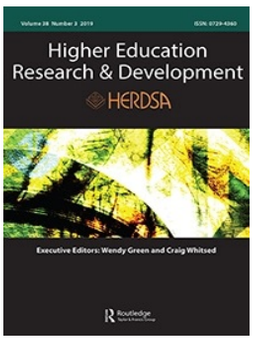

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From learner to teacher: (re)training graduate teaching assistants' teaching approaches and developing self-efficacy for and interest in teaching

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ABSTRACT

Graduate students often teach in higher education but lack necessary experience, while enrolment for teacher-training courses is often voluntary with varying standards. The development and malleability of graduate students' teaching approaches, self-efficacy, interest and teaching ability were evaluated in a mandatory teaching course at a research-intensive university using latent SEM (variable-centred) and latent profile transition (person-centred) analyses. Participants ($n = 310$) completed items from the Approaches to Teaching Inventory, Teacher's Sense of Efficacy Scale, and Teaching Interest Scale at the beginning and end of the course. Trainers assessed participants in end-of-course teaching. Prior student-focused teaching predicted future self-efficacy ($\beta = .30$) which predicted achievement (end-of-course teaching, $\beta = .33$). Prior self-efficacy was also found to predict future interest ($\beta = .17$). Initial differences in teaching approach reported by STEM and non-STEM participants did not persist, suggesting training can shape and alter previous conceptions. Three subgroups: Low-Teacher-Focused, Mid-Mixed, and High-Student-Focused indicated a developmental progression in teaching beliefs. Results suggest teaching beliefs can be developed and shaped during a short course. Theoretical and practical implications are discussed.

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KEYWORDS
Approaches to teaching; graduate teaching assistants; interest in teaching; self-efficacy in teaching; teacher education

Introduction

Teaching is not a top priority for many budding academics. For graduate students seeking a career in higher education, research is the critical first hurdle they must surpass. These same students, however, are often conscripted as teaching assistants for undergraduate classes. While this responsibility is often taken lightly, their role within teaching and learning should not be. Graduate teaching assistants (GTAs) often have little to no teaching experience but are expected to facilitate tutorials, laboratory teaching, guest lectures, field trips and assessments, while concurrently taking courses and learning how to conduct research (Park, 2004; Park & Ramos, 2002).

With such a crucial portion of higher education at stake, training for GTAs needs to be comprehensive and effective (Lueddeke, 2003). In reality, standards for this training are

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often inconsistent (Prieto & Meyers, 1999) across such factors as: the body that offers the training (Shum & Fryer, 2019; Young & Bippus, 2008), its duration and content covered (Gibbs & Coffey, 2004), the teaching opportunities offered, and whether it is mandatory (Stes et al., 2010). Even well-established training programmes can be insufficient to obtain mastery of instructional skills (Shum & Fryer, 2019).

In the absence of teaching experience, higher education teachers are likely to draw upon their past experiences as students, researchers, and in non-academic roles, which are often not the best basis for establishing best instructional practices (Oleson & Hora, 2014). A critical question, therefore, is 'Is it possible to shape and mould effective beliefs in teaching through training?'

Most early-career higher education teachers tend to not prefer one approach in teaching (Prosser et al., 2003) and are influenced by their preferred approach to learning in the same context (Shum & Fryer, 2019). Given that teaching with a focus on the behaviour of students yields higher-quality learning outcomes (Trigwell & Prosser, 1996), training should support the development of student-focused teaching approach beliefs. Teaching self-efficacy (Bandura, 1993; Prieto & Altmaier, 1994; Tschannen-Moran & Hoy, 2001) has been related to teaching performance and instructional practice in primary and secondary education (Klassen & Tze, 2014). Interest in teaching is further tied to teaching self-efficacy to predict mastery-oriented practices (Schiefele et al., 2013). The effects of training on self-belief development and influence on teaching performance remains unclear. Studies often present self-reports on teaching instructional practice (Holzberger et al., 2013), teaching self-efficacy (Tschannen-Moran & Hoy, 2001) or ask students to report on instructional teaching practice (Prosser et al., 2003). While these are related indicators, observed teaching performance by the course trainers in this early stage would assess the readiness of GTAs to teach.

The present longitudinal study examines the development of and interplay among teaching approach beliefs (Trigwell et al., 2005), teaching self-efficacy (Tschannen-Moran & Hoy, 2001), teaching interest (Schiefele et al., 2013) and their effects on teaching practice observed by course trainers over a 10-week mandatory teacher training course for GTAs. The effects of training support that GTAs are not entrenched in past experiences and can undergo meaningful development of self-beliefs. A person-centred analysis on teaching self-beliefs found differentiated patterns of beliefs among subgroups. Overall, a positive developmental path across the training course is outlined, complemented by a review of general and subgroup-specific implications for practice.

Background

In many higher education institutions worldwide, GTAs play a critical role within the higher education teaching workforce (Park, 2004; Park & Ramos, 2002). Regardless of differences in duties, and training methods, GTAs arrive to training and teaching experiences with teaching beliefs that have been shaped by their own learning, past non-academic work, and their ongoing research experiences (Oleson & Hora, 2014).

Approaches to teaching

Trigwell and Prosser (1996) developed the Approaches to Teaching Inventory (ATI) based on interviews of first-year higher education teachers, finding good agreement between

their beliefs and actual approaches of teaching. The ATI is intended for teachers to report their context-specific (e.g., students, subject) teaching approach on two scales: information transfer teacher-focused (assessing lecturing presentation skills, preparation for formal assessments), and conceptual change student-focused (assessing instruction supporting students' conceptual development) teaching. The ATI was expanded and reworded with simpler language to facilitate understanding (Trigwell et al., 2005). Criticisms regarding the ATI's development include a significant gender (male) and academic background (science) bias in the interviewees (Meyer & Eley, 2006). However, the instrument has been validated in a wide range of contexts (Prosser & Trigwell, 2006). With appropriate validation and controlling for covariates, the ATI is a useful tool to determine one's intended teaching approaches.

Research with the approaches to teaching inventory

The ATI has been used by teachers to self-report longitudinal development (e.g., Postareff et al., 2007) and researchers to examine relationships with other variables (e.g., Kaye & Brewer, 2013). At two Canadian universities, GTAs enrolled in short (one-day) and long (18–40 h) teacher training programmes and completed the ATI pre/post-course (Dimitrov et al., 2013). In one university, increases were observed in both scales for the short programme, (reflecting the need for some teacher-focused skills mastery prior to training student-focused skills; Trigwell et al., 2005), but only the student-focused scale in the long programme (increases in teacher-focused scores may be temporary in the presence of student-focused development). No significant differences were found at the other university, which was attributed to low sample size. Gibbs and Coffey (2004) found that training courses for GTAs and faculty (lasting over 60 h, across geographical contexts and facilitation methods) led to an increase in student-focused teaching. Lueddeke (2003) found that STEM teachers were more likely to apply a teacher-focused approach while non-STEM teachers more often applied a student-focused approach.

Relationships between approaches to teaching and students' approaches to learning have been unclear. The study process questionnaire (Biggs et al., 2001) tests students' approaches to learning on a deep approach (e.g., relating and understanding), and surface approach (e.g., rote memorisation). Shum and Fryer (2019) found that GTAs' student-focused and teaching-focused approaches associated with deep and surface approaches respectively while Kaye and Brewer (2013) reported the opposite associations for psychology graduate students.

Experienced higher education teachers tended to prefer a specific teaching approach (Prosser et al., 2003; Trigwell et al., 1999). In a person-centred analysis, most GTAs (>60%; Shum & Fryer, 2019) belonged to subgroups that indicated no preference between teacher-focused or student-focused teaching, suggesting most GTAs' teaching approaches are not yet cemented.

Self-efficacy in teaching

Self-efficacy is a belief in one's ability to successfully undertake a given task (Bandura, 1997). Building on Bandura (1993), Tschannen-Moran and Hoy (2001) developed the Teachers' Sense of Efficacy Scale (TSES) for teachers to report self-efficacy on student engagement, instructional strategies and classroom management. Research utilising this

survey, paired with self-reported student experiences, indicated that for primary and secondary school, teachers' self-efficacy is associated with their teaching performance (Klassen & Tze, 2014).

Young and Bippus (2008) reported increases in all three areas of the TSES over a 3-day teacher training seminar for GTAs studying communications. In US university psychology departments (Prieto & Meyers, 1999) and other disciplines (Prieto & Altmaier, 1994), GTAs with more training reported higher self-efficacy. DeChenne et al. (2015) found that the quality and duration of professional development for STEM GTAs significantly predicted increased teaching self-efficacy. Boman (2013) reported that a two-month training programme for GTAs at a Canadian university increased self-efficacy for teaching, with the greatest effects for GTAs with no prior experience. Furthermore, Tschannen-Moran and Hoy (2007) found that novice school teachers' teaching self-efficacy was much more easily influenced by contextual factors such as interpersonal support and teaching resources than experienced school teachers. Cross-context evidence supports the contention that training for GTAs increases self-efficacy. The connection between teaching self-efficacy and teaching performance remains to be tested in higher education.

Self-efficacy has been investigated alongside approaches to teaching in several contexts. In psychology GTAs at a UK university, a higher level of self-efficacy associated with a student-focused approach to teaching, while formal training increased self-efficacy (Kaye & Brewer, 2013). Postareff et al. (2007) compared four different groups of faculty teachers according to amount of training. Compared to no training, small amounts of training (under 30 h) associated with decreases in a student-focused teaching approach and self-efficacy. Those with more than 30 h of training had greater self-efficacy.

Self-efficacy has been intricately tied to development of interest in an object, topic or domain (Ainley et al., 2009; Fryer & Ainley, 2019). Schiefele et al. (2013) laid the groundwork for researching interest in teaching specifically.

Interest in teaching

Building on student interest research, Schiefele et al. (2013) developed the Teacher Interest Scale (14-items), hypothesising that teacher interest would impact teaching outcomes. However, the literature is scant on the nature and structure of teaching interest. Following the person-object theory of interest (Hidi et al., 2004), Schiefele theorised individual interest in teaching as being based on three underlying constructs: subject, didactic and educational interest. Furthermore, interest and self-efficacy are proposed to represent value and expectancy respectively (Schiefele et al., 2013). The Teacher Interest Scale was validated in elementary, high achieving and low achieving secondary schools (Schiefele et al., 2013; Schiefele & Schaffner, 2015).

Interviews with GTAs indicated that teaching interest was negatively affected by interest in and prioritising research (Dotger, 2011). Moreover, despite demonstrating an interest in teaching, GTAs may fail to see its contribution to their future career (Ethington & Pisani, 1993).

The interplay among teaching beliefs and their effects on teaching practice across training courses in GTA and related contexts is not well understood. Existing studies with these constructs are cross-sectional (e.g., Postareff et al., 2007), only regarding current practices excluding training (e.g., Kaye & Brewer, 2013), and utilise limited analyses (e.g., mean

differences; Dimitrov et al., 2013). Interest in teaching has not (to our knowledge) been evaluated quantitatively in GTA training courses. A firm understanding of these constructs and their effects on initial teaching practices is crucial to inform both theory and training practices.

The current study

The current study evaluated the development of, and interplay among teaching approach beliefs, self-efficacy, interest and teaching performance in a mandatory short GTA teacher training course. Using structural equation modelling (SEM), a fully-forward model using latent variables was analysed. Participants' gender and academic background were included as covariates. Latent Profile Transition Analysis (LPTA; Nylund et al., 2007) was conducted to assess the quality (Fryer & Shum, 2020), stability (stayers, remaining in the same subgroup) and variability (movers, changing subgroups) in a mover-stayer model of the sample's subgroups across the course. Implications for both the GTA context at large and specific subgroups are presented.

Research questions

RQ1) What is the interplay among and development of self-beliefs? Do pre-existing beliefs on teaching persist with training?

(a) Participants from STEM and non-STEM disciplines would self-report greater teacher-focused teaching and student-focused teaching approaches respectively (Lueddeke, 2003; Hypothesis 1). As existing notions are difficult to change in faculty contexts (Postareff et al., 2007), this difference was expected to persist throughout the GTA course (Hypothesis 2).
(b) End-of-course self-efficacy was hypothesised to predict achievement/teaching performance (Klassen & Tze, 2014; Hypothesis 3). Student-focused teaching approach, a course focus, was expected to predict end-of-course self-efficacy (Kaye & Brewer, 2013; Hypothesis 4).
(c) Student-focused approach and self-efficacy scores would increase across the course (Postareff et al., 2007; Shum & Fryer, 2019; Hypothesis 5).

RQ2) How does subgroup membership change across the course?

(a) Less movement was expected between subgroups with a clear preference for teacher-focused or student-focused teaching approach (Shum & Fryer, 2019; Hypothesis 6).

Methods

Participants and course details

The mandatory 10-week certificate training course is offered by the teaching centre at a large research-intensive university in the Asia-Pacific region whose medium of instruction is English. About 550–600 graduate students are trained each year in classes of about 20.

Meetings are held for three hours, twice a week in Weeks 1, 2, 9 and 10. Trainers employed a mix of teacher-focused techniques (e.g., short lecture), and student-focused techniques (e.g., think-pair-share, debate and discussion). Teaching topics included university environment, constructive alignment (Biggs, 1999), active learning, reflection cycles and grading/assessment. In Weeks 2 and 10, participants facilitated in-course teaching to their peers on an academic topic lasting five and 10 min respectively. Participants received written feedback from trainers and submitted their teaching materials. Participants completed two reflective assignments between Week 3 and Week 8: (1) develop an improvement plan based on feedback of the five-minute teaching, (2) observe a teacher and adopt an effective teaching strategy in the 10-minute teaching.

Procedure and data collection

Participants ($n = 310$, 45% Female) completed surveys at Week 1 (Time-1) and Week 9 (Time-2), September 2016 to June 2017. To measure teaching practice (Achievement), two course trainers designed an analytic rubric to assess the second teaching demonstration (Time-3). They reviewed the materials and written feedback comments of 10 participants and identified six categories (Learning Outcomes and Constructive Alignment, Active Learning Strategies, Explanations, Supporting Materials, Presentation Skills, and, Structure and Time management) evaluated from zero to three. The two trainers rated 80 teaching demonstrations according to the rubric, achieving excellent inter-rater reliability (weighted Cohen's $\kappa = .93$, good fit $\kappa > .75$; Fleiss et al., 2003). The remaining teaching demonstrations were split evenly and graded. Participants consented to study participation when submitting materials online. The study received the university's research ethics committee's approval.

Measures

The survey contained 25 Likert items and was completed in about 10 min during class time. Teaching Interest Scale and ATI questions were answered from 1-*not at all true* to 5-*very true or almost always true*. TSES items included the stem: 'How much can you personally do to … ' and were answered from 1-*nothing* to 5-*A great deal.* To safeguard the validity of the intended constructs, the initial selection of items was guided by previous research where possible, and appropriateness of context otherwise. Furthermore, item trimming was guided by low confirmatory factor analysis (CFA) loading across the two samplings (<.5; Hair et al., 2010), redundancy, and context.

Six items on each of the ATI Teacher-Focused (e.g., '*I structure my teaching in this subject to help students to pass the formal assessment items.*') and Student-Focused (e.g., '*I see teaching as helping students develop new ways of thinking in this subject.*') scales were identified to cover a broad range of the original 11-item scales (Trigwell et al., 2005). These items presented good CFA fit for a previous cohort (Shum & Fryer, 2019). One item was removed from the teacher-focused scale due to low loading (Time-1: .44) and its confounding with the student-focused scale.

Eight items of the TSES (e.g., '*How much can you personally do as a teacher to craft good questions for your students?*'; Tschannen-Moran & Hoy, 2001) were included from the instructional strategies and student engagement subscales. The classroom management subscale was less relevant to higher education and omitted. One item (motivating students

with low interest) was removed due to marginal loading (Time-1: .52) and inexperienced context.

Five items from the Teaching Interest Scale were included (e.g., '*I like to think about ways of making my teaching more effective and motivating*'; Schiefele et al., 2013) from the didactic interest and educational interest subscales. The subject interest subscale was omitted as participants could not choose their teaching assignment and did not reflect the current context. Due to low loading and context, one item (Time-1: .42, Time-2: .36) was removed (personal value on thinking about teaching methods).

Composite reliabilities (ρ; Raykov, 1997) for all subscales were acceptable (>.60; Tseng et al., 2006). See Table 1.

Analyses

To address the research questions, a broad approach including variable-centred and person-centred analyses was undertaken. Person-centred analyses can detect subgroups of participants that present similar traits and tracks their developments and transitions. This allows further interpretation of variable-centred results at a finer level to inform theory and suggest supportive measures for each subgroup. Variable-centred analyses included a fully-forward latent SEM (RQ1; Hypothesis 1–4), and ANOVAs (RQ1; group differences, Hypothesis 2; mean differences, Hypothesis 5). Person-centred analyses included latent profile analysis (LPA) at Time-1 and Time-2, and LPTA (RQ2; Hypothesis 6), ANOVAs and Tukey–Kramer Honest Significant Difference (HSD; to establish significant differences between subgroups) and MANOVAs (to test the explanatory power of the LPTA model). M*plus* 7.0 was used to conduct latent SEM, LPA and LPTA, R (R Core Team, 2018) was used to conduct ANOVAs, MANOVAs and all other analyses. Missing data (<3%) were handled by *mice* in R and Full Information Maximum Likelihood Estimation in M*plus*.

Variable-centred analyses

A fully-forward model (testing all predictions from past to future variables with no predictions removed to improve fit) was tested using latent SEM (Figure 1). Fit was

Table 1. Descriptive statistics, correlations, reliability.

	TFT1	SFT1	SET1	IT1	TFT2	SFT2	SET2	IT2	Ach T3
TFT1	–								
SFT1	.05	–							
SET1	.01	.30***	–						
IT1	.15**	.46***	.24***	–					
TFT2	.50***	−.02	−.02	.06	–				
SFT2	.08	.42***	.14*	.26***	.09	–			
SET2	.07	.28***	.44***	.18**	.13*	.45***	–		
IT2	.18**	.34***	.23***	.41***	.22***	.56***	.41***	–	
Ach T3	−.09	.02	.05	.04	−.07	.08	.17**	.05	–
Mean	3.35	3.93	3.46	4.10	3.43	4.06	3.76	4.17	3.07
SD	.67	.66	.61	.61	.68	.60	.58	.55	.46
ρ	.64	.78	.82	.67	.73	.80	.83	.62	–

Note: TF-Teacher-Focused, SF-Student-Focused, SE-Self-Efficacy, I-Interest. T1/T2/T3: Time-1/Time-2/Time-3, Ach – Achievement.

***$p < .001$,**$p < .01$,*$p < .05$.

determined using comparative fit index (CFI), root-mean-square error of approximation (RMSEA) and square root mean residual (SRMR). Values above .90/.95 for CFI (McDonald & Marsh, 1990) and below .05/.08 for RMSEA (Browne & Cudeck, 1992) indicated acceptable/good fit while SRMR<.08 indicated good fit (Hu & Bentler, 1999). To improve fit, the same items between Time-1 and Time-2, and latent variables at the same time were allowed to covary. Small/moderate/large effect cut-offs on predictions on learning influences (Keith, 2015) and mean-increases (Cohen, 1992) were $\beta > .05/.10/.25$ and $d > .20/.50/.80$ respectively.

Gender (138 females, 45%; Female = 1, Male = 0) and academic background (218 STEM, 69%; STEM = 1, non-STEM = 0) were controlled for in all variables. STEM included Science, Engineering, Medicine and Dentistry faculties while non-STEM included Art, Business and Economics, Social Science, Architecture, Education, and Law faculties.

ANOVAs were performed, simultaneously testing population differences on all Time-1 self-beliefs as dependent variables (RQ1; Hypothesis 2) with each of gender and academic background as the independent variable. This was repeated with Time-2 variables.

Person-centred analyses

Cross-sectional LPAs were used to probabilistically determine the number and membership of subgroups independently at each of Time-1 and Time-2 (RQ2). The analyses proceeded with LPTA determining if each participant moved to another subgroup (mover) or stayed in the same subgroup (stayer) between Time-1 and Time-2. Analyses also accounted for profile changes across time (i.e., subgroup variable means can change between Time-1 and Time-2).

Model fit was assessed from two to five subgroups, examining information criteria, and guided by likelihood ratio tests and minimum subgroup size. Akaike's Information Criterion (AIC; Akaike, 1987), Bayesian Information Criterion (BIC; Schwartz, 1978) and

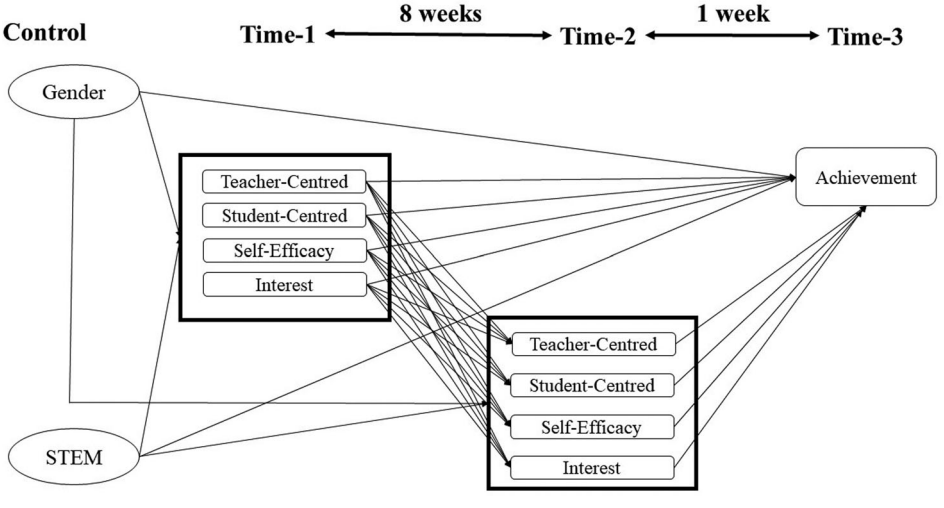

Figure 1. Fully-forward tested model.

sample-size adjusted BIC (SABIC) were used, where the best fitting model (number of subgroups) presents a minimum or an elbow (sharpest decrease). BIC is regarded as the most useful criterion (Nylund et al., 2007). Vuong-Lo-Mendell-Rubin (Vuong, 1989) and Lo-Mendell-Rubin (Lo et al., 2001) likelihood ratio tests indicated if the identified number of latent subgroups was more significant with one less subgroup. The best fitting model was analysed with ANOVAs and Tukey–Kramer HSD testing to determine significant differences between subgroups for each variable at each time. MANOVAs were conducted to test the explanatory power of the model at each of Time-1 and Time-2.

Results

Mean-based differences and correlations

Means and standard deviations for all scales are presented in Table 1. ANOVAs were performed with mean differences on each scale between Time-1 and Time-2 (Table 2). Student-focused teaching (small, $d = .21$) and self-efficacy (moderate, $d = .50$) exhibited significant increases (both $p < .01$; Hypothesis 5).

All auto-lagged correlations were significant ($r = .41–.50$). Interest at both time points significantly correlated with all variables ($r = .15–.56$) except for achievement, and interest at Time-1 with teacher-focused approach at Time-2. Achievement only significantly correlated with self-efficacy at Time-2 ($r = .17$). Student-focused teaching correlated with and across both times with self-efficacy ($r = .14–.45$). Teacher-focused teaching did not correlate significantly with student-focused teaching, and only with self-efficacy at Time-2 ($r = .13$).

Latent SEM analyses

CFA of the fully-forward model resulted in acceptable fit (CFI = .91, RMSEA = .034, 90% CI:[.029,.038], SRMR = .055). Figure 2 presents the significant paths of the SEM model, with variance explained.

Predictive effects

All auto-lagged predictions from Time-1 to Time-2 were significant ($\beta = .43–.62$, large, $p < .001$). Student-focused teaching at Time-1 predicted self-efficacy at Time-2 ($\beta = .30$, large, $p < .01$; Hypothesis 3), which predicted achievement at Time-3 ($\beta = .33$, large, $p < .05$; Hypothesis 4). Self-efficacy at Time-1 predicted interest at Time-2 ($\beta = .17$, moderate, $p < .05$).

Table 2. ANOVAs: Time-1/Time-2, effect size.

	Time-1	Time-2	*p*	*F*	*d*
Teacher-Focused	3.35(.67)	3.43(.68)	.219	1.52	.12
Student-Focused	3.93(.66)	4.06(.60)	.010**	6.66	.21
Self-Efficacy	3.46(.61)	3.76(.58)	<.0001***	38.08	.50
Interest	4.10(.61)	4.17(.55)	.178	1.82	.12

$p < .05$, **$p < .01$, ***$p < .001$.

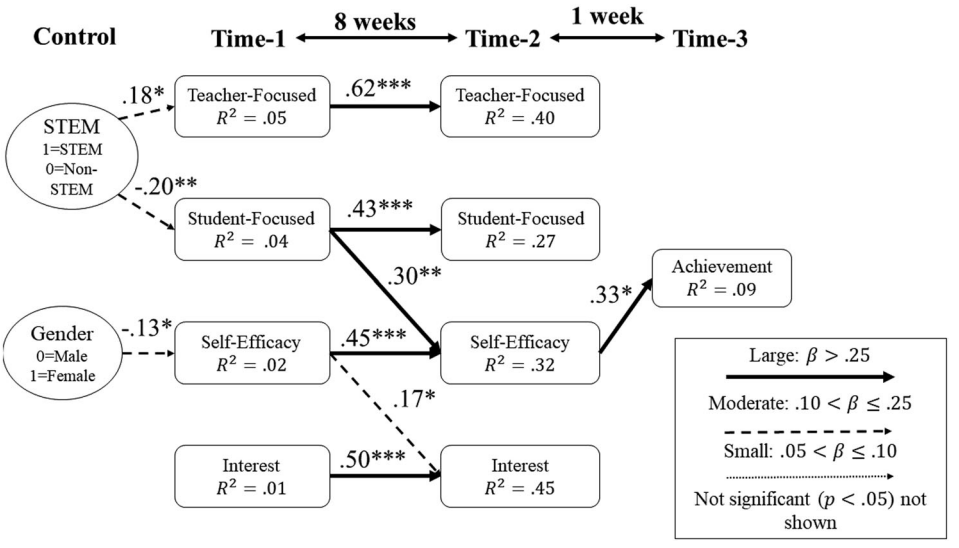

Figure 2. Fully-forward SEM model. Significant (*$p < .05$,**$p < .01$,***$p < .001$) paths are shown.

Control variables

Participants from STEM backgrounds reported greater teacher-focused approach ($\beta = .18$, moderate, $p < .01$) while non-STEM participants reported greater student-focused approach ($\beta = -.20$, moderate, $p < .01$) at Time-1 (Hypothesis 1). ANOVAs of all Time-1 variables on academic background revealed significant differences for teacher-focused ($F(1,308) = 4.15$, $p < .05$) and student-focused ($F(1,308) = 8.08$, $p < .01$) variables (Hypothesis 1). These findings did not persist to Time-2 (refuting Hypothesis 2). Females reported lower self-efficacy at Time-1 ($\beta = -.14$, moderate, $p < .05$), though ANOVAs on gender were not significant at either time.

Latent profile transition analysis

A minimum in BIC was found at three subgroups at both Time-1 and Time-2. AIC and SABIC supported this model by presenting the greatest decrease at three subgroups. The three-subgroup solution was further supported by likelihood ratio tests at Time-1, and by smallest meaningful group size at Time-2. Proceeding with LPTA, a three-subgroup solution also indicated the best fit in all three indicators. See Table 3.

Standardised level (overall means, see Figure 3) was significantly different across subgroups. Naming of subgroups was guided by level (means) and shape (relative differences between variables within the subgroup) of the profiles (Fryer & Shum, 2020), and previous person-centred GTA research using the ATI (GTAs are less likely to prefer one of teacher-focused or student-focused teaching; Prosser et al., 2003; Shum & Fryer, 2019). The subgroup means presented a developmental progression in teaching beliefs. Subgroups were named and ordered Low-Teacher-Focused, Mid-Mixed and High-Student-Focused. Low/Mid/High reflected relative amounts of self-efficacy and interest. The largest subgroup, Mid-Mixed, reported

Table 3. Latent Profile Analyses (LPA) and Latent Profile Transition Analysis (LPTA).

LPA									
Time-1	2-SG	3-SG	4-SG	5-SG	**Time-2**	2-SG	3-SG	4-SG	5-SG
AIC	2320.2	2291.8	2285.7	2278.2		2107.7	2063.9	2047.3	2036.6
BIC	2368.7	**2359.0**	2371.6	2382.8		2156.3	**2131.1**	2133.2	2141.2
SABIC	2327.5	2301.9	2298.7	2294.0		2115.0	2074.1	2060.3	2052.4
VLMR	.030	.038	.299	.042		.017	.305	.005	.379
LMR	.032	.041	.309	.046		.019	.314	.006	.386
LPTA									
	2-SG		3-SG		4-SG		5-SG		
AIC	4389.1		4288.6		4249.9	4230.1			
BIC	4490.0		**4438.0**		4455.5		4499.2		
SABIC	4404.4		4311.2		4281.0		4270.8		

Note: AIC – Akaike Information Criteria, BIC – Bayesian Information Criteria, SABIC – Sample-size Adjusted Bayesian Information Criteria, VLMR: Vuong-Lo-Mendell-Rubin Likelihood Ratio Test, LMR: Lo-Mendell-Rubin Likelihood Ratio Test, SG-subgroup.

similar levels of teacher-focused and student-focused teaching. The smallest subgroup, Low-Teacher-Focused, was borderline in size at Time-1 (8%) increasing in membership at Time-2 (12%). Mid-Mixed and High-Student-Focused presented strong stability (78% and 96% stayers compared to Time-1 respectively) across the course. Despite a total of 53 movers (17%), only 3 (1%) were not between developmentally adjacent subgroups (Hypothesis 6). Table 4 presents the odds-ratio for movers and stayers. Significant increases were observed in Mid-Mixed and High-Student-Focused subgroups in self-efficacy, and Low-Teacher-Focused subgroup in student-focused teaching across the course. Figures 3 and 4 present the standardised mean profiles of the stayers and movers respectively.

Subgroup differences

ANOVAs tested differences in the three subgroups for each variable at Time-1 and Time-2. ANOVAs were significant for all variables at both times ($p < .001$, except for teacher-focused, $p < .05$) with variance explained ranging from 2% to 3% for Low-Teacher-

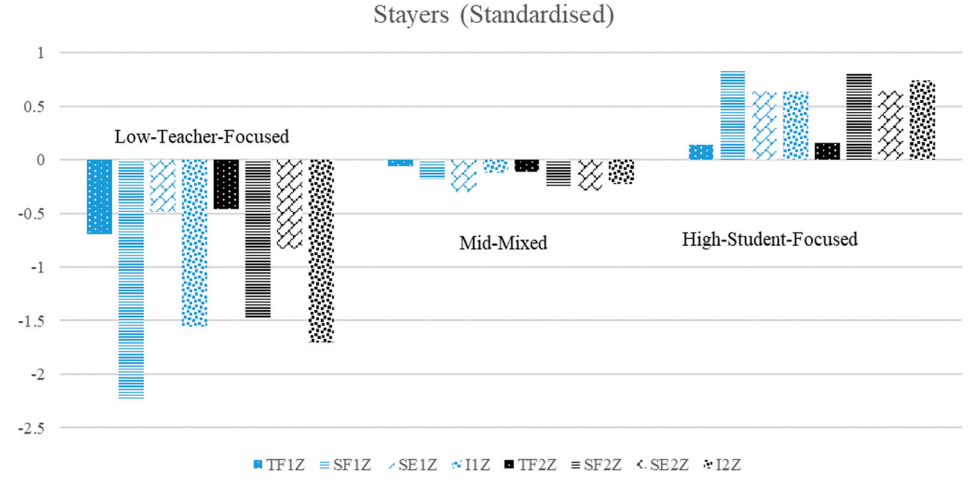

Figure 3. Standardised Profiles for Subgroup Stayers. TF-Teacher-Focused, SF-Student-Focused, SE-Self-Efficacy, I-Interest, 1,2: Time-1/Time-2.

Table 4. Odds-Ratio for stayers and movers. Odds(*n*,stayers/movers).

	Time-2 Low-TF	Time-2 Mid-Mixed	Time-2 High-SF	Time-1 Totals
Time-1 Low-TF	0.048(15,Stayers)	0.029(9,Movers)	0(0,Movers)	0.077(24)
Time-1 Mid-Mixed	0.065(20,Movers)	0.452(140,Stayers)	0.065(20,Movers)	0.582(180)
Time-1 High-SF	0.010(3,Movers)	0.003(1,Movers)	0.334(106,Stayers)	0.347(110)
Time-2 Totals	0.123(38)	0.484(150)	0.399(126)	

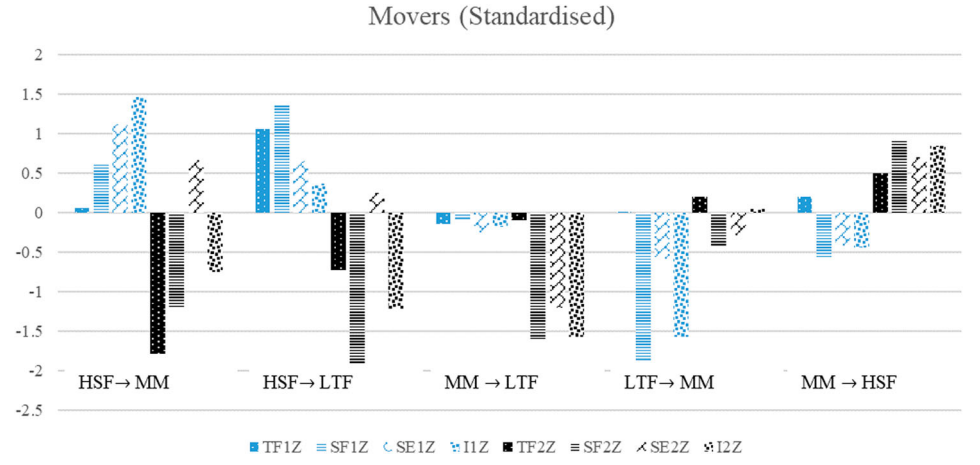

Figure 4. Standardised Profiles of Movers. LTF: Low-Teacher-Focused, MM: Mid-Mixed, HSF: High-Student-Focused. TF-Teacher-Focused, SF-Student-Focused, SE-Self-Efficacy, I-Interest, 1,2: Time-1/ Time-2.

Focused and 22–61% for other variables. Tukey–Kramer HSD testing across the subgroups at each time point was conducted (Table 5). MANOVAs at each of Time-1 and Time-2 tested the explanatory power of the three-subgroup model. Time-1 showed 72% variance explained (Wilk's Lambda = .28, $p < .001$, df = 8, F = 68.21) and Time-2 showed 78% variance explained (Wilk's Lambda = .22, $p < .001$, df = 8, F = 84.40), supporting the three-subgroup solution provided by the LPA analyses.

Table 5. Time-1 (T1) and Time-2 (T2) subgroup means (standard deviations), ANOVAs. Tukey-Kramer HSD testing ($p < .05$): Two subgroups are significantly different on respective scales if no letters overlap. TF-Teacher-Focused, SF-Student-Focused, SE-Self-Efficacy, I-Interest.

	Low-Teacher-Focused	Mid-Mixed	High-Student-Focused	*P*	F	R^2
TFT1	3.07(.82),a	3.33(.61),a,b	3.47(.71),b	.022	3.87	.02
SFT1	2.54(.46),a	3.79(.45),b	4.48(.33),c	<.001	239	.61
SET1	3.15(.53),a	3.28(.54),a,b	3.85(.53),c	<.001	42.86	.22
IT1	3.14(.63),a	4.00(.51),b	4.49(.44),c	<.001	79.05	.34
TFT2	3.23(.65),a	3.36(.63),a,b	3.57(.74),c	.006	5.147	.03
SFT2	3.12(.45),a	3.90(.39),b	4.55(.33),c	<.001	234.9	.60
SET2	3.21(.55).a	3.59(.45),b	4.13(.48),c	<.001	71.24	.32
IT2	3.29(.40),a	4.05(.37),b	4.58(.34),c	<.001	198.7	.56

Discussion

Answering RQ1, significant differences between STEM and non-STEM backgrounds on teacher-focused and student-focused approaches were found only at Time-1 (Hypotheses 1-2). Student-focused teaching at Time-1 was found to predict self-efficacy at Time-2, which predicted achievement at Time-3 (Hypotheses 3-4). Significant small increases in student-focused teaching and moderate increases in teaching self-efficacy were in line with previous findings in the same and related contexts (e.g., Dimitrov et al., 2013; Postareff et al., 2007; Hypothesis 5). For RQ2, only three of 53 movements between subgroups were not between developmentally adjacent subgroups (Hypothesis 6). Overall, the results suggest that training can support the reshaping and development of GTA's teaching approach beliefs and may be more effective at doing so at this stage than at the faculty level (Postareff et al., 2007). The results indicated a developmental pathway from student-focused teaching, to self-efficacy to in-course teaching performance. Person-centred analyses revealed that overall developments in student-focused teaching and teaching self-efficacy occurred in different subgroups, and that student-focused teaching was a developmental precursor to teaching self-efficacy. Furthermore, incremental movement between subgroups suggest the shaping of teaching beliefs occurs gradually (Shum & Fryer, 2019).

Implications for theory

The results imply that teaching approaches and self-efficacy are malleable in a short teaching training course and suggest a path forward to support teaching performance development. Furthermore, the results indicate that pre-existing teaching beliefs (Oleson & Hora, 2014) can change and training may support the argument that teaching approaches can be shaped and moulded despite previously held conceptions. This contrasts the faculty context (Postareff et al., 2007) where existing teaching conceptions are difficult to change, and further suggests that discipline-based preferences for teaching approach (Lueddeke, 2003) can be mitigated.

The developmental pathway from student-focused teaching to self-efficacy to teaching performance ties together existing research that have been in part replicated in similar (psychology graduate students; Kaye & Brewer, 2013) and tangential (primary and secondary school; Klassen & Tze, 2014) contexts.

Though self-efficacy and interest are often linked (Schiefele et al., 2013), this relationship appeared to only be unidirectional in this study. As teaching is a novel experience for most GTAs, sufficient interest (Hidi et al., 2004) might not have yet sufficiently developed.

Strong stability was observed in the High-Student-Focused subgroup (96%) indicating that once there, participants are unlikely to leave, bolstering maintenance in development. The Mid-Mixed subgroup was more volatile, presenting the largest movements in either direction. Though the Low-Teacher-Focused subgroup was small, the moderate increase of self-efficacy was not evidenced by this group. Some proficiency in teacher-focused teaching may be required prior to meaningful teaching self-efficacy development (Shum & Fryer, 2019; Trigwell et al., 2005), which is supported by Biggs (1993) developmental model on teaching beliefs: focus should eventually shift from what teachers do to what students do. Proximal movements suggest that development is stepwise. The largest (over 50%) subgroup reported a shape that would suggest no preference for either teaching

conception, reaffirming Shum and Fryer's (2019) findings that many GTAs' teaching approach beliefs remain fluid.

Implications for practice

The results support the call for teacher training in higher education (Stes et al., 2010) and specifically in GTAs' teaching skills (Park, 2004; Park & Ramos, 2002), self-efficacy (Kaye & Brewer, 2013; Prieto & Meyers, 1999), and teaching approach beliefs (Gibbs & Coffey, 2004). The results warrant further investigation into the mandatory training for GTAs with little or no teaching experience.

Results on self-efficacy development and its effects on interest and achievement support the finding and testing of practices that further strengthen self-efficacy. Specific strategies to promote teacher self-efficacy include interactive discussions with peers, mentors, informational presentations and exercises (Young & Bippus, 2008), and practicing with feedback (Klassen & Tze, 2014). The practices of the current training course are in line with these. Further training practices informed by Bandura's (1997) sources of self-efficacy: mastery experiences (e.g., extending training to include in-class teaching experiences), verbal persuasion (e.g., sustained positive feedback from trainers), vicarious experience (e.g., continued observations of experienced teachers) and affective states (e.g., supporting management of stress and anxiety in teaching; Klassen & Tze, 2014) should be pursued.

Training for a student-focused teaching approach has often been paired with support for conferences, departmental mentors and incentives for good teaching (Gibbs & Coffey, 2004). Dimitrov et al. (2013) also found student-focused teaching increases could be attributed to making learning relevant to students and catering to individual differences in instruction. Activating teaching methods (e.g., guided autonomous learning, peer/tutor feedback, discussions on good teaching practices) resulted in an increase of student-focused approach in faculty courses (Postareff et al., 2007), and could be tested in the GTA context. Research has generally suggested that once stabilised through experience, teaching approaches are difficult to change (Postareff et al., 2007; Prosser et al., 2003), which along with the results of this study, further supports the need for training in this early stage.

For subgroups, the preference in High-Student-Focused subgroup for student-focused teaching suggests current practices may be sufficient. The Low-Teacher-Focused preference for teacher-focused approach and Mid-Mixed's lack of preference suggest that additional measures are necessary. Training should help develop teacher-focused skills including content expertise and lecturing prior to student-focused approach development (Trigwell et al., 2005).

Limitations and future work

Though the results shed light on the research questions and hypotheses, they should be interpreted carefully. The measures at Time-1 and Time-2 are self-reported and are not directly measured. The study also lacks a control or comparison group. The prediction of teaching self-efficacy on teaching performance does not guarantee that the same results hold with the goal of teaching and learning in classrooms. A longitudinal study beyond the course could investigate longer-term effects of training, including subgroup

development and stability. A recent cross-sectional study reported that GTAs who had just finished training had higher self-efficacy compared to GTAs starting to teach in class (Chiu & Corrigan, 2019).

The measure of teaching self-efficacy may be skirting the limits of intended use (Bandura, 1993, 1997). The TSES asks for a self-assessment of teaching abilities generally. The study's context may differ from undergraduate teaching practice.

Finally, the low variance explained for Achievement might be increased by including the first teaching demonstration in Week 2.

Conclusion

GTAs, who often double as postgraduate students, are burdened with simultaneously taking their own courses and completing research requirements. The study investigated GTAs' development of and interplay among teaching approaches, teaching self-efficacy, teaching interest and their effects on teaching performance in a mandatory teaching training course. Participants underwent a small increase in student-focused teaching approach and moderate increase in teaching self-efficacy. Results suggested a developmental pathway from student-focused teaching to teaching self-efficacy to teaching performance. Disciplinary differences in teaching approach were observed only at the beginning of the course, but not at the end, suggesting pre-existing teaching conceptions do not dictate the teaching approach taken after training.

Person-centred analyses revealed three subgroups: Low-Teacher-Focused, Mid-Mixed and High-Student-Focused. Low-Teacher-Focused and Mid-Mixed participants may lack teacher-focused teaching abilities that should be trained concurrently with student-focused teaching. Movements between subgroups suggested incremental development and the need for training and study beyond the course. The High-Student-Focused subgroup showed the strongest stability, suggesting training supports and maintains development.

Overall, the research provides an encouraging outlook on the malleability of GTA's teaching approaches and self-efficacy, and the efficacy of training courses. A call is made for additional studies on similar courses and beyond into in-class teaching practice to determine how GTAs can be best supported in teaching development.

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