Mentoring on Early-Career Technology and Engineering Teachers

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ABSTRACT

Many researchers in technology and engineering education (TEE) have identified the shortage of TEE teachers as an existential crisis within the discipline. A major component of this crisis is the retention of early-career TEE teachers. The aim of this study was to identify and investigate the impact of current early-career mentoring practices on early-career TEE teachers' sense of belonging, job satisfaction, and expectations to remain in the teaching profession. Data were collected from early-career technology and engineering teachers via an online survey distributed across the United States of America through the Association for Career and Technical Education, the International Technology and Engineering Educators Association, and state-level Career & Technical Education directors. Data were analysed regarding the mentoring opportunities available to early-career TEE teachers, their perceived effectiveness, and the relationship between mentoring and sense of belonging, job satisfaction, and teachers' intentions to remain in the profession.

Key Words: Teacher Retention, Mentoring, Early-Career Teachers, Technology Education, TEE

1. INTRODUCTION

Teacher retention is a critical issue in education as teacher attrition continues to be a significant challenge worldwide (Boyd et al., 2011; Carver-Thomas & Darling-Hammond, 2017; Ronfeldt et al., 2013). High teacher turnover negatively impacts student achievement and school communities overall (Ronfeldt et al., 2013). Understanding the factors that influence teacher retention has become a focus in educational research, especially in the field of Technology and Engineering Education (TEE).

Many studies have examined factors influencing teacher retention, including pay, administrative support, mentoring programs, school climate, and professional

development (Boyd et al., 2011; Bullough, 2012; Gilles et al., 2017; Ritz, 2006). Effective mentoring programs may play an important role in supporting incoming teachers as they transition from teacher preparation programs to full-time teaching (Bullough, 2012). Nowhere are effective mentoring programs needed more than among TEE teachers.

The purpose of this study was to investigate the mentoring opportunities available to early-career TEE teachers, and to investigate the relationship between mentoring and job satisfaction, sense of belonging, and persistence intentions among early-career TEE teachers. The following research questions were developed for this study:

> What mentoring opportunities are available for early-career TEE teachers?

> Which mentoring activities are perceived as most effective by early-career TEE teachers?

> How does mentoring impact early-career TEE teachers' sense of belonging, job satisfaction, and persistence intentions?

2. LITERATURE REVIEW

Understanding factors influencing TEE teachers' persistence is crucial to addressing teacher shortages within the profession. Previous research has highlighted the positive impact of mentoring programs among early-career teachers (Gilles et al., 2017; Bullough, 2012). Mentoring programs have been shown to provide guidance, support, and professional development opportunities when implemented effectively. Additionally, mentoring contributes to a sense of belonging and increased job satisfaction by helping novice teachers establish connections within the school community (Hallam et al., 2012).

Sense of belonging has been recognized as a crucial factor in shaping job satisfaction and persistence intentions among new teachers (Ortiz, 2022; Skaalvik & Skaalvik, 2011). When teachers feel a sense of belonging within their school community, it can positively impact their job satisfaction and increase their intention to persist (Ortiz, 2022). Conversely, a lack of belonging may lead to lower job satisfaction and a higher likelihood of considering alternative careers.

Job satisfaction has also been recognized as an important component of early-career teacher retention (Ortiz, 2022; Renbarger & Davis, 2019; Skaalvik & Skaalvik, 2011). Ortiz (2022) found that job satisfaction mediated the relationship between sense of belonging and persistence intentions among TEE teachers. In addition, Renbarger & Davis (2019) found that job satisfaction among teachers was improved with the presence of a mentor.

The conceptual framework used in this study was based on the findings of Ortiz (2022). The present study measured the effect of early-career mentoring as a moderating variable on both job satisfaction and a sense of belonging as shown in Figure 1.

Conceptual framework for the impact of mentoring on job satisfaction and sense of belonging leading to increased TEE teacher persistence.
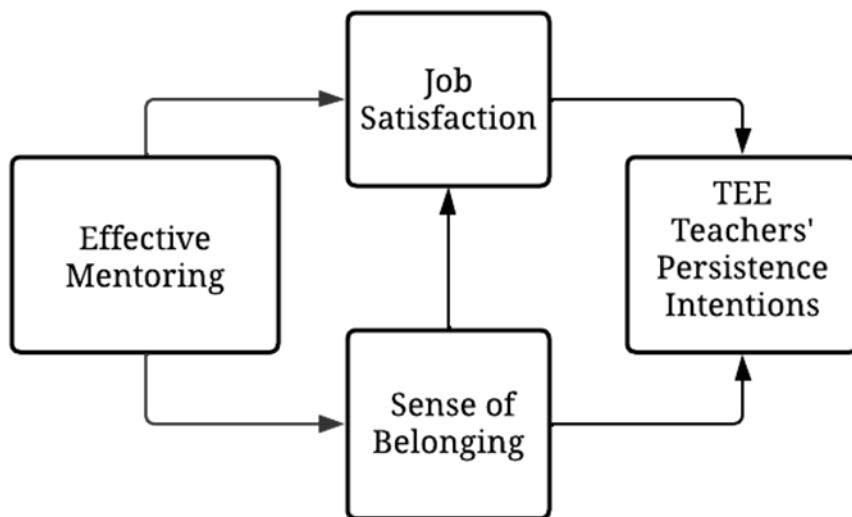
Existing literature has illuminated the interrelatedness between mentoring, job satisfaction, sense of belonging, and persistence among teachers, but more research is needed to further understand these relationships among TEE teachers. TEE teachers have unique characteristics, methodologies, and responsibilities compared to teachers from other disciplines such as language arts, mathematics, etc. Existing research has mainly focused on teachers generally and has not accounted for the unique needs of TEE teachers. This study sought to bridge this gap by investigating the relationships between mentorship, job satisfaction, sense of belonging, and persistence intentions among early-career TEE teachers and to identify mentoring opportunities available to early-career TEE teachers in the United States.

3. METHODOLOGY

This study utilized a convenience sample of early-career TEE teachers who responded to an anonymous online survey distributed through the International Technology and Engineering Educators Association (ITEEA), the Association for Career and Technical Educators (ACTE), and state CTE directors. No incentives were offered for participation in this study.

Teachers who were in their first five years of teaching technology and/or engineering (T&E) courses and completed the survey were included in the study. Other demographic information collected included type of licensure, gender, and race.

The survey instrument also incorporated measures of teachers' sense of belonging (adapted from the "Sense of Belonging to School" scale; Roberts, et al., 1995), job satisfaction (adapted from the "Job Satisfaction Survey;" Judge, et al., 1998), and persistence intentions (derived from Sorenson, 2015). These measures are detailed in the dissertation by Ortiz (2022). Examples from each construct are shown in Figure 2. The survey data was analysed using descriptive statistics, correlation, and regression analyses.

Figure 2.
Sample survey items

Sample Sense of Belonging Item

We would like to know about your sense of belonging as a technology and/or engineering teacher. Please indicate the extent to which you agree or disagree with each statement below.

	Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree
In my job, there is a great deal of cooperative effort among staff members.	○	○	○	○	○	○

Sample Job Satisfaction Item

The following statements address how you feel about your job. Please indicate the extent to which you agree or disagree with each statement below.

	Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree
I feel satisfied with my present job.	○	○	○	○	○	○

Sample Persistence Intentions Item

Please indicate the extent to which you agree or disagree with the following statements regarding your intentions to remain in your position as a technology and/or engineering teacher.

	Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree
I plan to remain a technology/engineering teacher until I retire.	○	○	○	○	○	○

4. RESULTS

4.1. Sample Description

In total, 293 participants began the survey; however, many prospective participants did not meet the inclusion criteria. In all, 68 participants completed the entire survey and met the inclusion criteria. Of these participants, 31 identified as male, 34 as female, 2 as non-binary, and 1 preferred not to say. For race, ethnicity, and origin, 89.7% of participants identified as White (non-Hispanic), 7.4% as Asian, 4.4% as Hispanic/Latinx/Spanish Origin, and 2.9% as American Indian/Alaska Native, and 1.5% each as Black/African American and Native Hawaiian/Pacific Islander, respectively.

This study included participants with between 1 and 5 years (inclusive of the current year) experience teaching secondary T&E classes. The average years of experience teaching T&E courses was 3.06 years ($SD = 1.47$). Total years of formal teaching experience, including years taught outside of secondary T&E courses was also collected ($M = 9.25$, $SD = 7.09$). 60.29% of the participants taught at the high school level (grades 9-12), while 35.29% taught at the middle school level (grades 6-8). 4.41% taught classes in both grade bands.

Participants were also asked about how they obtained their teaching credentials. 47.1% of participants obtained their credentials via a traditional four-year university teacher preparation program, 41.1% through an alternative route to licensure (ARL) program in which they completed licensure requirements during their first few years of teaching, and 11.8% obtained their credential via an emergency authorization and subsequently completed licensure requirements through an ARL program.

Participants were also asked about their membership in professional educator associations, including major organizations catering to TEE teachers in the United States, with 44.1% indicating membership in the Association for Career & Technical Education (ACTE), 14.7% in the International Technology & Engineering Educators Association, and 17.7% indicated belonging to another organization for professional educators. 42.7% of participants indicated that they did not belong to any professional educator association.

4.2. Availability and impact of mentoring opportunities

One research question in this study was to determine what type of mentoring opportunities exist for early-career TEE teachers. In the survey, participants were asked to select mentoring activities that were available to them as early-career TEE teachers. Table 1 shows the mentoring opportunities teachers in this sample had available to them.

Table 1.
Participant access to early-career mentoring opportunities (N = 68)

Mentoring Opportunity	Definition	f	%
Professional learning community (PLC) – TEE, horizontal	Meeting with a group of other TEE teachers in the same grade band	33	48.5

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PLC – TEE, vertical	Meeting with a group of other TEE teachers in different grade levels	14	20.6
PLC – non-TEE	Meeting with a group of other teachers where at least one is from a different content area	24	35.3
Informal mentor – TEE	Meeting with a non-assigned mentor who teaches TEE classes	19	27.9
Informal mentor – non-TEE	Meeting with a non-assigned mentor who does not teach TEE classes	13	19.1
Formal mentor – TEE	Meeting with an assigned mentor who teaches TEE classes	8	11.8
Formal mentor – non-TEE	Meeting with an assigned mentor who does not teach TEE classes	16	23.5
Professional conference attendance	Attending a professional conference for educators	43	63.2
Professional association resources	Access to resources (e.g., curriculum) provided by a professional organization for educators	30	44.1

Participants were also asked to select how often they utilized the mentoring opportunities that were available to them. Table 2 shows how often participants participated in the mentoring opportunities to which they had access.

Table 2. Participant engagement in available mentoring opportunities

Mentoring Opportunity	Never	1-2 times per year	A few times per year	≥ Once per month	≥ Once per week
PLC – TEE, horizontal	0 (0.0%)	8 (24.2%)	9 (27.3%)	11 (33.3%)	5 (15.2%)
PLC – TEE, vertical	1 (6.7%)	3 (20.0%)	2 (13.3%)	8 (53.3%)	0 (0.0%)
PLC – non-TEE	0 (0.0%)	0 (0.0%)	2 (8.3%)	11 (45.8%)	11 (45.8%)
Informal mentor – TEE	1 (5.3%)	4 (21.1%)	6 (31.6%)	3 (15.8%)	5 (26.3%)
Informal mentor – non-TEE	0 (0.0%)	0 (0.0%)	5 (38.5%)	5 (38.5%)	3 (23.1%)
Formal mentor – TEE	0 (0.0%)	2 (25.0%)	0 (0.0%)	2 (25.0%)	4 (50.0%)
Formal mentor – non-TEE	0 (0.0%)	1 (6.3%)	5 (31.3%)	4 (25.0%)	6 (37.5%)
Professional conference attendance	3 (7.0%)	29 (67.4%)	11 (25.6%)	0 (0.0%)	0 (0.0%)
Professional association resources	3 (10.0%)	8 (26.7%)	8 (26.7%)	4 (13.3%)	7 (23.3%)

4.3. Perceived effectiveness of mentoring activities

Pursuant to research question 2, participants were asked to rate the effectiveness of the mentoring opportunities they had access to. Ratings were made on a 6-point Likert scale ranging from Very ineffective (1) to Very Effective (6). Table 3 shows how participants perceived the effectiveness of the mentoring opportunities based on mean rating scores.

Table 3.
Participant rating of mentoring opportunity effectiveness

Mentoring Opportunity	M	SD
PLC – TEE, horizontal	4.7	1.2
PLC – TEE, vertical	4.6	1.3
PLC – non-TEE	3.5	1.6
Informal mentor – TEE	5.3	1.0
Informal mentor – non-TEE	3.9	1.7
Formal mentor – TEE	5.4	0.8
Formal mentor – non-TEE	4.4	1.2
Professional conference attendance	4.7	1.2
Professional association resources	4.3	1.4

4.4. Sense of belonging, job satisfaction, and persistence intentions

The final research question in this study was to identify impacts of mentoring programs on early-career technology and engineering teachers' sense of belonging, job satisfaction, and persistence intentions. Reliability was calculated for each of these three constructs within the survey instrument. For sense of belonging, the reliability of the instrument was found to be good to excellent ($\alpha = .881$). This also held true for job satisfaction ($\alpha = .886$) and persistence intentions ($\alpha = .891$).

Based on survey responses, average scores were calculated for participants' overall sense of belonging ($M = 4.2$, $SD = 1.0$), job satisfaction ($M = 3.8$, $SD = 0.9$) and persistence intentions ($M = 3.8$, $SD = 1.2$). In addition, these scores were disaggregated based on mentoring opportunities participants had available to them, as shown in Table 4.

Table 4.
Average job satisfaction, sense of belonging, and persistence intention scores disaggregated by mentoring opportunities

Mentoring Opportunity	Job Satisfaction		Sense of Belonging		Persistence Intentions	
	M	SD	M	SD	M	SD
PLC – TEE, horizontal	4.2	0.3	4.3	0.9	3.2	0.4
PLC – TEE, vertical	4.3	0.3	4.5	0.9	3.3	0.5
PLC – non-TEE	4.2	0.3	4.2	1.1	3.3	0.5
Informal Mentor – TEE	4.2	0.3	4.4	0.8	3.2	0.5
Informal Mentor – non-TEE	4.3	0.3	4.4	0.8	3.2	0.5
Formal Mentor – TEE	4.2	0.3	4.4	0.6	3.3	0.5
Formal Mentor – non-TEE	4.2	0.4	4.7	0.7	3.1	0.5
Professional conference attendance	3.9	0.9	4.2	0.9	3.8	1.2
Professional association resources	4.0	0.8	4.0	1.0	3.9	1.1

In addition, six participants did not mark any of the mentoring opportunities as available to them. Mean job satisfaction, sense of belonging, and persistence intention scores of these participants are shown in Table 5.

Table 5.
Job satisfaction, sense of belonging, and persistence intentions for participants marking no mentoring opportunity availability (n = 6)

	M	**SD**
Job Satisfaction	3.2	0.7
Belonging	4.2	0.9
Persistence Intentions	3.0	1.5

Finally, regression analysis was conducted for sense of belonging, job satisfaction and persistence intentions to identify which variables were statistically significant predictors of these constructs, as shown in Tables 6, 7, and 8, respectively.

Table 6.
Summary of multiple regression analysis for variables predicting sense of belonging (N = 68)

Effect on Sense of Belonging	B	SE B	95% CI		t	p
			LL	UL		
Job Satisfaction	0.21	0.12	-0.03	0.45	1.702	0.950

| Informal mentor – non-TEE | 0.65 | 0.25 | 0.15 | 1.15 | 2.531 | 0.014 |

Note. Adjusted R-Squared = .13; F-statistic: 5.02 on 2 and 52 DF, p-value: 0.010; CI = confidence interval LL = lower limit; UL = upper limit.

Table 7.
Summary of multiple regression analysis for variables predicting job satisfaction (N = 68)

Effect on Job Satisfaction	**B**	**SE B**	**95% CI**		**t**	**p**
			LL	UL		
Sense of Belonging	0.27	0.13	0.01	0.52	2.03	0.048
PLC – non-TEE	-0.57	0.25	-1.05	-0.09	-2.31	0.025

Note. Adjusted R-Squared = .11; F-statistic: 4.454 on 2 and 52 DF, p-value: 0.016; CI = confidence interval LL = lower limit; UL = upper limit.

Table 8.
Summary of multiple regression analysis for variables predicting persistence intentions (N = 68)

Effect on Persistence Intentions	**B**	**SE B**	**95% CI**		**t**	**p**
			LL	**UL**		
Job Satisfaction	0.772	0.133	0.51	1.03	5.811	<0.001
Sense of Belonging	0.302	0.136	0.04	0.57	2.231	0.030
ACTE Membership	0.563	0.236	0.10	0.57	2.389	0.021

Note. Adjusted R-Squared = .487; F-statistic: 18.12 on 3 and 51 DF, p-value <.001; CI = confidence interval LL = lower limit; UL = upper limit.

As shown in Tables 6-8, statistically significant regression models were identified for sense of belonging, job satisfaction, and persistence intentions. With job satisfaction as an outcome, the model using sense of belonging and the availability of a non-assigned (informal) mentor who did not teach TEE classes as predictors accounted for 13% of the variance with the mentor variable being statistically significant.

With job satisfaction as the outcome and sense of belonging and the availability of a non-TEE professional learning community as the predictor, the model accounted for 11% of the variance with both variables being statistically significant predictors. For teachers' persistence intentions, the model predicted 48.7% of the variance, with job satisfaction, sense of belonging and membership in ACTE as statistically significant predictor variables.

5. DISCUSSION

The analyses outlined above provided several insights about the impact of mentoring on early-career technology and engineering teachers. First, it is clear that many different opportunities to participate in mentoring activities exist for these teachers; however, some tend to be more

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commonly available than others (see Table 1). For example, most participants reported that attending professional conferences was an available option for them, while nearly half also reported having access to resources produced by professional organizations, such as curriculum. Nearly half of respondents reported that a professional learning community (PLC) of other technology and engineering teachers in the same grade band was available, and more than a third of participants reported that they had access to a PLC consisting of teachers from different content areas. Conversely, fewer teachers reported that they had access to either a formal or informal mentor, whether in or out of their content area.

The apparent lack of availability of individual mentors among these participants is concerning since, when participants were asked to identify which mentoring opportunities they felt were most effective (see Table 3), having an assigned mentor within their own content area, was perceived as the most effective support out of all of the mentoring opportunities investigated in this study. Formal mentors were rated more highly than informal mentors, and mentors in the same content area were rated as more effective than those outside technology and engineering education. In addition, attendance at professional conferences, professional learning communities consisting of teachers in the same content area (whether in the same or different grade bands), and resources provided by professional educator associations were also perceived as more effective supports.

Curiously, while participants tended to have strong opinions about which mentoring opportunities were most effective in supporting them as early-career technology and engineering teachers, these did not necessarily align with findings relating the availability of mentoring opportunities with participants actual scores on measures of sense of belonging, job satisfaction, and persistence intentions. As shown in Table 4, mean scores in all three constructs were fairly consistent across different mentoring opportunities with only a few exceptions (e.g., participants who were involved in professional associations through conferences or resources scored somewhat higher on persistence intentions). However, when participants who noted no availability of any of the mentoring opportunities, mean scores in job satisfaction were notably lower.

This apparent disconnect between participants perception of the effectiveness of different interventions and the actual relationship with their sense of belonging, job satisfaction, and persistence intentions was further borne out in the regression analysis. None of the highest-rated mentoring opportunities emerged as statistically significant predictors in the regression models for any of the three constructs, while some mentoring activities that were rated lower by the participants (e.g., non-TEE PLCs) were statistically significant predictors. There are some possibilities which could help explain this disconnect. First, obtaining a sufficient sample size for a robust regression analysis was a challenge despite the efforts undertaken by the researchers to reach many early-career TEE teachers across the United States. This could have resulted in data that was biased due to the composition of the sample (notably, the unexpectedly high percentage of female participants). Second, the few minutes taken to fill out an online survey may not have afforded time for participants to recall situations where they were effectively mentored through all the activities presented in the survey.

Despite challenges, the regression analysis did offer some support for the conceptual framework chosen for this study. At least some mentoring activities did support teachers' sense of belonging and job satisfaction. Job satisfaction was also predicted in part by sense of belonging, and both

job satisfaction and sense of belonging were found to be significant predictors of persistence intentions. This suggests that, challenges notwithstanding, this research is on the right track in terms of investigating how mentoring can be an effective tool to retain early-career technology and engineering teachers.

6. CONCLUSIONS

The retention of early-career technology and engineering teachers is a major issue within technology and engineering education, both within the United States and elsewhere. The purpose of this study was to investigate the impact of mentoring on the sense of belonging, job satisfaction, and persistence intentions of early-career TEE teachers, with the hope that this research will inform further research in this area as well as better practices at the national, state, and local level with respect to programs targeted to retain technology and engineering teachers beyond the early-career phase. Several implications for further research and best practices emerged from this research.

6.1. Implications for further research

One of the challenges in conducting this study was obtaining a large sample for analysis. Further quantitative research in this area should perhaps take a different approach to sampling procedures, such as narrowing the focus to an individual state/province or collecting data at professional conferences. Online surveys are easily passed over in the busy life of a teacher, particularly early in their career. Obtaining a larger sample size with better data collection strategies would allow for more reliable findings regarding best-practices.

Further qualitative or mixed-methods research could focus on narrowing down to specific mentoring practices that are found to be effective, and identifying the characteristics that make these practices effective. For example, studies should be conducted which investigate what types of interactions between an individual mentor and early-career TEE teacher are most helpful in supporting the novice teacher, or what characteristics in a mentor are most impactful. This could also be done with respect to professional learning communities, beyond just looking at PLC composition but how PLCs among technology and engineering teachers can best be structured and implemented to support teachers early in their careers. Finally, research should be conducted to identify what supports offered by professional associations, both at and outside of conferences, are most effective in encouraging a sense of belonging.

6.2 Implications for practice

Some findings in this study can be of immediate use to administrators who oversee the development of early-career technology and engineering education teachers, such as district-level Career & Technical Education directors, individual building administrators, and stakeholders at the state level such as content-area specialists. First, it appears that early-career technology and engineering teachers strongly perceive that having an assigned mentor who teaches in their content area is the most effective support for their development. While many technology and engineering teachers in the United States are the only teacher in their school who teaches this

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content, district-level administrators could easily implement a program assigning another teacher from a nearby school who teaches the same content as a mentor for an early-career teacher. It is critical that early-career technology and engineering teachers have access to at least one individual mentor. A similar approach could hold true for implementing content-area PLCs that bring technology and engineering teachers together regularly from across an entire school district, or a portion thereof to share pedagogical strategies and curriculum.

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