EFFECT OF A PRACTICE-INTENSIVE COURSE ON DOCTORAL TEACHING ASSISTANTS' TEACHING SELF-EFFICACY AND PRIORITIES (RESEARCH)

S. R. Isaac[1]
Centre for Learning Sciences, Swiss Federal Institute of Technology (EPFL)
Lausanne, Switzerland
ORCID: 0000-0002-1527-8510

J. de Lima
Teaching Support Centre, Swiss Federal Institute of Technology (EPFL)
Lausanne, Switzerland
ORCID: 0000-0001-9235-9704

Conference Key Areas: *Teaching methods & Assessment*
Keywords: *Doctoral teaching assistants, self-efficacy, pedagogical training, practise-intensive course, academic career preparation*

ABSTRACT

Doctoral teaching assistants (TAs) provide key support for learning in STEM fields because they are present during exercises, labs and projects when students are actively engaging with course material. While some institutions provide training for TAs, their effect on teaching activities is rarely assessed. We use the lens of Social Cognitive Theory (SCT) to analyse data on the pre and post course teaching priorities of 20 doctoral TAs who followed a 5 day practice-intensive course on STEM HE. Course time was split between instructors modelling interactive teaching strategies to engage TAs in a data-driven reevaluation of their beliefs about teaching and having each TA teach a lesson everyday using a structured feedback loop to promote

[1] *Corresponding Author*
S. R. Isaac
siara.isaac@epfl.ch

reflection. TAs reported self efficacy gains for designing instruction, addressing disruptive behaviour and managing student attention spans after the course. Their priorities also appear to shift away from ‘teaching’ and towards ‘learning’. TAs’ affective reactions and utility judgements after the course indicated that they thought the course was useful and they intended to use the strategies that they had learnt. This practice and reflection intensive course model, able to accommodate up to 40 TAs, is relevant for institutions seeking to improve the quality of undergraduate education or doctoral candidates' preparation for academic roles.

1 INTRODUCTION

Doctoral programs primarily prepare doctoral students for research, and may not sufficiently prepare them for other aspects of academic life including teaching [1, 2]. Additionally, doctoral candidates often play a key role as teaching assistants (TAs) in undergraduate courses and can contribute significantly to the quality of the learning. In engineering, TAs are present during exercises, labs and projects - i.e. when students are actively engaging with course material [3] and developing key disciplinary thinking skills. The importance of ongoing training is underlined by the high turn-over rate, with approximately half the TAs being new to teaching every year [3]. Investing in TA training is therefore not only relevant to prepare them for their future academic careers (presumably at a different institution) but also for maintaining excellence of the education offered to undergraduates at their current institution.

1.1 Theoretical framework

We use the framework of Social Cognitive Theory (SCT) to explore the effect of a practice-intensive course on the evolution of TAs’ teaching priorities. The SCT [4] has been used in multiple fields, including education, to describe how behaviours can be learnt and maintained. One of the key features of the theory is the social dimension of learning, i.e. behaviours are learnt and/or reinforced by observing and interacting with the environment. A very important dimension of the SCT is the importance it places on the role of self-efficacy. Bandura [4] describes self efficacy as “*people’s judgement of their capabilities to organize and execute courses of action required to attain designated types of performances*” (p.395). High self-efficacy is a good predictor for higher performance on tasks. However, self-efficacy can be influenced by other social dimensions such as ethnicity and culture [5].

1.2 SCT and self-efficacy in teaching

Prior research has shown that the social dimension of learning is very important for developing teaching behaviours. Teachers draw from the way they were taught and as well as their experiences in research and non-academic roles [6]. Connolly et al. [1] and DeChenne et al. [7] summarise prior work showing a correlation between high self-efficacy and teachers’ characteristics of good teaching (learning focus, classroom management skills, willingness to experiment with teaching methods), as well as in TAs (persistence, student achievement). Since self- efficacy develops with experience on task, less experienced teachers tend to focus on their own behaviour (teaching v learning) and worry about student misbehaviour, potentially decreasing implementation of evidence-informed teaching strategies [8]. Bitting et al. [2] collate a series of studies that further link novice faculty's reluctance to implement evidence-informed teaching strategies to low self efficacy and concerns about the effect of negative student feedback on tenure decisions. Therefore, providing opportunities that allow TAs to practice their instructional skills and to develop self-efficacy in lower stakes environments are important dimensions for the pedagogical development of doctoral students.

Despite broad agreement about what constitutes good teaching in higher education, (see [8] Ch. 8 for a review), traditional teaching methods persist in STEM labs, exercises and projects. Bitting et al.'s review [2] identifies TAs' tendency to reproduce their own educational experiences (which rarely include interactive courses or inquiry labs) and low self-efficacy for 'novel' pedagogical strategies as barriers to the adoption of evidence-informed approaches. Their review also highlights that "*changes in practice without supporting changes in beliefs are often short lived, inconsistent, or ineffective*" (p.520).

Tormey et al. [9] argue that STEM TAs need "*training which is informed by evidence, which addresses the needs of engineering disciplines and which is short enough so that doctoral assistants will not be discouraged from participation*" (p.379). While rigorous evaluations of STEM TA training programs are scarce [2, 7], three Canadian studies particularly interested us. White et al. [10] found that participants in a two day workshop for STEM TAs did not hold different ideas about teaching than non-participants, however attendees reported they would allocate more class time for student-to-student discussions and lecture less than non-attendees. They conclude that their workshop assisted TAs to identify effective pedagogical strategies. Meadows et al. [11] report that their training with aspects of intercultural communication designed to assist a diverse TA cohort to understand the local teaching and learning culture had better outcomes on teaching self-efficacy, observed teaching effectiveness, and adoption of student-centred approaches to teaching compared to their standard training. Hughes and Ellefson [12] report that biology students whose TAs trained them to ask good questions (*vs.* trained to provide good answers) performed better on the exam.

Our approach has been significantly informed by Tormey et. al.'s nine recommendations for TA training [9, p.383] resulting from their review of teacher education and STEM literature. For example, opportunities to confront their own ideas about good teaching, practising and getting feedback on teaching skills, and addressing the concerns of novice teachers, such as classroom management.

1.3 Description of the course

The format of this course, offered to doctoral TAs at a research-intensive public engineering school, is shown in Figure 1a. The course content focuses on strategies for inteactive teaching informed research evidence from higher education in general with a specific focus on the disciplinary skills and epistemologies of STEM.[2] The key pedagogical innovations are the course activities designed to leverage the principles for developing expertise identified by Tormey and Isaac (2022, p.257). Course time was split between instructors modelling interactive teaching strategies to engage TAs in a data-driven reevaluation of their beliefs about teaching and having each TA teach a lesson everyday. This peer microteaching occured in stable 4-5 person groups and employed a structured feedback loop (Fig. 1b) [13]. The five days of the course spanned 4 weeks to allow participants time to develop their next lesson plan and to complete additional readings. The first two days were entirely on campus and the final three days were hybrid. Daily reflective reviews, where TAs write about what they had learnt, their experience in the microteaching and the implications for their practice, are an integral part of the course. These daily reviews enable instructors to follow TAs' evolving thinking about STEM pedagogy and to provide feedback. Asssessment takes the form of a project report where TAs summarise their teaching evolution through three of Brookfield's lenses: self-reflection, peer-feedback and the literature [14]. TAs' teaching skills did not contribute to course grades.

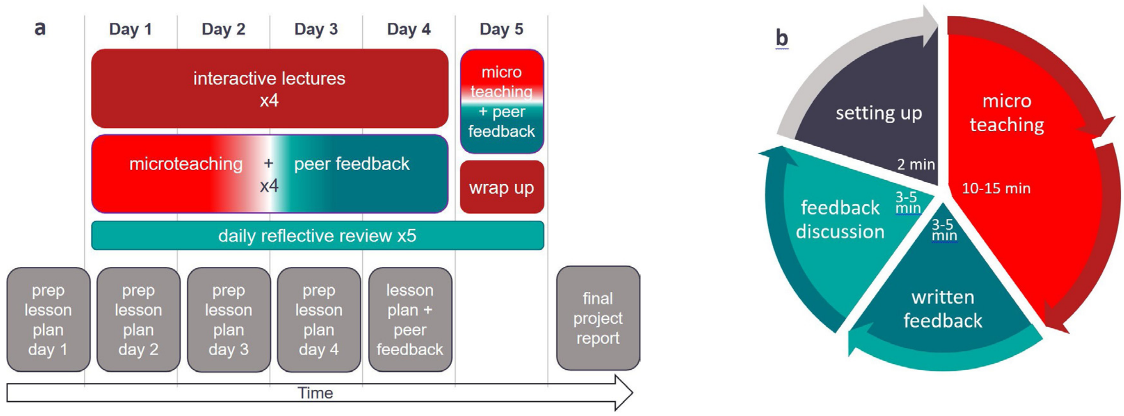

Fig 1. Schematic of (a) the course plan and (b) the microteaching cycle. *The course included daily interactive sessions with the instructors (deep red) as well as an opportunity for each student to teach and get peer feedback (red + teal). Students submit several deliverables (grey + deep teal) before, during, and after the course for teacher feedback.*

The four key components of increasing self-efficacy [15] have been addressed by various aspects of this course:

1. Mastery experience: TAs taught five lessons to their peers during the course. They were advised to use the feedback to design every subsequent lesson.
2. Social modelling: TAs observed their peers teaching and were able to analyse and learn from the strategies they chose to use.
3. Improving physical and emotional states: Since they were teaching their peers TAs were able to gain mastery in a low stress environment. Additionally, they were able

[2] More details available in the course description: https://edu.epfl.ch/coursebook/en/lecturing-and-presenting-in-engineering-ENG-629

to deal with the positive and negative emotions that come from receiving feedback in a supportive environment.

4. Verbal persuasion: TAs got a lot of feedback from their peers as well as from the instructors.

1.4 Research question

While many universities offer some TA training, the impacts are rarely assessed because it is resource intensive. This is unfortunate given the important role TAs play for STEM undergraduate programmes. In our study, we were interested in assessing the impact of a practice-intensive course on the self-efficacy and teaching priorities of doctoral teaching assistants. Specifically, does this course have a measurable impact on TAs' intention and self efficacy to teach in evidence-informed ways?

2 METHODOLOGY

2.1 Participants

2022 represents the 6th edition of this course and its first hybrid iteration. The 20 doctoral TAs came from 12 programmes including Robotics, Photonics, Electrical Engineering, Chemical engineering, and Computational biology. Roughly ¼ of the TAs were in their first 18 months of their PhD and ¼ were in the final phases of completing their doctoral work. All TAs reported that they had some prior teaching experience; 85% reported being a TA for a university level course and 50% had done private academic tutoring. Before starting the course, ⅓ of TAs had read advice about teaching well (n = 7), ⅕ had read at least one educational research paper (n = 4), and ¼ had previously attended one of the various half day pedagogical development workshop offered by our teaching support centre (n = 5).

2.2 Data collection and treatment

To generate relevant observations for our research question, we identified a series of behaviours and strategies that we anticipated course participants would use during their TA duties, such as organising group work or managing disruptions. Course participants' teaching self-efficacy assessments for teaching strategies (4 level agreement Likert scale) and teaching behaviour intentions (temporal scale, ie 5-10 minutes per hour) were collected at two time points: on the first day of the course and on the final day of the course. The final questionnaire had items oriented towards evaluating the course, including utility judgements. Both questionnaires concluded with a free text question. A set of anonymous unique identifying codes was circulated among the students to allow the pre and post data sets to be linked, ensuring that the instructors were unable to link responses to individual students. Given the nature of the study design, it was exempt from a full review of the institutional ethics review board for research involving human participants and was conducted in accordance with our institution guidelines.

This approach generated 21 responses to the pre survey and 19 responses to the post survey. Qualitative analysis and descriptive statistics used the entire data set; however only the 16 data sets which could be paired were used for statistical tests. While the non-normality of our data suggested that a Wilcoxian signed-rank test would be most appropriate to assess pre and post treatment effects, we ultimately employed a paired t-test due to constraints of the Wilcoxian signed-rank test that make it an inapporiate statistical test when ⅓ of participants report only small changes. Pre and post treatment differences for items on the ordinal temporal data scale were determined via a mixed effects ordinal logistic regression (with unique identifier as random intercept).

3 ANALYSIS AND RESULTS

We evaluated TAs' self efficacy assessments for teaching behaviours (Fig. 2). While their responses before the course show that they were already relatively confident about their teaching skills before the course, TAs' reported statistically significant improvements (paired t-test; $p < 0.05$) for 3 behaviours: Directly address students' disruptive behaviour in the moment to allow other students to work efficiently, Manage students' limits in working memory and attention span, and Design instruction using complementary modes of communication and representation. There was no increase in participants' self-assessment of their ability to 'proactively minimise disruptive behaviour'; this is useful feedback for us as instructors. While we did employ some of the proactive strategies for fostering a constructive class climate and avoiding disruptions in the current course, we did not step outside our immediate teaching role to reveal our behind-the-scenes thinking that informed our instructional choices. Nor, given the brevity of their microteaching slots, were TAs able to employ such practices in their own microteaching.

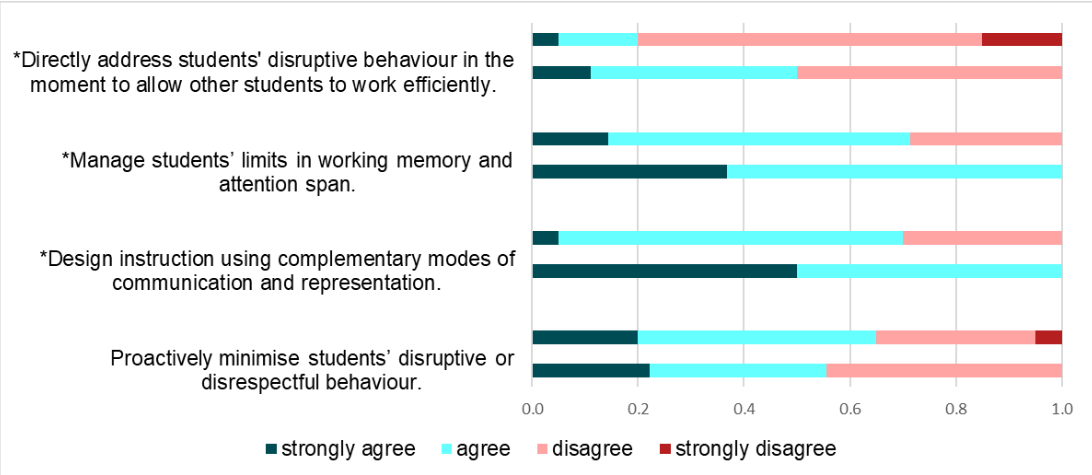

Fig 2. Comparison of TAs' self efficacy assessments for teaching behaviours. *For each item, responses on the first day appear on the upper line and post data on the lower line. Total n= 20 for the chart; missing values are excluded. Paired t-test performed only on the 16 matched questionnaires; * designates items with statistically significant differences at p < 0.05.*

TAs' intentions in terms of the number of minutes they would anticipate using various teaching behaviours are shown in Fig. 3. TAs' pre survey responses indicate that when teaching, they devote most of their time to presenting material and modelling their thinking for students. TAs' responses in terms of the time they would spend asking questions to their students, providing students with feedback on their learning or using small group activities spanned the entire spectrum (never to as much as possible). ⅔ of respondents stated that they would spend less than 5 minutes being silent to allow students to think during class.

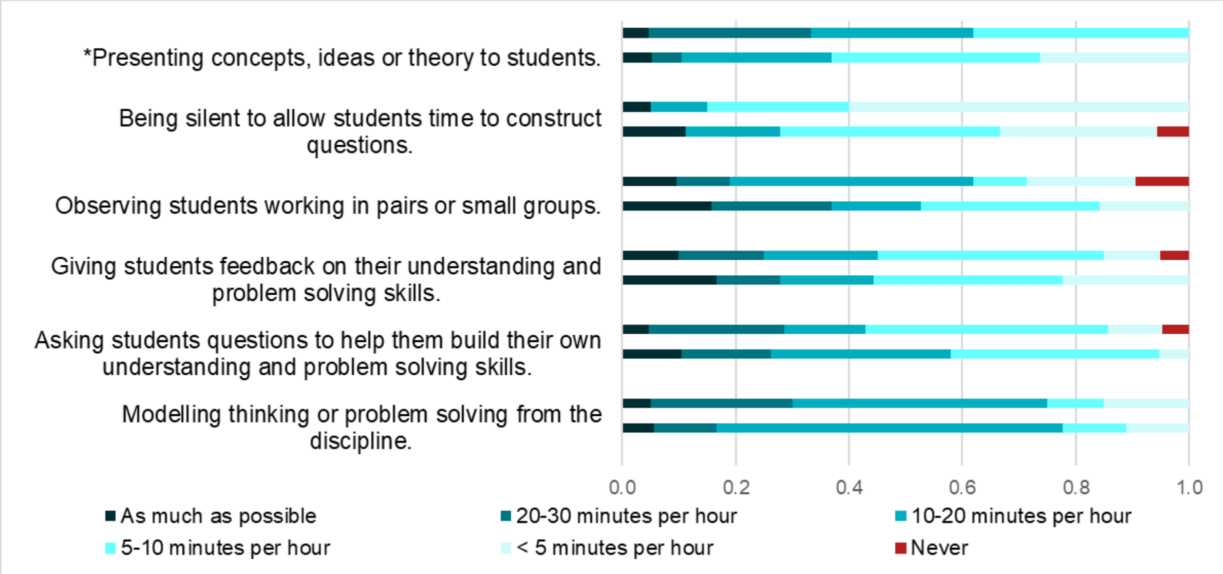

Fig 3. Comparison of TAs' intentions for teaching behaviour *. For each item, responses on the first day appear on the upper line and post data on the lower line. *designates items with statistically significant differences at $p < 0.05$ using a mixed effects ordinal logistic regression (with student code as random intercept) to analyse the data.*

Comparing the pre and post course data from a descriptive approach, TAs report small increases in the time they intend to spend on learning-focused behaviours such as 'Asking students questions to help them build their own understanding and problem solving skills' and 'Observing students working in pairs or small groups'. However these observations were (unsurprisingly given the small sample size) not statistically significant. The one item that had a statistically significant increase was a decrease in the time that TAs intended to spend 'Presenting concepts, ideas or theory to students.' There was not an appreciable difference in the time TAs intended to spend giving students feedback, making the material relevant, being silent and modelling thinking or problem solving. It is interesting to note that, after the course, TAs intended to spend less time presenting to students but to maintain their modelling of thinking or problem solving. This seems to be a pedagogically sound priority.

We also evaluated the TAs' affective reactions and utility judgements [16] following the course (Fig. 4). This allowed us to go beyond simply quantifying their satisfaction and to assessing the utility of the course as well as intentions to put learnt skills into

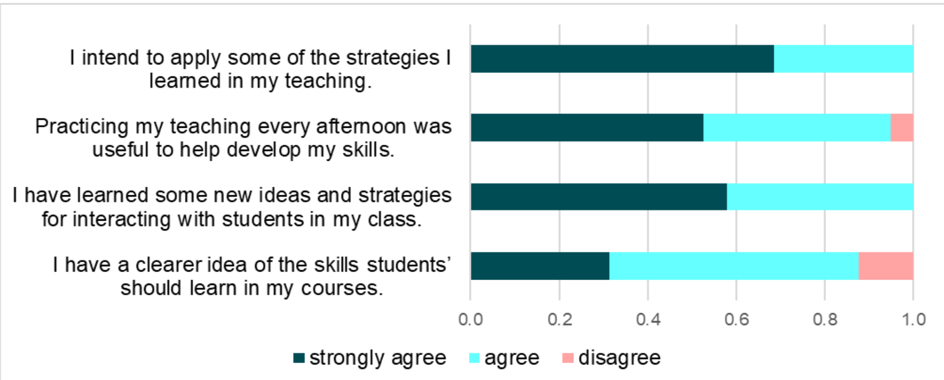

Fig 4. TAs' affective reactions and utility judgements of their experience in the course.

practice. In addition to the TAs thinking that this course was good, and useful in terms of learning and developing new teaching skills, all of them indicated that they intend to apply some of the strategies they learnt in their teaching.

We analysed the free response questions, using qualitative content analysis, to determine the key concepts that emerged. Similar concepts were then grouped together into main themes wherever possible.

Before the course, TAs' responses to the question "What are the three things you would like to improve to be a better teacher?" prioritised the 'teaching' aspect of the teaching and learning process (Fig. 5a).TAs focused on what they, as teachers, would be doing. This included structuring presentations/classes (n = 13), explaining concepts (n = 6), and attracting student attention (n = 4). Some TAs did mention wanting to learn about ways to enhance student engagement (n = 6), pedagogical research that underpins teaching methodologies (n = 4), and how to tailor the material to suit the audience (n = 3).

After the course, TAs' responses to the question "What are the three strategies you found most useful and will be using in your teaching?" indicated a shift in their priorities towards the 'learning' aspect of the teaching and learning process (Fig. 5b). While they still included teacher actions such as lesson planning (n = 16), the main focus was on enhancing student learning by using active learning (n = 16) and various active learning strategies (n = 18). Additionally they spoke about the importance of creating a classroom culture (n = 5) and giving/getting feedback (n = 5) in order to enhance learning.

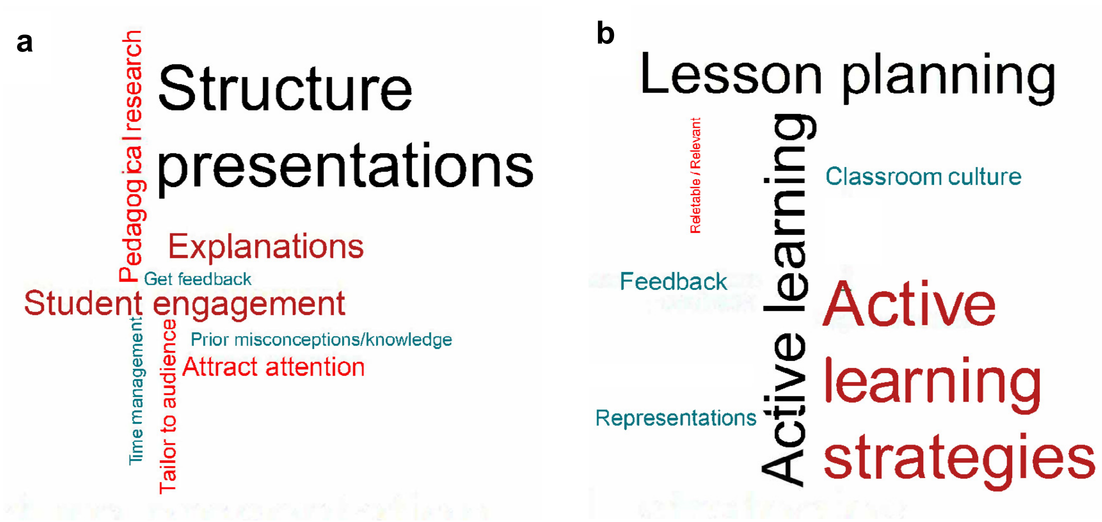

Fig. 5. Main themes from TAs' comments on (a) pre-course and (b) post-course questionnaires. *Size and colour of the font corresponds to the frequency with which these concepts appeared in student responses.*

4 CONCLUSION

This study investigated what TAs thought that they should prioritise in their teaching (a pragmatic approach to teaching philosophy) and how well prepared they feel to realise their prioroties in their teaching (self-efficacy). Our study showed that the course was effective in shifting TAs' priorities and focus away from teaching and towards learning, including using pedagogical strategies with higher cognitive engagement. TAs also reported increased teaching self-efficacy for the skills which they practiced during the course. Similar effects of TA training programs have been documented in other studies [1, 7, 10, 11]. As Connolly et al. [1] postulated, it is possible that courses such as ours increase TAs' self-efficacy by providing students opportunities to engage in the four key activities for increasing self-efficacy.

At the end of the course, TAs reported positive affective reactions (they liked the course) and utility judgements (they intend to use concepts and strategies from the course). A meta analysis by Alliger et al. [16] identified that intention to use material from a training was more strongly correlated with implementation than direct measures of learning. So while we did not directly observe the impact of the course on TAs' actual in class teaching behaviours, the shift in their priorities and increased self efficacy is expected to increase their use of evidence-informed teaching strategies. While we are planning a more robust evaluation of this course, the current findings support our practice and reflection intensive model. Further, the course format can accommodate up to 40 TAs without requiring significantly more resources while maintaining all the microteaching and reflection opportunities. This is relevant both within our institution, and potentially for colleagues, in light of institutional priorities around the quality of undergraduate education and doctoral candidates' preparation for academic roles.

ACKNOWLEDGEMENTS

Dr. Mridul Thomas for statistical advice and Dr. Cécile Hardebolle for contributions to developing the course material in previous editions of this course.

REFERENCES

[1] Connolly, M. R., Lee, Y. G., & Savoy, J. N. (2018). The effects of doctoral teaching development on early-career STEM scholars' college teaching self-efficacy. *CBE—Life Sciences Education*, 17(1), ar14.

[2] Bitting, K. S., Teasdale, R., & Ryker, K. (2017). Applying the geoscience education research strength of evidence pyramid: Developing a rubric to characterize existing geoscience teaching assistant training studies. *Journal of Geoscience Education*, 65(4), 519-530.

[3] Louis, R. A., & Matusovich, H. M. (2012, October). Work in progress: Describing the responsibilities of Teaching Assistants in first-year engineering programs. In 2012 Frontiers in Education Conference Proceedings (pp. 1-2). IEEE.

[4] Bandura, A. (1986). Social foundations of thought & action: A social cognitive theory. Englewood Cliffs, NJ: Prentice Hall.

[5] Lindley, L. D. (2006). The paradox of self-efficacy: Research with diverse populations. *Journal of Career Assessment*, 14(1), 143-160.

[6] Oleson, A., & Hora, M. T. (2014). Teaching the way they were taught? Revisiting the sources of teaching knowledge and the role of prior experience in shaping faculty teaching practices. *Higher education*, 68(1), 29-45.

[7] DeChenne, S. E., Koziol, N., Needham, M., & Enochs, L. (2015). Modeling sources of teaching self-efficacy for science, technology, engineering, and mathematics graduate teaching assistants. *CBE—Life Sciences Education*, 14(3), ar32.

[8] Tormey, R., and Isaac, S. With Hardebolle, C., & Le Duc, I. (2022). Facilitating Experiential Learning in Higher Education: Teaching and Supervising in Labs, Fieldwork, Studios, and Projects. Taylor & Francis Group. https://doi.org/10.4324/9781003107606

[9] Tormey, R., Hardebolle, C., & Isaac, S. (2020). The Teaching Toolkit: design of a one-day pedagogical workshop for engineering graduate teaching assistants. *European Journal of Engineering Education*, 45(3), 378-392.

[10] White, P. J., Syncox, D., Heppleston, A., Isaac, S., & Alters, B. (2012). Putting research into practice: Pedagogy development workshops change the teaching philosophy of graduate students. *Canadian Journal of Higher Education*. 42(1), 98-111.

[11] Meadows, K. N., Olsen, K. C., Dimitrov, N., & Dawson, D. L. (2015). Evaluating the differential impact of teaching assistant training programs on international graduate student teaching. *Canadian Journal of Higher Education*, 45(3), 34-55.

[12] Hughes, P. W., & Ellefson, M. R. (2013). Inquiry-based training improves teaching effectiveness of biology teaching assistants. *PLoS One*, 8(10), e78540.

[13] Johnson, J.B. (2006). Instructional Skills Workshop Handbook for Participants. Vancouver, BC: The Instructional Skills Workshop International Advisory Committee. https://www.iswnetwork.ca/

[14] Brookfield, S.D. (1995). Becoming a Critically Reflective Teacher. San Francisco: Jossey-Bass.

[15] Bandura, A. (1997). Self-efficacy: The exercise of control. New York: Freeman.

[16] Alliger, G. M., Tannenbaum, S. I., Bennett Jr, W., Traver, H., & Shotland, A. (1997). A meta-analysis of the relations among training criteria. *Personnel psychology*, 50(2), 341-358.