1 Research Interests and Questions

1.1 Teacher metacognition & technology

Today's mass education systems which mandate compulsory schooling (K-12), exhibit an isomorphic mimicry [23] of visible indicators like curriculum standards, teacher-student accountability relationships, and high-stakes testing. Although these indicators are intended to improve learning, they mainly serve as a form rather as a function. Isomorphic mimicry possibly explains why teachers stereotype recurrent classroom problems and employ direct instruction rather than *instructional adaptations* [22]. Typically, teaching is a balancing act of numerous contextual variables that arise between curricular requirements and students' real needs. Teachers achieve this balance when they engage in *adaptive metacognition* [21]. Furthermore, if educational technologies are not critically evaluated, they risk becoming isomorphic in school settings [27]. Despite extensive research on the impact of sociocultural variables on teacher efficacy, we only have a superficial understanding of their relationship with teachers' affective experiences [6, 28, 26]. I am particularly interested in defining teachers' metacognitive strategies and extending the insights to build technological solutions. The research question I intend to answer is: *How can we design technologies to assist teachers in developing metacognitive skills?* My expected research contributions would be in Human-Computer Interaction (designing metacognitive scaffolds for teacher-facing technologies) and Educational Psychology (theoretical insights on teacher metacognition).

1.1.1 Literature Review

In educational psychology research, the concept of metacognition [16] has diversified over the years to the extent that various terms have been coined to describe the process, including self-regulated learning [29], self-explanations [7], self-theories [12] (later popularized as Mindset [13]), and socio-emotional learning [15]. It is an interventional approach in each case that is primarily focused on students' conscious regulation of *emotions*, *beliefs*, and *learning behaviors*. The same principles can be studied in the context of teaching, referred to as *adaptive metacognition* [21] by Xiaodong Lin et al. (2005). Yet, metacognitive interventions in teaching and teacher education have received little attention [3, 25, 11]. My research objective is to address this theoretical gap by focusing concretely on teachers' academic emotions [5] and the corresponding metacognitive experiences [14].

In educational technology research including the literature in HCI, there are several publications on data-driven technologies for teachers, particularly in schools with technology-intensive classrooms. Even so, it is still unclear how teachers interpret various data sources such as classroom sensing data [2, 17], classroom dashboards [18], emotional data [4, 10], quantified-self data [20], in order to make meaningful teaching decisions. The technological affordances mentioned in these studies are a natural fit in promoting adaptive metacognition in teachers, when carefully designed. The research gap here is that the studies do not account for teachers' academic emotions and place little emphasis on how interventions result in significant changes in teaching styles.

1.1.2 Potential Research Directions

I would narrow down my research focus to study the impact of technology in shaping teachers' metacognitive experiences, with a particular emphasis on (i) teachers' positive well-being, (ii) classroom emotional climate, and (iii) data-driven teacher tasks.

(i) Improving teachers' emotional literacy (including meta-emotions) can aid in the prevention of occupational burnout. There are well-studied theories in emotional psychology that can be used to assess emotional literacy, one of which is the *affect grid* [24] which takes into account the intensity and valence of emotions.

(ii) Teachers use tacit strategies to gauge the emotional climate of the classroom. It's unclear how they'll use students' emotional data to rethink teaching practices. This presents an opportunity to assist teachers in developing the habit of reading students' emotions in depth while prioritizing their autonomy, which may lead to proactive metacognitive behaviors.

(iii) Although data collection (both digital and physical) and its usage are widespread in schools, teachers' interaction with data leads to surface-level discussions about self-improvement or it is almost entirely focused on accountability. Instead, we need teacher-facing interfaces that enable emotionally sensitive models of reflection and improvisation.

1.1.3 Research Methods

How do we design technological interventions that support the goals listed above that fit in the digital lives of K-12 teachers, irrespective of their socio-economic environments? Research methods are critical in answering the question, so I use human-centered design or HCI methods [19]. This, however, is insufficient to fully empathize with the stakeholders because ground-level challenges arise due to various contingent factors. For instance, the needs and priorities of the teachers with whom we work can vary greatly, often determining our thematic focus. To address these issues, I believe we need researcher-practitioner partnerships [8, 1] with systems-level capacities. RPPs minimize infrastructural challenges and are established using a Design-Based Implementation Research (DBIR) approach [9], which include participatory-design methods, improvement-science methods (or prevention-science methods), and iterative co-designing of technologies with practitioners (in my case, teachers). The research methods detailed here are crucial to immerse completely in the lives of teachers. Most importantly, it enables me to concentrate on specific teaching behaviors that teachers perceive and are willing to discuss, fostering a bottom-up approach in integrating technology into teaching.

2 Aspirations

My aspirations are for perpetual changes in education by influencing the micropolitics that determines the cognitive liberty of students and teachers. Amid concerns about the role of technology in improving teaching practices, we cannot ignore the enormous potential

of today's ubiquitous technologies that are a part of teachers' lives. We can achieve better teaching outcomes if technological interventions and their critical perspectives are appraised with equal importance! I am reasonably confident that building on educational psychology principles is the appropriate first step in improving instructional technology design. I hope to use my research findings to influence global education policies and create scalable EdTech products. I am convinced it is critical to strive for innovation in addressing educational issues and advancing sustainable solutions to make the world a better place.

· · ·

" Teaching departs from recipes, formulas, and algorithms. It requires improvisation, spontaneity, the handling of a vast array of considerations of form, style, pace, rhythm, and appropriateness in ways so complex that even computers must lose the way. "

– NATHANIEL L. GAGE
The Phi Delta Kappan, 1984

References

[1] June Ahn et al. "Designing in Context: Reaching beyond Usability in Learning Analytics Dashboard Design." In: *Journal of Learning Analytics* 6.2 (2019), pp. 70–85.

[2] Pengcheng An et al. "ClassBeacons: Designing distributed visualization of teachers' physical proximity in the classroom". In: *Proceedings of the Twelfth International Conference on Tangible, Embedded, and Embodied Interaction*. 2018, pp. 357–367.

[3] Roger Azevedo. "Reflections on the field of metacognition: Issues, challenges, and opportunities". In: *Metacognition and Learning* 15 (2020), pp. 91–98.

[4] Madeline Balaam et al. "Exploring affective technologies for the classroom with the subtle stone". In: *Proceedings of the SIGCHI conference on human factors in computing systems*. 2010, pp. 1623–1632.

[5] Junjun Chen. "Refining the teacher emotion model: evidence from a review of literature published between 1985 and 2019". In: *Cambridge Journal of Education* 51.3 (2021), pp. 327–357.

[6] Junjun Chen and Tianjun Cheng. "Review of research on teacher emotion during 1985–2019: a descriptive quantitative analysis of knowledge production trends". In: *European Journal of Psychology of Education* (2021), pp. 1–22.

[7] Michelene TH Chi et al. "Self-explanations: How students study and use examples in learning to solve problems". In: *Cognitive science* 13.2 (1989), pp. 145–182.

[8] Cynthia E Coburn and William R Penuel. "Research–practice partnerships in education: Outcomes, dynamics, and open questions". In: *Educational researcher* 45.1 (2016), pp. 48–54.

[9] *Design-Based Implementation Research (DBIR)*. http://learndbir.org/.

[10] Elena Di Lascio et al. "In-classroom self-tracking for teachers and students: preliminary findings from a pilot study". In: *Proceedings of the 2017 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2017 ACM International Symposium on Wearable Computers*. 2017, pp. 865–870.

[11] Eva Durall and Begoña Gros. "Learning Analytics as a Metacognitive Tool." In: *International Conference on Computer Supported Education*. 2014, pp. 380–384.

[12] C. S. Dweck. "Self-theories and goals: Their role in motivation, personality, and development." In: *R. A. Dienstbier (Ed.), Nebraska Symposium on Motivation: Perspectives on motivation* (1991), pp. 199–235.

[13] Carol S Dweck. *Mindset: The new psychology of success*. Random House, 2006.

[14] Anastasia Efklides. "Metacognition and affect: What can metacognitive experiences tell us about the learning process?" In: *Educational research review* 1.1 (2006), pp. 3–14.

[15] Maurice J Elias et al. *Promoting social and emotional learning: Guidelines for educators*. Ascd, 1997.

[16] John H Flavell. "Metacognition and cognitive monitoring: A new area of cognitive–developmental inquiry." In: *American psychologist* 34.10 (1979), p. 906.

[17] Kenneth Holstein et al. "The classroom as a dashboard: Co-designing wearable cognitive augmentation for K-12 teachers". In: *Proceedings of the 8th international conference on learning Analytics and knowledge*. 2018, pp. 79–88.

[18] Emily Jensen et al. "Toward automated feedback on teacher discourse to enhance teacher learning". In: *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*. 2020, pp. 1–13.

[19]   Jonathan Lazar, Jinjuan Heidi Feng, and Harry Hochheiser. *Research methods in human-computer interaction.* Morgan Kaufmann, 2017.

[20]   Victor R Lee, Joel R Drake, and Jeffrey L Thayne. "Appropriating quantified self technologies to support elementary statistical teaching and learning". In: *IEEE Transactions on Learning Technologies* 9.4 (2016), pp. 354–365.

[21]   Xiaodong Lin, Daniel L Schwartz, and Giyoo Hatano. "Toward teachers' adaptive metacognition". In: *Educational psychologist* 40.4 (2005), pp. 245–255.

[22]   Seth A Parsons et al. "Teachers' instructional adaptations: A research synthesis". In: *Review of Educational Research* 88.2 (2018), pp. 205–242.

[23]   L. Pritchett. *The Rebirth of Education: Schooling Ain't Learning.* Brookings Institution Press, 2013. ISBN: 9781933286785. URL: https://www.cgdev.org/sites/default/files/rebirth-of-education-brief-lant-pritchett.pdf.

[24]   James A Russell, Anna Weiss, and Gerald A Mendelsohn. "Affect grid: a single-item scale of pleasure and arousal." In: *Journal of personality and social psychology* 57.3 (1989), p. 493.

[25]   Petr Slovák and Geraldine Fitzpatrick. "Teaching and developing social and emotional skills with technology". In: *ACM Transactions on Computer-Human Interaction (TOCHI)* 22.4 (2015), pp. 1–34.

[26]   Rosemary E Sutton and Karl F Wheatley. "Teachers' emotions and teaching: A review of the literature and directions for future research". In: *Educational psychology review* 15.4 (2003), pp. 327–358.

[27]   Rebecca Turczynowicz et al. *How Has Isomorphic Mimicry Contributed To The Failure Of Fulfilling The Educational Objectives Of The Una Laptop Por Niño Programme In Peru?* https://blogs.lse.ac.uk/internationaldevelopment/files/2018/03/DV450_OLPCPeru.pdf.

[28]   Michalinos Zembylas. "Beyond teacher cognition and teacher beliefs: The value of the ethnography of emotions in teaching". In: *International journal of qualitative studies in education* 18.4 (2005), pp. 465–487.

[29]   Barry J Zimmerman. "Models of self-regulated learning and academic achievement". In: *Self-regulated learning and academic achievement.* Springer, 1989, pp. 1–25.