

## Locating the Learner in Collaborative Constructionist Design

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**> Upshot** • Involving professionals in the design of c-books is a feasible and promising way for constructionism to influence large-scale educational practice. However, the role of learners as readers of c-books was unclear in Kynigos's account. Here I review the critical role that learners play in the conceptualization of educational environments, and I make recommendations for centering learners in the process of collaborative constructionist design.

« 1 » In his target article, Chronis Kynigos describes first steps in the design of what he and colleagues call “c-books” – e-books with embedded constructionist “widgets” that allow readers to interact with and create their own examples of mathematical phenomena. These books, Kynigos suggests, offer an opportunity for the constructionist community to extend beyond our current niche and to inform the broader educational enterprise. To explore how constructionism could both infuse and transform the existing educational milieu, diverse collaborative groups (“communities of interest,” or CoI) including designers, educators, and other professionals were assembled to envision c-book units that challenged conventional notions of mathematical creativity.

« 2 » I was excited to read Kynigos's detailed analysis of the CoI's design processes. Systemic accounts of design – in particular, early ideation among collaborative groups – are rare. This analysis identified specific moments and tensions that were productive in the advancement of groups' designs, and traced the trajectories of designers as they worked across disciplinary boundaries. One key finding of the work was that ideas that were “put into use” (§37) were more likely to be pursued and refined by a CoI. Another was that designers came to understand c-books as living documents that were “eter-

nally improvable” (§15). The article lends new insight into how we can foster successful collaborative constructionist design, lending a voice to the very professionals we rely on to connect to actual classrooms, learners, and the educational enterprise.

« 3 » However, I was left wondering where one very critical element – the learner or reader of c-books – was located within this suggested ecology of collaborative constructionist design. In the article's guiding questions, the reader is clearly at the centre: “How can we design a resource that addresses a reader who can use the same resource to tinker and construct with it?” and “How can we foster creativity in the design and writing of c-books aiming to engage ‘readers’ in creative constructionist activity for mathematical thinking?” However, readers were not part of the design teams. They were not specified in the design tasks given to the CoI. And designers' attention to readers as learners was not an explicit focus of analysis.

« 4 » At the same time, it seems questions and tensions about readers are what drove the CoI to make progress. In the “Windmills” case, the critical episode that led teachers to consider the c-book as a “valise” of resources rather than a static artifact (§24) emerged from concerns about how to engage readers of different ages and preparation levels. In the “Cycling in the City” case, new versions of the MyGPS tool were inspired by Sara and Sharon's concerns about their own students as potential readers. In both cases, these tensions emerged organically after some time, as CoI worked themselves to specify readers of c-books. Those tensions and specifications prompted development of multiple versions of the c-book unit, which subsequently propelled each group forward as they thought about the flexibility and novelty of c-books as a medium. Still, these spates of progress were inspired by discussions that focused on somewhat superficial characteristics of readers such as age, preparation, or developmental level.

« 5 » What would it look like to center readers more explicitly and more deeply in the design of c-books at these early stages? Here, I make a few proposals, and consider how such re-centering might further increase the chances for creativity and feasibility in the resulting products.

### Involving learners as co-designers

« 6 » There is a tradition of involving youth as designers of technology in the constructionist community (Harel & Papert 1990; Kafai, Ching & Marshall 1997). Often, this work focuses on what *students* learn from design experiences. However, young people are adept at using technology-mediated tools, and are likely to bring new perspectives designers might not expect. Allison Druin (2002) describes ways to involve youth not only as users or testers but as informants or co-designers of technology. Involving readers early on as members of a CoI is feasible and likely to introduce new, creative, and youth-accessible solutions to c-book design problems.

### Consulting student work and video

« 7 » In the cases presented, questions about readers' age and curricular experiences helped provide CoI with traction in creating multiple, flexible designs. But even learners of the same age and educational experience exhibit diversity and dynamics in how they approach a task. Teacher educators have found that engaging with student work can help teachers focus on student thinking and learning, and to develop appropriate instructional trajectories (Kazemi & Franke 2004). Similarly, reviewing video or examples of student work can bring together researchers, designers, and teachers to integrate different perspectives (Sherin 2003). Just as putting ideas to use can help designers make progress, *seeing* ideas in use can shed light on what novel creative pursuits can be enabled in using c-books.

### Building on existing learner and classroom practices

« 8 » Youth, families, and classroom communities already engage in a variety of creative practices that can serve as bridges to technology-rich explorations emerging within c-books. Readers sketch, tell stories, play games, and craft with classroom materials – these all feed into and inform their experiences with technology. Building on readers' existing knowledge and practices can promote creativity, engagement, and interactions with one another using new media (Lee 2003; Horn 2014). For example, learners quickly appropriate tools that fuse programming with pre-existing creative and

play activities such as wooden block toys (Bers & Horn 2010) to create fundamentally new technological experiences. Logo itself was built upon learners' embodied experience of movement in the world (Papert 1980). Exploring such connections explicitly can re-center student activity and establish better connections between c-books and the broader pedagogical agenda.

« 9 » The careful, well-documented collaborative design of c-books is a promising way for constructionism to enter the broader educational conversation. Involving readers themselves as part of this design ecology, however, is critical. In the end, measures of successful design and design learning lie with the readers: materials are eternally improvable because readers are ever changing, and readers are ultimately the ones who will make sure materials are put to good use.

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## Thoughts on Developing Theory in Designing C-Books

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> **Upshot** • As a mathematics teacher educator and “digital tourist,” I focus my response to the many questions posed by Kynigos from three perspectives. First, I outline the theories he uses to frame the reporting of the research into the design of constructionist e-books. Second, I compare his theoretical tools with

design-based research as an organising framework for a research project of this nature. Third, I propose the possible contribution of further theory-testing to the work.

### Possibilities for constructionist e-books

« 1 » Chronis Kynigos introduces two theoretical constructs that he found useful in researching the “participatory design processes” that the creation of c-book units requires. These are “documentational genesis” (DG; Gueudet & Trouche 2012b) and “boundary crossing” (BC). DG theory encompasses two closely related processes:

- *instrumentation*: in which features of a resource or resources influence a teacher's practice and the knowledge the teacher develops through using the resource(s); and
- *instrumentalization*: in which the teacher's expertise guides choices between different resources and how they are modified and used.

Extensions of and adaptations of DG theory have been discussed by Birgit Pepin, Ghislaine Gueudet and Luc Trouche (2013) to encompass a technique for structuring teacher education courses where teachers share resources and jointly discuss and develop them within professional communities of practice (Kiernan, Tanguay & Solares 2012). This augmented DG theory frames the iterative nature of the research, both retrospectively in examining what has happened in the four communities of interest (CoI) on which Kynigos reports and prospectively as an imagined future in the hands of teachers and students as “readers” of the c-books as designed. Unless the construction of the c-book is an end in itself, there may be need for a further robust “framework which seeks to describe the salient features and relationships between relevant concepts to describe a phenomenon, but making no claims about it” (da Ponte 2013: 319).

### Design-based research (DBR)

« 2 » Although the research project reported here does not identify itself as design-based research, it appears to exhibit most of the characteristics of such research (Anderson & Shattuck 2012):

- being situated in an actual educational context;
- focusing on the design and testing of a significant intervention;
- using mixed methods;
- involving multiple iterations;
- involving a collaborative partnership between researchers and practitioners; and
- evolution of design principles.

An earlier account of the “crosscutting features” of DBR places theory-building and theory-testing at the heart of the project, giving DRB “an intermediate theoretical scope” and describing such theories as “humble” as opposed to “grand” (Cobb et al. 2003). Constructionism might be classed as a grand theory and the project might benefit from the development of further more “humble” theories in the testing of repeated iterations of the work in the educational settings at which they are aimed.

« 3 » The first and most compelling argument for initiating design research stems from the desire to increase the relevance of research for educational policy and practice (van den Akker et al. 2006). While there are huge pedagogical challenges inherent in the c-book research project, which aims to foster innovative technology-based mathematical creativity that can be translated into “a new kind of mediation in educational practice” (Kynigos), the generation of increasingly fine-grain theories of learning would increase the usefulness of the research by linking the creation, design, function(s) and goal(s) of the c-textbooks.

### Conclusion

« 4 » The outlines of critical episodes in relation to the “Windmills” and the “Cycling in the City” groups both appear to pivot around issues of purpose and applications to teaching. The case is strongly made for a wealth of possibilities for the development of CMT and for mathematics teacher development in the diversity of expertise among participants. Kynigos draws on “boundary crossing” as a theoretical construct to describe participation in the socio-technical environment comprising “communities of diverse professionals with an interest in education.” Etienne Wenger (1998) conceives of boundary crossing as “brokering,” a job that he regards as “complex.” He also attests to