Teachers' Perceptions of the Contribution of CT to STEM Classrooms

This paper reports on high school STEM teachers' perceptions of the contribution of CT to their classrooms following CTSI. The current research, which is based on a qualitative analysis of the participating teachers' exit interviews, aims to answer the following research question: What are STEM teachers' perceptions of the contribution of CT to teaching and learning?

Importantly, teachers overall have little knowledge of the skills involved in CT and the ways in which these skills could be incorporated in the classroom (Chang & Peterson, 2018; Fessakis & Prantsoudi, 2019; Sands et al., 2018). Although teacher development programs have proven effective in promoting CT-related content knowledge and pedagogical content knowledge (Bower et al., 2017; Haines et al., 2019; Kong et al., 2020; Morreale & Joiner, 2011; Yadav et al., 2014), this change may be limited, as such programs are relatively short (often a week-long or less), and include little or no support to classroom implementation (Menekse, 2015).

Methods. We used post-workshop semi-structured interviews to collect data from CTSI teachers (N=8). Interviews lasted between 30-50 minutes, during which the teachers were asked questions on their perceptions of CT (general and domain-specific); beliefs on teaching (general and domain-specific); existing and new pedagogic content knowledge (general and domain-specific); perceptions of learning from the workshop; and influence of domain of practice. We used the Direct Content Analysis method to analyze the interview scripts, with variables derived from ISTE Standards for Educators (International Society for Technology in Education, 2017).

Findings. We will now present the main themes that have raised from our analysis.

Pedagogy*: CT Enables New and Effective Ways for Teaching and Learning, However Assessment Remains Traditional*

Following CTSI, teachers became aware of different ways in which CT could change teaching and learning; the most prominent ways by which this change could be manifested is by introducing students to coding, engaging them with more open-ended experimentation, and acquiring them with tools relevant to 21st century skills. As such, teachers described CT as enabling "students [to be] more involved in the design and collecting phase of experimentation" (Philip), allowing them "more experiences where students design their own experiments" (Peter).

However, when asked about assessing the new CT-enriched units, teachers mentioned traditional assessment methods, relying on tests and class discussions, for assessing content knowledge and not CT knowledge; "I'm going to give them the same test that they had before" (Betty).

Authenticity*: Different, Suitable, Authentic Learning*

Teachers mentioned that CT-enriched activities may be useful in the science classroom, as they enable scientific inquiry that would be otherwise very difficult to conduct or merely impossible; "There are problems that are hard for students to visualize […] and when you have a computer simulation that can show you what's going on, like all at once, [the students] can see [it]" (Peter).

Also, interacting with the CT-enriched activities made teachers appreciate the way this kind of learning helps students familiarize themselves with science as scientists do it; "We know that's what scientists do in the field to give us results. So I think students should be seeing that process in the classroom" (Brenda).

Engaging with CT-based models may help students deeply understand simulated phenomenon; one of the participants, reflecting upon his students having "a hard time getting to understand why the [acceleration] graph is the way it is," stated that visualization using a computational model may help "reinforcing what [the] philosophy [of] acceleration [is]" (Phillip).

***Equity**: CT Gives Students Agency to Discovery and Will Help them to Become Active Citizens*

Teachers perceived the CT-enriched units as an opportunity to facilitate student-centered exploratory learning; "[Students] are going to have an influence on how are we going to get the information from a […] set of data, and they're going to have to tell it what to do" (Phillip).

Also, our participants claimed that their students should change the way they learn because it will help them in their future world. As one of the participants put it, the value of incorporating CT in the science classroom is "to get [the students] thinking about that now and how that skill could serve them in the future" (Carrie). Taken together, allowing agency and being better prepared as citizens may help in increase equity and decrease societal gap.

***Broadening Participation**: CT Encourages Collaboration Among Teachers Within School*

Participating teachers understood that developing effective CT-enhanced units requires a few people with different expertise. This led them to think of collaborating with their peers, in a way that would overall impact students' learning; one of the participants mentioned sharing "vertically within our school," which "gives more of a nice flow between courses" (Brenda).

This understanding made participating teachers thinking of initiating and leading such collaborations; "I was wondering if maybe we could think about doing [...] a workshop with some other teachers from our department. […] It's a time for that discussion" (Carrie).

Conclusions. By positioning teachers as both CT learners and equal collaborators to design CT-enhanced curricula, we see evidence of teachers re-evaluating and expanding their ideas of how technology and CT can positively impact them and their students in ways that can transform their classrooms. The four main themes found refer to pedagogy, authenticity, equity, and broadening participation. These are some of the core ideas of incorporating CT in STEM classroom in the first place (Weintrop et al., 2016). Bringing evidence to these ideas being realized is encouraging; it emphasizes the important role of CT in the larger educational process, and the need in effective, well-designed professional development programs.

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