representations, and the collective negotiation of the viability and validity of solution paths. Such complex activity can disrupt well-defined lesson structures and allocations of time (both duration and synchronicity)(c.f. Ritella & Hakkarainen's [2012] discussion of chronotype), interrupting the potential flow of a lesson, with implications for following a prescribed scope and sequence of mathematics. Managing these non-linear activity flows calls for more prominent roles for teachers and entails developing new forms of capacity in terms of understanding curriculum progressions and coordinating (orchestrating) multiple tools and artifacts in the workspace.

The work of designers focuses on the interactive and flexible features of digital resources, while other actors – policy makers and purveyors of online content (mostly commercial interests and philanthropies operating from a neoliberal perspective) – emphasize different features, explored below. The different features emphasized by these other actors have implications in terms of the roles and capacities envisioned for teachers.

Free and open digital content

Policy makers have pushed digital content that is freely available and open source. They argue that this would make high-quality content accessible to low-resource high needs districts. Internationally, there has been a push for Open Education Resources (OER) for nearly a decade now: “The open educational resource (OER) movement aims to break down such barriers [from proprietary systems] and to encourage and enable freely sharing content” (OECD, 2007). Recently, the US Department of Education launched an initiative designed to encourage districts to adopt open resources and to share their efforts and experiences with others, in part to make access to high-quality instructional resources more equitable (USDoe, 2016). The use of open resource content, however, can be time-consuming and the resources themselves are of uneven quality. There is little quality control with respect to content, and much of it requires little interactivity or minimal educative features for explaining the design rationale to teachers. Furthermore, these efforts assume that teachers have considerable capacity to evaluate, select, and sequence content chosen from a variety of sources. Given that much of these efforts are aimed at low-resourced districts, especially in the U.S., there is an assumption that teachers can use the materials without modifications, which aligns with the resource as tool perspective. Recently, there have been efforts to curate content in ways that provide quality control and articulate curriculum progressions (Confrey, 2016); however, these efforts have yet to be coordinated with the larger policies for open resources and their impact on teacher design capacity is not yet determined.

Customizing content for individual learners

Policy makers, commercial publishers, and large philanthropies have emphasized the promise of digital content to be customized to meet the needs of individual learners. Customization has been discussed in a variety of ways. This can be achieved through systems that emphasize mastery learning, in which software dictates the sequencing of content for a learner based on the learner's performance on skills-based assessments (e.g., Means, Peters, & Zheng, 2014). Or, it could involve personalizing

the software settings so that the user has control over video and audio as well as the presentation of the text. A third way is for the teacher to make content selections within a program so that different students would see different content. Mostly, however, the personalized systems entail diagnostic assessments administered through online programs that dictate the pacing and sequencing of content (Choppin, Carson, Borys, Cerosaletti, & Gillis, 2014). These efforts, largely funded and publicized by large philanthropic or corporate entities, push to embed digital content in comprehensive learning management systems that include data reporting and classroom management systems. They also emphasize adaptive programs based largely from the mastery learning perspective (e.g., courseware funded by the Gates Foundation). Some educational websites, either for-profit or philanthropy-funded, create collections of lessons, sometimes developed by a small group or by larger author groups (e.g., Khan Academy, sofatutor.com). While these programs may eventually involve sophisticated adaptive systems and customized learning tools that allow learners to explore content in complex workspaces, the initial versions of these programs typically entail low-level content and reporting of percentage of correctly answered multiple-choice questions (Choppin, Carson, Borys, Cerosaletti, & Gillis, 2014), characteristics that constrain opportunities for learning. Furthermore, the programs minimize the role of the teacher, impacting development of teacher capacity.

Implications of tensions between perspectives

Teachers' interactions with digital resources involves agency: in the act of designing, teachers take up digital curriculum resources, interpret their purposes, and transform them to respond to their pedagogical purposes and their evolving understanding of how those resources can be used to engage students. This assumes that teachers are designers, actively interacting with and transforming curriculum resources to engage students. The three perspectives describing teachers' interactions with digital resources denote different assumptions with respect to teacher agency and the connections between capacity development and resource use. The assumed role of the teacher differs across the perspectives of the different sets of actors that relate to the design and development of digital curriculum resources.

The analysis illustrates that different perspectives on the design and dissemination of digital resources have implications for the opportunities teachers have to understand, adapt, and transform digital resources and thus develop capacity as a result. The designer perspective offers the greatest possibility of alignment between views of teachers as designers and the affordances of digital curriculum materials, though much of their focus and expectations is on creating a medium for rich student interaction rather than informing teacher use and capacity development. Other actors – such as policy makers, commercial publishers, large philanthropies – have different perspectives, and motives, for designing and disseminating digital curriculum. The programs associated with these perspectives show little sensitivity to the complexities involved with how teachers take up digital curriculum resources, and minimize the role of teachers to transform digital resources to suit their purposes. Many of these programs emphasize personalized learning, which entails little interaction with teachers, and little flexibility on the teacher's part to construct learning experiences for students. These entities exercise great influence on which programs are available, and their impact on teacher autonomy and teacher capacity needs to occupy the attention of researchers.

Acknowledgment

This research was funded by U.S. National Science Foundation, DRL #1222359.

References

- Centre for Education, Research, & Innovation. (2009). *Country Case Study Report On Sweden in Beyond Textbooks: Digital Learning Resources as Systemic Innovation in the Nordic Countries*. Paris: OECD.
- Chazan, D. & Yerushalmy, M. (2014). The future of mathematics textbooks: Ramifications of technological change. In Stocchetti, M. (Ed.), *Media and Education in the Digital Age: Concepts, Assessments, and Subversions* (pp. 63-78).
- Choppin, J., Carson, C., Borys, Z., Cerosaletti, C., & Gillis, R. (2014). A typology for analyzing digital curricula in mathematics education. *International Journal of Education in Mathematics, Science, and Technology*, 2(1), 11-25.
- Diekema, A., & Olsen, M. (2014). Teacher personal information management (PIM) practices: Finding, keeping, and re-finding information. *Journal of the Association for Information Science and Technology*, 65(11), 2261-2277.
- Drijvers, P., Doorman, M., Boon, P., Reed, H., & Gravemeijer, K. (2010). The teacher and the tool: instrumental orchestrations in the technology-rich mathematics classroom. *Educational Studies in Mathematics*, 75(2), 213-234.
- Drijvers, P., Tacoma, S., Besamusca, A., Doorman, M., & Boon, P. (2013). Digital resources inviting changes in mid-adopting teachers' practices and orchestrations. *ZDM Mathematics Education*, 45(7), 987-1001.
- Duncan, A. G. (2010). Teachers' views on dynamically linked multiple representations, pedagogical practices and students' understanding of mathematics using TI-Nspire in Scottish secondary schools. *ZDM Mathematics Education*, 42(7), 763-774.
- Gueudet, G., Bueno-Ravel, L., & Poisard, C. (2014). Teaching Mathematics with Technology at the Kindergarten Level: Resources and Orchestrations. In A. Clark-Wilson, O. Robutti, & N. Sinclair (Eds.), *The Mathematics Teacher in the Digital Era* (Vol. 2, pp. 213-240): Springer Netherlands.
- Gueudet, G., & Trouche, L. (2009). Towards new documentation systems for mathematics teachers? *Educational Studies in Mathematics*, 71(3), 199-218.
- Gueudet, G., & Trouche, L. (2012). Communities, documents and professional geneses: Interrelated stories. In G. Gueudet, B. Pepin, & L. Trouche (Eds.), *From Text to 'Lived' Resources* (pp. 305-322). Springer Dordrecht.
- Kasten, S. E., & Sinclair, N. (2009). Using dynamic geometry software in the mathematics classroom: A study of teachers' choices and rationales. *The International Journal for Technology in Mathematics Education*, 16(4), 133-143.
- Lew, H.-c. (2016). Developing and implementing "smart" mathematics textbooks in Korea: Issues and challenges. In M. Bates & Z. Usiskin (Eds.), *Digital Curricula in School Mathematics* (pp. 35-51). Charlotte, NC: Information Age Publishing.
- Means, B., Peters, V., & Zheng, Y. (2014). *Lessons from five years of funding digital courseware: Postsecondary success portfolio review*. Menlo Park, CA: SRI Education.
- Organisation for Economic Co-operation and Development. (2007). *Giving knowledge for free: The emergence of open educational resources*.
- Rabardel, P. (2002). *People and technology*. Retrieved from <http://ergoserv.psy.univ-paris8.fr/> unpublished manuscript.

- Remillard, J. T. (2011). Modes of engagement: Understanding teachers' transactions with mathematics curriculum resources. In G. Gueudet, B. Pepin, & L. Trouche (Eds.), *From Text to 'Lived' Resources* (pp. 105-122). Dordrecht: Springer.
- Remillard, J. T. (2013). Examining resources and re-sourcing as insights into teaching. *ZDM Mathematics Education*, 45(7), 925-927.
- Ruthven, K. (2013). From design-based research to re-sourcing 'in the wild': reflections on studies of the co-evolution of mathematics teaching resources and practices. *ZDM Mathematics Education*, 45(7), 1071-1079.
- Tabach, M. (2011). A mathematics teacher's practice in a technological environment: A case study analysis using two complementary theories. *Technology, Knowledge and Learning*, 16(3), 247-265.
- Trgalová, J., & Jahn, A. P. (2013). Quality issue in the design and use of resources by mathematics teachers. *ZDM Mathematics Education*, 45(7), 973-986.
- Trouche, L. (2004). Managing the complexity of human/machine interactions in computerized learning environments: Guiding students' command process through instrumental orchestrations. *International Journal of Computers for Mathematical Learning*, 9(3), 281-307.
- U.S. Department of Education. (2016). *Future ready learning, reimagining the role of technology in education: 2016 National Education Technology Plan*. Washington, DC. Retrieved from <http://tech.ed.gov>.
- Wertsch, J. V. (1998). *Mind as Action*. New York: Oxford University Press.
- Yerushalmy, M. (2016). Inquiry curriculum and e-textbooks: Technological changes that challenge the representation of mathematics pedagogy. In M. Bates & Z. Usiskin (Eds.), *Digital Curricula in School Mathematics* (pp. 87-106). Charlotte, NC: Information Age Publishing.
- Zhao, Y., Zhang, G., & Lai, C. (2010). Curriculum, digital resources and delivery. In P. Peterson, E. Baker, & B. McGaw (Eds.), *International Encyclopedia of Education* (pp. 390-396). Oxford: United Kingdom: Elsevier Ltd.