Research Article

The Relationship Between Teacher Efficacy, Writing Apprehension, and Writing to Learn Using Structural Equation Modeling

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Structured Abstract

- **Background:** In the United States, students continue to struggle in the core content areas of language arts, social studies, math, and science. To improve student content learning, writing to learn (WTL) across the content emerged as a potential mechanism. However, few studies examine the extent to which secondary content teachers are ready and willing to implement WTL to improve student learning in those content areas. This study uses structural equation modeling (SEM) to examine how much teaching efficacy, writing apprehension, years teaching, grade level, and content area contribute to teachers' efficacy of using WTL and their perception of the relevance of WTL to their content areas.
- **Literature Review:** The review of literature first examines the history of WTL and then provides an overview of empirical research into the effects of WTL on student content area learning. The review then examines the literature on specific strategies to use WTL in content areas of social studies, science, and mathematics, and the evidence of their effectiveness in the empirical research. It then examines the limited literature on teacher preparedness to use WTL and the association between teacher longevity and WTL implementation. This section ends with an overview of the theory of self-efficacy, focusing on self-efficacy of teaching, self-efficacy of writing, and writing apprehension.
- **Research Questions:** This paper answers the following research questions:

1. Do the teaching writing to learn scale (TWTLS), writing apprehension scale (WAS), and teaching efficacy scale (TES) show evidence of measurement validity and reliability?
2. How do teaching efficacy, writing apprehension, grade level, years teaching, and teacher content area contribute to teachers' perceived relevance and efficacy of using WTL strategies in their classrooms?

- **Methodology:** A total of 6,080 surveys were sent to public secondary teachers of grades 6 through 12 in a mountain west state and 377 responded. The latent factor of teaching efficacy came from the teaching efficacy scale (TES; Woolfolk & Hoy, 1990), the writing apprehension scale (WAS) came from Daly and Miller (1975), and the teaching writing to learn scale (TWTLS) came from Perkins (2014).

  Exploratory factor analysis was conducted on the TES and WAS, generating two factors for each scale. The TWTLS consisted of two factors derived from previous research. Each of the three scales (TWTLS, TES, and WAS) were loaded in separate confirmatory factor analysis (CFA) models where fit indices were examined. This informed a final six-factor model to be used for the SEM. Internal consistency reliability was tested using Cronbach's Alpha and McDonald's Omega.

  Bivariate regression analysis and analysis of variance (ANOVA) were conducted to test the convergent validity of the latent factors and the observed variables of grade level, years teaching, and content on the factors of the WTLS.

  Finally, two structural equation models were conducted to address the research questions. The first SEM examined the direct effects of the latent factors of the TES and WAS as well as the observed variable of content area. The second SEM tested the indirect effects of content area as a mediator variable on the model. Both SEM models were tested for fit.

- **Results:** The individual CFAs for TES, WAS, and TWTLS yielded final models with acceptable fit. The final six-factor CFA that incorporated all scales also showed acceptable fit. Measures of reliability also showed strong evidence of internal consistency of all the scales. The results of the bivariate regression analyses showed evidence of concurrent validity between the factors of the WAS and the factors of the TWTLS. Years teaching and the factors of the TES showed low correlations with the TWTLS. The results from the ANOVA show statistically significant differences with larger than typical effect sizes in average scores of each TWTLS and WAS factor. The results of the SEM show that

writing apprehension and content area predict the factors of the TWTLS, with content area acting as a mediator variable.

- **Discussion:** The final model and all the scales showed evidence of validity and reliability. The results of the ANOVAs, bivariate regressions, and the structural equation models suggest that writing apprehension and content areas affect teachers' perceived relevance of writing in their classrooms as well as their efficacy in using WTL in their content areas. Further, content area appears to act as a mediator variable, suggesting an indirect effect between writing apprehension and the factors of the TWTLS.
- **Conclusion:** These results suggest that effectively implementing WTL across content may relate to teachers' apprehension to write. Teachers with more apprehensiveness to write may choose undergraduate studies that require less writing and thus end up teaching those content areas. These findings parallel other research that report variability in preparation to use WTL strategies by content area. However, there is evidence of writing's positive effects on content areas. Therefore, more research should empirically test the effects of WTL on content area to inform practice in teacher training programs.

Keywords: writing across the curriculum, writing analytics, writing to learn, structural equation modeling

1.0 Background

Students in the United States continue to struggle in the core academic areas, which include social studies, science, math, reading, and writing. According to the National Association of Educational Progress (NAEP; 2015a, 2015b), in 2015, 25 percent of 12th grade students scored proficient or higher in mathematics, 37 percent scored proficient or higher in reading, and 22 percent scored proficient or higher in science. In addition, in 2018, 24 percent of eighth grade students scored proficient or higher in civics, and 15 percent were at or above proficient in U.S. History (NAEP, 2018a, 2018b).

Beginning in the 1970s, much conversation began to center around using writing to learn (WTL) across the content (or writing across the curriculum), hypothesizing that writing may act as a way not only to improve student performance in writing, but may also help students in their content areas (Grisham & Wolsey, 2005; Maxwell, 1996; Mendelman, 2007; Monroe & Troia, 2006; Perkins, 2014; Richardson, 2008).

Little research measures the extent to which teachers may be ready and willing to use writing in content areas outside of English/language arts, and how their measured readiness to use WTL correlates with other aspects of teaching. Therefore, the purpose of this study is to examine the extent to which writing apprehension, self-efficacy of teaching, grade level, years teaching, and content area predict secondary teachers' readiness to use writing to learn in the core academic content areas. First, this study examines the measurement validity of the teaching writing to learn scale (TWTLS; Perkins, 2014), the writing apprehension scale (WAS; Daly & Miller, 1975), and the teachers' sense of efficacy scale (TES; Gibson & Dembo, 1984; Woolfolk & Hoy, 1990). Then, this study examines the relationship between the writing apprehension scale and the teachers' sense of efficacy scale, teacher content area, years teaching, and grade level with the factors in the TWTLS.

2.0 Literature Review

The idea that students should be well-rounded in multiple content areas dates to ancient Greece with philosophers like Plato ("The Republic," 1998) and Aristotle (Barnes & Kenny, 2014). Those ideas rematerialized during The Enlightenment with philosophers such as Locke (1779) and continued into the early 20th century with thinkers such as Dewey (1897). All these thinkers believed in some combination of a well-balanced education including rhetoric, the arts, mathematics, oratory, and other subjects. This idea continued into the 20th century when content areas were compartmentalized, mirroring the industrialization of Western civilization (Boers, 2007). As the industrial model grew, it became desirable for students to be more specialized. Time was standardized and subjects were compartmentalized (O'Brien et al., 1995). By the end of the 20th century with the No Child Left Behind Act (2001), the use of standardized assessment in specific content areas began to dominate the kindergarten through 12th grade (K-12) education system.

2.1 Writing and Academic Content Areas

In the late 1970s and early 1980s, researchers began to examine ways in which to incorporate writing in academic content areas (Ackerman, 1993, O'Brien et al., 1995). Some authors provided specific strategies to incorporate writing (Fulwiler, 1982; Martin, 1976), while others began to explore the idea that writing can be used to instigate learning in multiple academic content areas outside of English or language arts (Freisinger, 1982; Britton et al., 1975). By the late 1980s into the 1990s, researchers began to directly explore the use of writing as a tool for learning material other than writing itself, or WTL (Fulwiler, 1982; Young & Fulwiler, 1986). Currently, organizations such as the National Writing Project (NWP), the Writing Across the Curriculum (WAC) Clearinghouse, and the National Council of Teachers of English (NCTE) generate reports, books, articles, and guides on writing in content areas (National Writing Project, 2012; National Council of Teachers of English, 2011, *WAC Clearinghouse Home - The WAC Clearinghouse*, 2021).

The literature on writing in content areas makes a distinction between writing to communicate (WTC) and writing to learn. WTC is concerned with the quality of a writing artifact (Tynjala et al., 2001), whereas WTL uses the writing process to assist with student learning of specific content materials, emphasizing the writing product less than the process (Applebee, 1984; Bazerman et al., 2005).

Limited literature examines the effects of using WTL across the content areas. Johnson (1991) and Kasparek (1993) studied the effects of using writing on secondary (grades 6-12) student content performance. Bangert-Drowns et al. (2004) conducted a metanalysis on 48 articles and found a small pooled effect size of .17 on the effects of time to write on college content area improvement (95% confidence interval between .11 and .22). Of the 48 articles pulled, 12 showed negative effects of WTL on content learning. Recently, a metanalysis by Graham et al. (2020) reviewed 56 experimental or quasi-experimental studies published between 1998 and 2017 that examined the effects of WTL on social studies, science, and math. Of the 56 studies examined, 24 were peer-reviewed and the rest were dissertations. The studies were vetted for several criteria for rigor including features such as attrition, evidence of measurement reliability, statistical control of pretest scores, and absence of ceiling effects in scores. They also did not use grades as measures. Overall, WTL had a pooled size (g) of .30. Mediator analysis indicated little difference between the effects on math, science, and social studies, as all had pooled effect sizes around .30.

2.2 Strategies to Improve Content Areas With WTL

Much of the literature on WTL is informative and practitioner-based, written for teachers who want to implement writing in their classrooms. Other research does provide empirical evidence of intervention effectiveness. For mathematics, Maxwell (1996) recommends teachers use vocabulary journals and journals about the process of learning mathematics, and have students write about the process of solving problems or explain mathematical concepts. Johnson (1991) found that staff development on WTL resulted in an increase in posttest algebra scores. Kasparek (1993) had mixed results on WTL on algebra performance. More recently, Braun (2014) provides ways to use expository, critical, and creative writing in mathematics. Hines et al. (2016) found that the use of expressive writing may increase math anxiety, though the results were mixed, with results differing between anxiety scales. Limin and Hall (2018) present ideas for using writing in mathematics, with samples from preservice teachers.

In science, like math, much literature provides examples of how to use writing to improve content, but few provide evidence of the effects. Schickore (2008) advocates for the use of journals where students can learn vocabulary and write about their experiences with the scientific process or the process of learning science. Dallacqua and Peralta (2019) give an example of using comics to increase science outcomes and Scott and Shazia (2020) show how to use WTL to help students evaluate science web resources. These examples provide pedagogical ideas, but the ideas are not empirically studied. Other research examines the strategies' effects on student science outcomes. Bernacki et al. (2016) used comparison group design and found that the use of science diaries increased student science interest in the treatment group. Telesca et al. (2020) found a metalinguistic activity on eighth grade urban students improved comparisons and contrasts. Wright et al. (2019) found that WTL interventions helped avoidant students and students with visual learning preferences improve in their science writing. Willey (1988) found the use of writing to improve student science attitudes and performance.

Social science offers several opportunities to implement WTL. Cantrell et al. (2000) offer several strategies to use writing in the social studies classroom, including brochures, creative writing as historical characters or events, as well as journaling. Boscolo and Mason (2001) studied a WTL intervention on a history class that also integrated science. The study consisted of 32 fifth grade students, 12 of whom made up the control group. Analysis of variance (ANOVA) tests indicated that the treatment group scored higher than the control group on historical understanding. Morphy (2013) found that students who used a WTL activity requiring outlining and contrasting demonstrated greater knowledge about Frederick Douglas than traditional composition students who just used vocabulary, rereading, and rewriting activities.

2.3 Content Teachers' Preparedness to Use WTL

Ray et al. (2016) and Gillespie et al. (2014) indicate that the use of WTL by teachers varies depending on the content areas of language arts, social studies, science, and math. Gillespie et al. (2014) analyzed 211 surveys from ninth to twelfth grade teachers. Of the respondents, 47 percent reported minimal or no formal preparation to use WTL in their content area, 23 percent reported receiving preparation to use WTL in college, 24 percent reported adequate preparation, and only six percent reported extensive preparation. In addition, content appeared to be a mediator variable as language arts teachers were more likely to report preparedness, followed by social studies, then science, then math.

Ray et al. (2016) analyzed 102 survey responses from sixth to ninth grade teachers of those core content areas on the writing strategies they implemented in their classrooms. The teachers reported that they taught 46.66 percent of the writing to learn strategies surveyed. However, use of the strategies was a function of content area, with language arts teaching a greater percentage, followed by social studies. Like in Gillespie et al.'s (2014) study, the teachers in Ray et al.'s (2016) study reported minimal to no formal college preparation to use writing in their content area.

2.4 Longevity and Openness to New Teaching Methods

Some research examines the relationship between teacher longevity and trying new teaching practices in their classrooms. Russel et al. (2007) found that the way technology is defined varies by an individual's age, but not so much on its use. Clotfelter et al. (2007) found that teacher longevity correlated with student outcomes. Admiraal et al. (2017) found that teachers with more longevity exhibited fewer positive attitudes to technology than newer teachers, but this study only examined technology attitudes and not general attitudes towards changing their practices not related to technology. No research that examines teachers changing their teaching to include WTL activities was found.

2.5 Self-Efficacy

According to Bandura (1977), self-efficacy is a person's confidence that they can successfully complete a task. Self-efficacy, which resides in the broader frame of social cognitive theory, purports that cognitive processes change behavior and behavior is influenced by three determinants: (a) personal determinants in the individual's social world, (b) environmental determinants imposed on the individual, and (c) the individual's behaviors and subsequent consequences (Bandura, 1977). According to Bandura (2012), mastery experience, social modeling, social persuasion, and physical or emotional arousal act as sources of a person's expectation to successfully complete a task. Of these four sources of efficacy expectations, mastery experience, which is when the task is completed successfully, is the most powerful influencer of future efficacy expectations. Social modeling (vicarious reinforcement) occurs when the individual observes a similar person experience mastery and is the second most powerful influencer of efficacy expectation. Social persuasion is the third most powerful influencer and occurs when others communicate or encourage the individual towards the task. Finally, the least effective approach to efficacy expectation is emotional or physical arousal, when emotions that arise push or encourage the individual towards the task (Bandura, 1977).

Self-efficacy has several decades of empirical research supporting its influence on outcomes and behaviors. Much research in self-efficacy began with phobia interventions and found that people are more likely to act towards a phobia behavior when their self-efficacy is higher and that self-efficacy negatively correlates with fear arousal (Bandura, 1982; Bandura & Adams, 1977). More recent research finds that self-efficacy positively correlates with goals and motivations (Bandura, 1989), working through stress (Bandura & Locke, 2003), and job satisfaction (Canrinus et al., 2012; Caprara et al., 2006; Johnson, 2010; Scwarzer, 2008) and negatively correlates with anxiety (Akin & Kurbanglu, 2011; Czerniak, 1989; Goodman & Cirka, 2009) .

2.5.1 Teaching Self-Efficacy

Self-efficacy is a task-specific concept and thus requires an action or behavior. Therefore, self-efficacy is often applied to a multiple of mastery tasks. One such task is teaching. Self-efficacy of teaching is the extent to which an educator feels as though they can successfully complete the tasks of teaching. Several scales have measured teaching efficacy using various items and approaches. These include work by Armor et al. (1976), Rose and Medway (1981), Guskey (1982), Dembo and Gibson (1985), Ashton (1984), Riggs and Enochs (1990), and Bandura (1977). Woolfolk Hoy (2020) exhibits several teaching self-efficacy instruments on her website.

2.5.2 Writing Self-Efficacy

Much research finds positive correlations between student self-efficacy and performance in science (Britner, 2002; Czerniak, 1989; Desouza et al., 2004; Meluso et al., 2012; Sayers, 1988), mathematics (Adeyemi, 2012; Champion, 2010; Clutts, 2011; Hackett, 1985; Hamilton, 2012;

Johnson, 2009; Sakiz, 2007; Sexton, 1987), social studies (Bercu, 2010; Fitchett et al., 2012; Gehlbach et al., 2008; Holt, 2010; Lyons-Wagner, 2011), and writing (Bruning et al., 2012; Pajares et al., 2000; Prat-Sala & Redford, 2012; Schunk & Swartz, 1993; Zimmerman & Bandura, 1994; Zimmerman & Kitsantas, 2002). Little research examines self-efficacy of teaching writing. Lavelle (2006) examined teacher self-efficacy of writing but did not connect it to teaching writing. Bowie (1996) found that non-writing teachers may lack confidence in teaching writing.

Writing apprehension is the extent to which a person avoids writing (Daly & Miller, 1975) and is thus related to writing self-efficacy. Research by Crumbo (1999), Pajares (1996, 2003), Pajares and Johnson (1993), and Pajares et al. (2007) find that writing apprehension negatively correlates with writing self-efficacy.

2.6 Gaps in the Literature

The empirical research on the effectiveness of using WTL to improve content area student learning is limited (Brewster & Klump, 2004). In addition, although much literature informs ways to implement WTL in the classroom, and often theorizes ways to integrate curricula, limited research beyond Ray et al. (2016) and Gillespie et al. (2014) examines the extent to which teachers have integrated WTL across the content, and little is known of the extent to which teachers are ready and comfortable with implementing WTL across the content. The meta-analyses by Bangert-Drowns et al. (2004) and Graham et al. (2020) illustrate that a search of two or more decades for empirical studies yields very few. Some literature examines educational change in general, much offers theory of method, but little research examines the relationship of longevity to changes in trying new teaching approaches, let alone longevity and the willingness to adapt WTL across the content. Other research shows that most teachers do not feel adequately trained to use writing in their content areas and are thus less likely to do so (Gillespie et al., 2014; Ray et al., 2016). Therefore, there is a need to measure teacher readiness to use WTL, validate the data collected from that measure, and then examine correlates of readiness to use WTL to help inform targeted interventions. Once teacher readiness to implement WTL is established and subsequently improved, it will be possible to explore the effects of using writing to improve student learning across the content areas.

3.0 Research Questions

One way to increase the use of WTL across the content is to provide educational training and professional development to train teachers and preservice teachers to use these strategies. To help better understand ways to implement these trainings, it is useful to identify factors that influence teachers' willingness to use WTL. This study uses structural equation modeling (SEM) to examine the relationship between the WAS, the TES, content area, and grade level with the TWTLS and addresses the following research questions:

1. Do the teaching writing to learn scale (TWTLS), writing apprehension scale (WAS), and teaching efficacy scale (TES) show evidence of measurement validity and reliability?
2. How do teaching efficacy, writing apprehension, grade level, years teaching, and teacher content area contribute to teachers' perceived relevance and efficacy of using WTL strategies in their classrooms?

4.0 Research Methodology

4.1 Sample

This research was submitted to the institution's institutional review board (IRB) and was expedited and then approved. A survey containing the WAS, TES, and TWTLS as well as questions about grade level and content area was sent to 6,080 secondary (6th through 12th grade) teachers in a mountain west state, and 377 responded to all the factors of the TWTLS; 157 responded to the TWTLS, WAS, and TES; and 172 responded to the factors of the TWTLS and the WAS. Teacher email addresses were obtained using publicly accessible school district websites. Teachers were only asked to respond to the survey items and the listed attributes. They were not asked to identify themselves, their schools, or their school districts. Therefore, the data were anonymous. This research uses the data from that survey.

A-priori power analyses for the bivariate correlations, ANOVAs, and SEMs were conducted to determine the minimal sample needed to obtain statistical power. The pwr package (Champely, 2020) was used to determine the minimum sample size needed for the bivariate correlation analyses and the ANOVAs. With a power level of .80, an r of .40, and a p of .04, the minimum sample for bivariate correlation was 46. For a one-way ANOVA with four groups, an effect size of .70, a p value of .05, and power of .8, the minimum sample per group was seven. To determine the sample size needed for the SEM, an a-priori power analysis was conducted using Soper's (2021) SEM sample size calculator, which examines the number of latent variables and the number of observed variables to calculate a minimum sample size. With .8 statistical power, the recommended sample size for the TWLS, WAS, and TES model was 156, and the minimum sample size for the TWTLS and the TES model was 166. The semPower package (Moshagen, 2020) was also used to calculate minimum sample size using degrees of freedom and a .80 level of statistical power given root mean square error of approximation (RMSEA) of .05, and found a minimum sample size requirement of 131 for the first SEM model using the TWTLS, TES, and WAS, and minimum sample size of 228 for the second SEM model using the TWTLS and WAS. The second model fell short of the second a-priori power analysis of sample size for a RMSEA of .05. The estimated statistical power for the sample of 172 with the second SEM model was .63. This will be addressed in the discussion.

Table 1 shows the characteristics of the sample. As shown in the table, most of the respondents were female (72.4%), taught grade 9 through 12 (55.5%), and taught science, math, English/language arts, or social studies (62.1%). Also shown in the table, many teachers taught more than one content area. Notably, some social studies teachers also taught English/language arts (4.8%), and some language arts teachers also taught remedial reading (2.9%).

Table 1

Demographic Variables of the Sample in Number and Percent

Demographic variable	*N*	Percent
Gender		
Male	104	27.6
Female	273	72.4
Grade Teaching		
6th grade	30	8.0
7th grade	28	7.4
8th grade	36	9.5
9th grade	6	1.6
10th grade	6	1.6
12th grade[a]	1	.3
More than one 6th-8th	58	15.4
More than one 9th-12th	196	52.0
Other	16	4.2
Teacher's Content Area		
Language arts[b]	64	17.0
Mathematics[b]	57	15.1
Science[b]	66	17.5
Social studies[b]	47	12.5
English as a second language (ESL)	8	2.1
Special Education (SPED)	17	4.5
Remedial reading	4	1.1
Consumer sciences	5	1.3
Fine art	4	1.1
Music	7	1.9
Physical education (PE)	4	1.1
Technology education	7	1.9
Mathematics and language arts	2	.5
ESL and language arts	4	1.1
Remedial reading and language arts	11	2.9
Mathematics and science	7	1.9
Social Studies and language arts	18	4.8
Science and social studies	7	1.9
Other	38	10.1

[a]*No teacher reported only teaching 11th grade.*
[b] *"Core" content areas used for SEM analyses*

4.2 Description of the Measures

The writing apprehension scale (WAS; Daly & Miller, 1975) consists of 25 items with two factors. One factor consists of items that directly express apprehension to write (e.g., "Taking a comprehension course is very frightening to me"); the other factor contains items that directly express positive tendencies towards writing (e.g., "Handing in a composition makes me feel good"). These positive items are reverse coded prior to analyses. The result is that the higher the apprehension score, the less likely the respondent is to engage in writing tasks. Daly and Miller (1975) used analysis of variance (ANOVA) with perceived communication requirements and anxiety as the dependent variables to provide evidence of validity (n=116). All 25 items of the original scale were included in the survey sent to participants of this study.

The teaching efficacy scale (TES; Gibson & Dembo, 1984; Woolfolk & Hoy, 1990) is made up of 19 items and consists of two factors. The first factor, personal teaching efficacy, consists of items such as "If parents would do more for their children, I could do more." The second factor, general teaching efficacy, consists of items such as "A teacher is very limited in what he/she can achieve because a student's home environment is a large influence on his/her achievement." All 19 items were included on the survey to participants of this study.

The teaching writing to learn scale (TWTLS) consists of six items on two factors derived from an exploratory factor analysis (EFA), followed by a confirmatory factor analysis (CFA) (Perkins, 2014). The first factor, perceived relevance, consists of items such as "On a scale from 1 to 10, this is how confident I am at integrating writing activities in my class to help students learn my content area." The second factor, self-efficacy of using writing, consists of items such as "When students write, it helps them to improve in my class." All these items were sent to participants in the study.

4.3 Analytic Approach

The data were extracted to Microsoft Excel, screened, cleaned, and imported into R (R Core Team, 2020) for analyses using the apaTables (Stanly, 2020), base (R Core Team, 2020), car (Fox & Weisberg, 2019), dplyr, (Wickham et al., 2020), lavaan (Rosseel, 2012), psych (Revelle, 2020), pwr (Champely, 2020), semPower (Moshagen, 2020), and stats (R Core Team, 2020) packages. Descriptive statistics, exploratory factor analyses, and confirmatory factor analyses were run in each separate instrument (WAS, TES, and TWTLS), then a CFA was run on all the scales to test the fit of the final model. ANOVA tests and Pearson's moment product correlation (r) were used to test criterion evidence and identify predictor and mediator variables for the SEM analyses.

4.3.1 Measures of Reliability

Cronbach's alpha (α) and McDonald's omega (ω) were used to measure the internal consistency reliability of all factors of the TWLS, WAS, and TES using the psych package on R (Revelle, 2020). Cronbach's alpha examines the internal consistency, or the relationship, of all the items of a latent variable (DeVellis, 2012). Alpha is used to measure inter-item covariance for each unit of composite variance, as shown in equation 1 (Raykov & Marcoulides, 2011).

$$\alpha = \frac{p}{p-1}\left[1 - \left(\frac{\sum_{i\neq j} Cov(X_i, X_j)}{S^2}\right)\right] \quad (1)$$

As shown in equation 2, McDonald's omega also measured the internal consistency of each scale using the factor loadings by estimating the ratio of true variance to observed variance (McDonald, 1999).

$$\omega = \frac{(\Sigma\hat{b}_{ik})^2}{(\Sigma\hat{b}_{ik})^2+\Sigma\hat{\theta}_{ik}} \quad (2)$$

4.3.2 Factor Analyses

The R psych package (Revelle, 2020) was used to conduct an EFA with an oblique rotation on the WAS and an EFA on the TES prior to conducting the CFAs. Oblique rotation is to be used when the underlying constructs are believed to correlate (DeVellis, 2012). The EFAs were loaded with the recommended number of factors from the original scales (Daly & Miller, 1975; Woolfolk & Hoy, 1990).

The lavaan package (Rosseel, 2012) was used to conduct the CFAs. Fit indices were determined by examining the Tucker-Lewis index (TLI), the comparative fit index (CFI), and the root mean square error of approximation (RMSEA). CFI and TLI are standardized indices, so evidence of fit is stronger when those values are closer to 1 (Hu & Bentler, 1998; Raykov & Marcoulides, 2011). RMSEA represents the misfit of the model for each degree of freedom. The smaller the RMSEA, the better the model fits (Raykov & Marcoulides, 2011). As shown in equations 3 to 5, fit indices are calculated by comparing the proposed CFA model to the null model. All indices use chi-square and degrees of freedom but are better indicators of fit than chi-square alone since it is sensitive to sample size.

$$RMSEA = \frac{\sqrt{\chi^2 - df}}{\sqrt{df(n-1)}} \quad (3)$$

$$CFI = \frac{[\chi^2(null)]-[\chi^2(proposed)]}{\chi^2(null)} \quad (4)$$

$$TLI = \frac{[\chi^2/df(null)]-[\chi^2/df(proposed)]}{\chi^2/df(null)} \quad (5)$$

After examining fit indices, item discrepancies, which examine the covariance of residuals, were used to determine item retention or removal. The matrix produces positive or negative values. Discrepancies $\geq |.1|$ indicate pairs of items that may account for lack of fit (McDonald, 1999).

4.3.3 Convergent Validity

Pearson's coefficient *r* was used to estimate the convergent validity of the two factors of the TWTLS by correlating them with the factors of the TES, the factors of the WAS, and teacher longevity (DeVellis, 2012; McDonald, 1999; Netemeyer et al., 2003; Raykov & Marcoulides, 2011). In addition, ANOVA was used to test for statistically significant difference in TWTLS factors and years teaching given teacher content area (English, social studies, science, or math) and level of school (middle [grades 6-8] or high [grades 9-12]).

4.3.4 Structural Equation Modeling

After testing the measurement validity of the six-factor model including the TES, WAS, and TWTLS, two structural equation models (SEMs) were conducted. SEM tests a "causal" model against a hypothesis. The model is typically derived from a theory of causal processes (Byrne, 2012). In the case of this study, the theoretical causal process is represented by each of the SEM models that examine the direct and indirect effects of the latent factors of the WAS and TES scales as well as the observed variables on the latent factors of the TWTLS. In SEM, latency is defined as concepts indirectly observed, often through the use of instruments (Byrne, 2012; Kline, 2016).

SEM not only tests the direct and indirect effects of latent and observed variables, but it also provides evidence of measurement validity as the SEM model is tested with the same fit indices as CFA, allowing the model to be assessed or corrected for measurement error. This is one distinction between SEM and regression techniques, which often assume the measurement tools to obtain variables contain no error (Byrne, 2012). Often, studies using traditional statistical techniques report internal consistency reliability, but make little mention of other aspects of measurement validity. In addition, SEM allows for the testing of indirect effects of latent and observed variables on an outcome in a causal model. There are few other statistical methods that allow for these types of analyses. For example, methods using the general linear model do not measure indirect effects (Byrne, 2012; Kline, 2016). Finally, SEM allows for the use of a mix of latent and observed variables in its modeling while still estimating measurement error (Byrne, 2012).

This study examined two SEMs. The first examined the direct relationship between the latent factors of TES and WAS and the effects of the observed variables on the latent factors of the TWTLS. The second model examined the indirect effects on the factors of the TWTLS using the observed variables as mediators.

5.0 Results

The statistical results consist of four general analytical activities. The first uses exploratory factor analysis to test the structure of the teaching efficacy scale and the writing apprehension scale. The second uses confirmatory factor analysis to test the theoretical structure of the teaching efficacy scale, writing apprehension scale, and teaching writing to learn scale for construct validity as well as the measures of internal consistency reliability. The third consists of tests of convergent and known-groups validity using Pearson's r coefficient and analysis of variance (ANOVA). The final analysis consists of two structural equation models. The first model examines the direct effects of the factors of the teaching efficacy scale and writing apprehension scale and content area on the factors of the teaching writing to learn scale, and the second model examines the indirect effects of the factors of the teaching efficacy scale and writing apprehension scale on the factors of the teacher writing to learn scale using teacher content area as a mediator variable. A summary of all statistical tests with the technical details is provided in each respective table.

5.1 Exploratory Factor Analyses

Table 2 shows the factor loadings of the teaching efficacy scale (Woolfolk & Hoy, 1990) and writing apprehension scale (Daly & Miller, 1975). The results of both exploratory factor analyses mirrored the way Perkins (214) designed their factor structures. Writing apprehension showed two factors: positive writing apprehension and negative writing apprehension. Teaching efficacy also showed two factors: personal teaching efficacy and external teaching efficacy. Items with low factor loadings were removed prior to conducting the confirmatory factor analysis. Exploratory factor analysis was not conducted on the teaching writing to learn scale as its structure was derived from Perkins (2014).

Table 2

Pattern Matrix of the EFA Mode for Writing Apprehension (Daly & Miller, 1978) and Teacher Efficacy (Gibson & Dembo, 1984; Woolfolk & Hoy, 1990)

Writing apprehension		
Item	**f1**	**f2**
1	**0.290**	
2	**0.270**	
3	0.610	
4		0.610
5		0.680
6	0.470	
7		0.650
8		0.410
9	0.700	
10	0.830	
11		0.440
12	0.690	
13		0.650
14	0.530	
15	0.860	
16		0.680
17	0.830	
18		0.570
19	0.720	
20	0.770	
21		0.770
22		0.850
23		0.460
24		0.530
25		0.580
Teacher efficacy		
Item	**f1**	**f2**
1		0.630
2		0.710
3		0.370
4		0.580
5	0.460	
6		0.470
7		0.380
8		0.390
9		**0.130**
10	0.750	
11	0.510	
12		**0.280**
13	0.580	
14	**0.300**	
15	0.440	
16		0.420
17	0.620	
18	0.780	
19	0.630	

5.2 Confirmatory Factor Analyses

While exploratory factor analysis is typically used as an inductive method to see how the items cluster, confirmatory factor analysis is a deductive method that tests the theoretical structure of an instrument (DeVellis, 2012; Raykov & Marcoulides, 2011). The theoretical structure of the writing apprehension scale and teaching efficacy scale was derived from the author's designs and each exploratory factor analysis, and the theoretical structure of the teaching writing to learn scale was derived from the author (Perkins, 2014). First, confirmatory factor analysis in *lavaan* (Rosseel, 2012; Rosseel, 2020) was used to test each scale separately. Each model was tested against a baseline one-factor model and against its previous model. As each model was tested, item discrepancies were examined and one or more pairs >|.1| were removed (McDonald, 1999).

Next, a final six-factor model was tested that combined all three scales given their individual confirmatory factor analysis results. Table 3 shows the results of all the models as well as their fit indices. The final model, which consisted of six factors with 19 items, showed acceptable fit and reliability indices. Table 4 shows the factor loadings and results from the internal consistency reliability analyses. Table 5 provides the descriptive statistics of each item by factor, and Appendix A gives the final items. The final six-factor model thus showed strong evidence of valid and reliable data and was later used in the structural equation models.

Table 3

Chi-Square (χ)^2, Degrees of Freedom (df), Change in Chi-Square ($\Delta\ \chi$)^2, RMSEA, CFI, and TLI values of each factor analysis for Writing Apprehension (Daly & Miller, 1978), Teacher Efficacy (Woolfolk & Hoy, 1990), and Readiness to Use WTL (Perkins, 2014)

Writing apprehension					
Model	**χ^2 (df)**	**$\Delta\ \chi^2$**	**RMSEA**	**CFI**	**TLI**
1 factor CFA	1108.2 (275)	N/A	.10	.77	.79
2 factor CFA with all items	703.08** (274)	405.13	.06	.88	.87
Final 2 factor CFA discrepant items removed	31.10** (19)	671.98	.04	.98	.973
Teaching efficacy					
1 factor CFA	885.51 (152)	N/A	.13	.49	.42
2 factor CFA with all items	408.92** (103)	476.59	.10	.76	.72
Final 2 factor CFA with discrepant items removed	25.09** (19)	383.83	.03	.99	.98
Readiness to use WTL					
1 factor CFA	809.66 (20)	N/A	.32	.70	.58
2 factor CFA with all items	70.17** (153)	739.49	.09	.98	.97
Final model for SEM including all scales' items					
1 factor CFA	1595.19 (209)	N/A	.16	.47	.41
3 factor CFA	1175.92** (206)	419.27	.14	.63	.58
6 factor CFA	261.64** (231)	914.88	.04	.97	.97
Final 6 factor CFA with discrepant items removed	141.35** (137)	119.68	.01	1.00	1.00

Note. *p <.05, ** p < .001 relating to comparison with the baseline model.

Table 4

The Estimated Factor Loadings (Estimate), the Standard Error (S.E.) of Each Loading, the Loading Divided by the Standard of Error (Est./S.E.), the Statistical Significance (p), Cronbach's Alpha (α) and McDonald's Omega (ω) of Each Item for Each Factor of Perceived Relevance, Efficacy of Using WTL, External Teaching Efficacy, Personal Teaching Efficacy, Positive Writing Apprehension, and Negative Writing Apprehension

	Estimate	S.E.	Est./S.E.	*p*	*α*	*ω*
Relevance of Writing						
Relevance of Writing 3	0.950	0.012	79.17	<.001	0.90	0.91
Relevance of Writing 4	0.931	0.013	71.62	<.001		
Relevance of Writing 5	0.813	0.024	33.88	<.001		
Efficacy of WTL						
Efficacy of WTL 1	0.937	0.011	85.18	<.001	0.94	0.95
Efficacy of WTL 2	0.963	0.009	107.00	<.001		
Efficacy of WTL 3	0.866	0.018	48.11	<.001		
External Teaching Efficacy						
Ext. Teaching Efficacy 18	0.814	0.036	22.61	<.001	0.78	0.80
Ext. Teaching Efficacy 17	0.688	0.043	16.00	<.001		
Ext. Teaching Efficacy 19	0.692	0.043	16.09	<.001		
Ext. Teaching Efficacy 13	0.597	0.049	12.18	<.001		
Personal Teaching Efficacy						
Pers. Teaching Efficacy 2	0.896	0.056	16.00	<.001	0.73	0.76
Pers. Teaching Efficacy 1	0.776	0.053	14.64	<.001		
Pers. Teaching Efficacy 6	0.405	0.059	6.86	<.001		
Positive Writing Apprehension						
Positive Writing Apprehension 9	0.69	0.041	16.83	<.001	0.79	0.79
Positive Writing Apprehension 17	0.838	0.032	26.19	<.001		
Positive Writing Apprehension 19	0.704	0.04	17.60	<.001		
Negative Writing Apprehension						
Negative Writing Apprehension 4	0.553	0.054	10.24	<.001	0.69	0.70
Negative Writing Apprehension 7	0.643	0.049	13.12	<.001		
Negative Writing Apprehension 13	0.778	0.043	18.09	<.001		

Table 5

Descriptive Statistics and Discrimination Scores for Final Model's Items

Item	Min	Max	x̄	S	DISCR
Relevance of Writing 3	1	6	5.20	1.22	0.52
Relevance of Writing 4	1	6	5.16	1.27	0.50
Relevance of Writing 5	1	6	4.94	1.39	0.51
Efficacy of WTL 1	1	10	7.61	2.10	0.66
Efficacy of WTL 2	1	10	7.75	2.11	0.68
Efficacy of WTL 3	1	10	7.64	2.24	0.59
Ext. Teaching Efficacy 13	1	4	2.64	0.78	0.19
Ext. Teaching Efficacy 17	1	4	3.05	0.66	0.16
Ext. Teaching Efficacy 18	1	4	3.10	0.61	0.27
Ext. Teaching Efficacy 19	1	4	2.86	0.69	0.22
Pers. Teaching Efficacy 1	1	4	3.08	0.58	0.11
Pers. Teaching Efficacy 2	1	4	2.90	0.64	0.21
Pers. Teaching Efficacy 6	1	4	2.58	0.68	0.17
Positive Writing Apprehension 9	1	4	2.38	0.98	-0.19
Positive Writing Apprehension 17	1	4	2.22	0.81	-0.23
Positive Writing Apprehension 19	1	4	1.92	0.67	-0.15
Negative Writing Apprehension 4	1	4	1.65	0.73	-0.15
Negative Writing Apprehension 7	1	4	1.77	0.70	-0.16
Negative Writing Apprehension 13	1	4	1.77	0.74	-0.17

5.3 Correlations and Difference Tests

Correlation analysis and ANOVA were used to test how the factors of each scale correlated with each other and to see how the factors of the scale and years teaching differed given teachers' content areas. Specific statistical results are provided in the tables, but a summary is given here.

First, the factor of perceived relevance of writing on the teaching writing to learn scale showed a positive correlation with efficacy of teaching writing, but negative correlations with positive and negative writing apprehension. Perceived relevance did not show a statistically significant correlation with either of the teaching efficacy factors and showed a low positive correlation with years teaching. The other factor of the teaching writing to learn scale showed similar results. This means that both factors of the teaching writing to learn scale negatively correlate with both factors of writing apprehension. In other words, as writing apprehension increases (or teachers are less likely to write), teachers are less likely to see writing as relevant to their content area and are less likely to be efficacious about using writing in their content areas.

Table 6

Minimum, Maximum, Means (x̄), Standard Deviations (σ), and correlations (r) of Perceived Relevance of WTL (Relevant), Self-Efficacy of Teaching WTL (WTLE.), External Teaching Efficacy (ETE), Personal Teaching Efficacy (PTE), Positive Writing Apprehension (PWA), Negative Writing Apprehension (NWA), and Years Teaching (YearsTeach)

Variable	Min	Max	x̄	σ	1	2	3	4	5	6
1. Relevant	3	18	15.29	3.55						
2. WTLE	3	30	23.00	6.11	.49**					
3. ETE	4	16	11.65	2.12	.00	.15*				
4. PTE	3	12	8.56	1.53	.02	.11	.13*			
5. PWA	3	12	6.52	2.05	-.36**	-.43**	-.09	.08		
6. NWA	3	11	5.19	1.71	-.26**	-.38**	-.10	-.09	.52**	
7. YearsTeach	1	26	12.71	7.90	-.12*	.15**	.05	-.08	-.11	-.00

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

Next, ANOVA was used to see if there was a statistically significant difference in all factors of writing apprehension, teaching efficacy, and the teaching writing to learn scale as well as years teaching given a secondary teacher's content area. This resulted in 14 ANOVAs, each with omnibus tests and post-hoc tests. Tukey was used to adjust the critical alpha to control for family-wise error on the pairwise post-hoc tests, and Cohen's *d* was used to examine effect sizes (Leech et al., 2011). Tables 7 and 8 give the results of each of the ANOVAs, including the sum of squares, degrees of freedom, mean squares, *F* statistics, *p* values, and partial η^2 omnibus effect sizes. Table 9 gives means and standard deviations. Table 10 gives the pairwise differences in mean with 95 percent confidence intervals and Cohen's *d* effect sizes.

Table 7

Fixed Effects ANOVA Results for Perceived Relevance of Writing, Self-Efficacy of Teaching WTL, External Teaching Efficacy, Personal Teaching Efficacy, Years Teaching, Positive Writing Apprehension, and Negative Writing Apprehension Given Content Area (Math, Science, Social Studies, or Math) and Level of School (Middle or High)

Predictor	Sum of squares	*df*	Mean square	*F*	*p*	partial η^2
Perceived relevance of writing by content (math, science, social studies, or English)						
(Intercept)	20199.52	1.00	20199.52	3212.23	0.00	
Content	982.18	3.00	327.39	52.06	0.00	0.40
Error	1446.31	230.00	6.29			
Perceived relevance of writing by level of school (middle or high)						
(Intercept)	35869.90	1.00	35869.90	2915.69	0.00	
Level of school	0.70	1.00	0.70	0.06	0.81	0.00
Error	4416.55	359.00	12.30			
Efficacy of using writing by content area						
(Intercept)	48180.25	1.00	48180.25	2169.10	0.00	
Content	4202.11	3.00	1400.70	63.06	0.00	0.45
Error	5108.78	230.00	22.21			
Efficacy of using writing by level of school						
(Intercept)	83989.01	1.00	83989.01	2206.10	0.00	
Level of school	99.18	1.00	99.18	2.61	0.11	0.01
Error	13667.61	359.00	38.07			
Years teaching by content area						
(Intercept)	9677.64	1.00	9677.64	159.21	0.00	
Content	108.44	3.00	36.15	0.59	0.62	0.01
Error	13980.95	230.00	60.79			
Years teaching by level of school						
(Intercept)	22711.61	1.00	22711.61	366.68	0.00	
Level of school	30.60	1.00	30.60	0.49	0.48	0.00
Error	22236.12	359.00	61.94			
Teaching efficacy (external) by content						
(Intercept)	5848.20	1.00	5848.20	1288.78	0.00	
Content	5.31	3.00	1.77	0.39	0.76	0.01
Error	766.88	169.00	4.54			
Teaching efficacy (external) by level of school						
(Intercept)	15275.57	1.00	15275.57	3473.88	0.00	
Level of school	1.32	1.00	1.32	0.30	0.59	0.00
Error	1156.48	263.00	4.40			

Table 7 (Continued)

Predictor	Sum of squares	*df*	Mean square	*F*	*p*	partial *η*2
Teaching efficacy (personal) by content						
(Intercept)	3345.42	1.00	3345.42	1526.66	0.00	
Content	7.86	3.00	2.62	1.20	0.31	0.02
Error	370.34	169.00	2.19			
Teaching efficacy (personal) by level of school						
(Intercept)	8857.29	1.00	8857.29	3910.93	0.00	
Level of school	24.20	1.00	24.20	10.69	0.00	0.04
Error	595.63	263.00	2.26			
Writing apprehension (positive) by content						
(Intercept)	1383.51	1.00	1383.51	372.61	0.00	
Content	140.36	3.00	46.79	12.60	0.00	0.18
Error	623.80	168.00	3.71			
Writing apprehension (positive) by level of school						
(Intercept)	4943.62	1.00	4943.62	1140.72	0.00	
Level of school	0.14	1.00	0.14	0.03	0.86	0.00
Error	1144.12	264.00	4.33			
Writing apprehension (negative) by content						
(Intercept)	965.30	1.00	965.30	378.17	0.00	
Content	59.87	3.00	19.96	7.82	0.00	0.12
Error	428.83	168.00	2.55			
Writing apprehension (negative) by level of school						
(Intercept)	2996.25	1.00	2996.25	1023.72	0.00	
Level of school	1.29	1.00	1.29	0.44	0.51	0.00
Error	772.68	264.00	2.93			

Table 8

Means and Standard Deviations of Perceived Relevance of Writing, Efficacy of Using Writing, Years Teaching, External Teaching Efficacy, Personal Teaching Efficacy, Positive Writing Apprehension, and Negative Writing Apprehension on Content Area (Math, Science, Social Studies, English/Language Arts (LA), and Level of School (Middle or High)

Level	*n*	$\bar{x}$	*S*
Perceived relevance of writing by content area**			
English/LA	64	17.77	0.96
Social studies	47	16.30	2.73
Science	66	15.58	2.58
Math	57	12.19	3.31
Perceived relevance of writing by level of school			
Middle school	152	15.36	3.42
High school	209	15.27	3.57
Efficacy of using writing by content area**			
English/LA	64	27.44	2.94
Social studies	47	23.68	3.72
Science	66	21.30	5.18
Math	57	15.86	6.24
Efficacy of using writing by level of school			
Middle school	152	23.51	5.96
High school	209	22.44	6.32
Years teaching by content area			
English/LA	64	12.30	8.02
Social studies	47	12.96	7.77
Science	66	11.08	7.04
Math	57	11.74	8.37
Years teaching by level of school*			
Middle school	152	12.22	7.77
High school	209	12.81	7.94
Teaching efficacy (external) by content			
English/LA	45	11.40	1.81
Social studies	36	11.61	1.96
Science	45	11.16	2.59
Math	47	11.55	2.04
Teaching efficacy (external) by level of school			
Middle school	112	11.68	2.19
High school	153	11.54	2.03

Table 8 (Continued)

Level	*n*	x̄	*S*
Teaching efficacy (personal) by content			
English/LA	45	8.62	1.45
Social studies	36	8.28	1.49
Science	45	8.62	1.34
Math	47	8.15	1.63
Teaching efficacy (external) by level of school**			
Middle school	112	8.89	1.54
High school	153	8.28	1.48
Writing apprehension (positive) by content**			
English/LA	47	5.43	1.75
Social studies	38	6.58	1.54
Science	46	7.20	1.96
Math	41	7.83	2.35
Writing apprehension (positive) by level of school			
Middle school	115	6.56	2.07
High school	151	6.51	2.09
Writing apprehension (negative) by content**			
English/LA	47	4.53	1.52
Social studies	38	5.24	1.68
Science	46	5.11	1.43
Math	41	6.17	1.77
Writing apprehension (negative) by level of school			
Middle school	115	5.10	1.81
High school	151	5.25	1.63

Note. *, ** = p <.05, p <.001 respectively, given the results from the ANOVA test.

Table 9

Post Hoc Pairwise Comparisons (Tukey) Including Difference in Mean, Effect Size, and 95% Confidence Intervals of the Mean Differences

Pairwise effects	x̄ diff.	Lower bound	Upper bound	*p*	Effect size (*d*)
Perceived relevance of writing					
Social studies to English	-1.47	-2.71	-0.22	.010	-0.72
Science to English	-2.19	-3.33	-1.05	<.001	-1.13
Math to English	-5.57	-6.75	-4.39	<.001	-2.29
Science to social studies	-0.72	-1.96	0.52	.430	-0.13
Math to social studies	-4.10	-5.38	-2.83	<.001	-1.35
Math to science	-3.38	-4.56	-2.21	<.001	-0.50
Efficacy of using writing					
Social studies to English	-3.76	-6.10	-1.41	<.001	-1.21
Science to English	-6.13	-8.27	-3.99	<.001	-1.46
Math to English	-11.58	-13.80	-9.36	<.001	-2.37
Science to social studies	-2.38	-4.71	-0.05	.040	-0.26
Math to social studies	-7.82	-10.22	-5.42	<.001	-1.73
Math to science	-5.44	-7.65	-3.24	<.001	-1.05
Positive writing apprehension					
Social studies to English	1.15	0.06	2.24	.030	0.70
Science to English	1.77	0.73	2.81	<.001	0.95
Math to English	2.40	1.34	3.47	<.001	1.16
Science to social studies	0.62	-0.48	1.71	.460	0.35
Math to social studies	1.25	0.12	2.38	.020	0.63
Math to science	0.63	-0.44	1.71	.420	0.29
Negative writing apprehension					
Social Studies to English	0.70	-0.20	1.61	.108	0.44
Science to English	0.58	-0.28	1.44	.310	0.39
Math to English	1.64	0.75	2.52	<.001	0.99
Science to social studies	-0.13	-1.04	0.78	.980	-0.08
Math to social studies	0.93	0.00	1.87	.050	0.54
Math to science	1.06	0.17	1.95	.010	0.66

Table 10

Standardized and Unstandardized Factor Loadings (EST), Standard Errors (SE), z Statistics, and p Values for the SEM Direct Effects Model

	Standardized					Unstandardized			
Factor and item	**EST**	**SE**	***z***	***p***		**EST**	**SE**	***z***	***p***
Relevance of Writing									
Relevance of Writing 3	0.87	0.03	26.70	<.001		1.00			
Relevance of Writing 4	0.87	0.03	26.62	<.001		0.97	0.07	14.75	<.001
Relevance of Writing 5	0.87	0.07	12.65	<.001		1.24	0.11	10.82	<.001
Efficacy of WTL									
Efficacy of WTL 1	0.88	0.03	26.34	<.001		1.00			
Efficacy of WTL 2	0.96	0.02	54.78	<.001		1.16	0.07	17.23	<.001
Efficacy of WTL 3	0.91	0.03	36.05	<.001		1.12	0.08	13.39	<.001
Ext. Teaching Efficacy									
Ext. Teaching Efficacy 13	0.59	0.09	6.83	<.001		1.00			
Ext. Teaching Efficacy 17	0.66	0.10	6.72	<.001		1.00	0.22	4.51	<.001
Ext. Teaching Efficacy 18	0.85	0.08	10.92	<.001		1.14	0.25	4.49	<.001
Ext. Teaching Efficacy 19	0.68	0.09	7.75	<.001		1.00	0.20	4.90	<.001
Pers. Teaching Efficacy									
Pers. Teaching Efficacy 1	0.64	0.08	7.78	<.001		1.00			
Pers. Teaching Efficacy 2	0.97	0.08	12.14	<.001		1.69	0.32	5.21	<.001
Pers. Teaching Efficacy 6	0.44	0.09	4.80	<.001		0.81	0.18	4.41	<.001
Positive Writing Apprehension									
Pos. Writing Apprehension 9	0.72	0.05	13.48	<.001		1.00			
Pos. Writing Apprehension 17	0.86	0.05	18.06	<.001		0.96	0.10	9.42	<.001
Pos. Writing Apprehension 19	0.69	0.06	11.82	<.001		0.66	0.08	8.17	<.001
Negative Writing Apprehension									
Neg. Writing Apprehension 4	0.63	0.08	8.17	<.001		1.00			
Neg. Writing Apprehension 7	0.64	0.09	7.01	<.001		1.00	0.24	4.12	<.001
Neg. Writing Apprehension 13	0.69	0.09	8.05	<.001		1.18	0.19	6.18	<.001

These results show that perceived relevance of using writing and efficacy of using WTL show statistically significant differences between content areas with typical to large effect sizes. The further a teacher's content area is away from English, the less likely they are to find writing relevant and the less likely they are to feel confident about using WTL. Similar effects are found with writing apprehension. English teachers are the least apprehensive to write, find writing the most relevant to their content areas, and are less efficacious to use WTL. This is followed by social studies teachers, then science teachers, then math teachers. However, little to no difference is found between teacher content areas and the factors of teaching efficacy or years teaching.

5.4 Structural Equation Models

Next, a structural equation model (n=157) was conducted to examine the effects of the factors of the teaching efficacy scale, the writing apprehension scale, and teacher content area on the factors of the teaching writing to learn scale. The model loaded with acceptable fit (CFI=1.00, TLI=1.03, $RMSEA$<.001). Table 10 gives the standardized and unstandardized factor loadings of the structural equation model, and Table 11 gives the results of the model, which did not test indirect effects. Perceived relevance of writing correlated with writing to learn efficacy and teacher's content area. Efficacy of using writing to learn correlated with negative writing apprehension and teacher content area. In both cases, a negative correlation with content area indicates that the further a teacher is from teaching English, the lower their score. Figure 1 shows the path model. The predictors accounted for 54.3 percent of the variance in perceived relevance and 61.5 percent of the variance in WTL efficacy.

Figure 1

Standardized Regression Coefficients (β) of the SEM Model Examining Negative Writing Apprehension (NWA), Postive Writing Apprehension (PWA), External Teaching Efficacy (ETE), Personal Teaching Efficacy (PTE), and the Observed Variable of Content Area (CON) on Percieved Relevance of Writing (REL) and Efficacy of WTL (WTL)

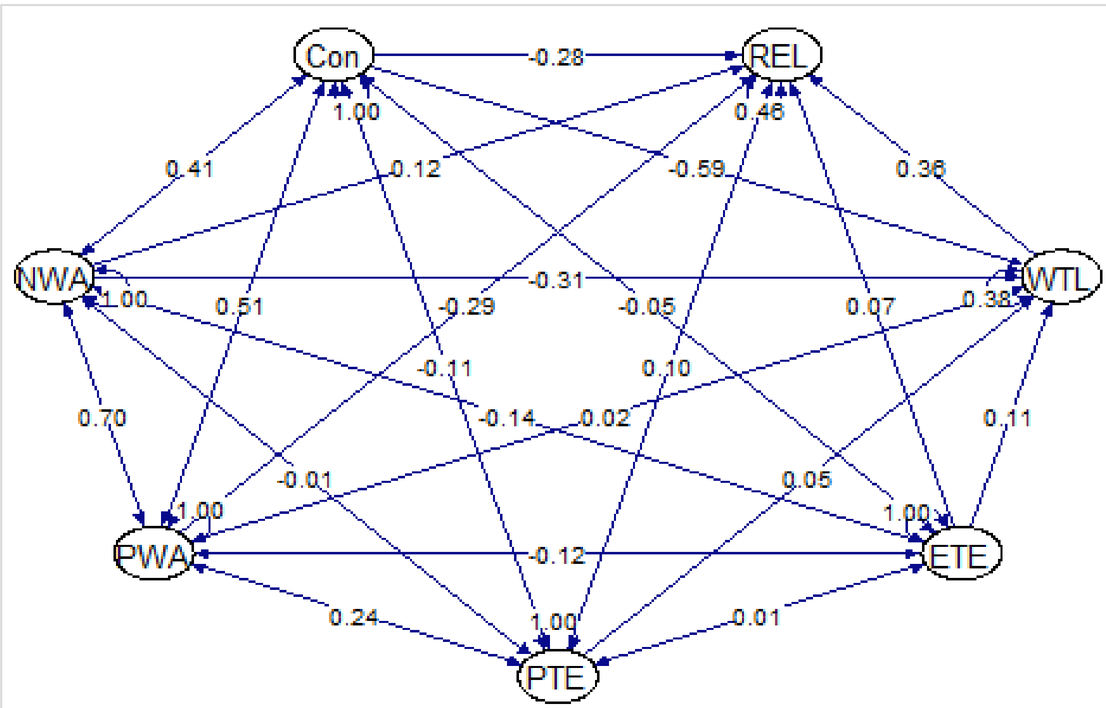


Table 11

Standardized and Unstandardized Regression Coefficients (β, B), Standard Errors (SE), z Statistics, and p Values for the SEM Model Testing the Effects of External Teaching Efficacy (ETE), Personal Teaching Efficacy (PTE), Positive Writing Apprehension (PWA), and Negative Writing Apprehension (NWA) on Teachers' Perceived Relevance of Writing and Efficacy to Use Writing to Learn (WTLE)

	Standardized				Unstandardized			
	β	SE	*z*	*p*	*B*	SE	z	*p*
Relevance of writing								
WTLE	0.37	0.18	1.99	0.05	0.19	0.09	2.19	0.03
ETE	0.07	0.07	1.10	0.29	0.15	0.14	1.06	0.29
PTE	0.10	0.07	1.51	0.13	0.26	0.18	1.43	0.15
PWA	-0.29	0.15	-1.89	*0.06*	-0.39	0.22	-1.77	*0.08*
NWA	0.13	0.16	0.77	0.44	0.28	0.36	0.76	0.45
Content	-0.28	0.13	-2.21	0.03	-0.24	0.12	-2.07	0.04
Efficacy of WTL								
ETE	0.11	0.07	1.55	0.12	0.45	0.29	1.56	0.11
PTE	0.05	0.08	0.63	0.52	0.24	0.38	0.62	0.54
PWA	0.02	0.19	0.11	0.91	0.05	0.48	0.11	0.91
NWA	-0.31	0.16	-1.98	0.05	-1.31	0.69	-1.91	0.06
Content	-0.59	0.08	-7.47	<001	-0.96	0.16	-5.96	<.001

Finally, a second structural equation model (*n*=172) was conducted to test the effects of both factors of writing apprehension on both factors of the teaching writing to learn scale using content area as a mediator. The model loaded with acceptable fit (*CFI*=1.00, *TLI*=1.03, *RMSEA*<.001). Direct effects, as shown in Table 12, show a positive correlation between content and positive writing apprehension, a negative correlation between writing to learn efficacy and content, a negative correlation between writing to learn efficacy and negative writing apprehension, and a negative correlation between relevance and content. Content showed a statistically significant indirect effect between the dependent factor of positive writing apprehension and the dependent factor of perceived relevance, and on positive writing apprehension on the dependent factor of efficacy of WTL. Content showed weaker indirect effects on negative writing apprehension and efficacy of WTL and negative writing apprehension and perceived relevance. The predictors for the perceived relevance and WTL efficacy models accounted for 48.4 percent and 60.9 percent of the variance, respectively. For content, 23.1 percent of the variance was explained by writing apprehension. Tables 12 and 13 give the factor loadings and the regression coefficients, and Figure 2 shows the path of the mediator model.

These results indicate that a teacher's content area may act as a mediating variable between their apprehension to write and their perceived relevance of writing in their classrooms and between their efficacy of using WTL.

Table 12

Standardized and Unstandardized Factor Loadings (EST), Standard Errors (SE), z Statistics, and p Values for the SEM Mediator Model

	Standardized				Unstandardized			
Factor and Item	**EST**	**SE**	***z***	***p***	**EST**	**SE**	***z***	***p***
Relevance of Writing								
Relevance of Writing 3	0.89	0.03	32.61	<.001	1.00			
Relevance of Writing 4	0.81	0.06	12.61	<.001	0.92	0.06	15.52	<.001
Relevance of Writing 5	0.84	0.07	12.55	<.001	1.15	0.10	11.35	<.001
Efficacy of WTL								
Efficacy of WTL 1	0.88	0.03	26.52	<.001	1.00			
Efficacy of WTL 2	0.95	0.02	52.50	<.001	1.14	0.07	17.38	<.001
Efficacy of WTL 3	0.91	0.03	35.52	<.001	1.13	0.08	13.67	<.001
Positive Writing Apprehension								
Positive Writing Apprehension 9	0.74	0.06	13.47	<.001	1.00			
Positive Writing Apprehension 17	0.82	0.05	15.76	<.001	0.92	0.10	8.88	<.001
Positive Writing Apprehension 19	0.69	0.06	12.19	<.001	0.65	0.08	8.24	<.001
Neg. Writing Apprehension								
Neg. Writing Apprehension 4	0.64	0.08	8.49	<.001	1.00			
Neg. Writing Apprehension 7	0.68	0.09	7.35	<.001	1.04	0.24	4.26	<.001
Neg. Writing Apprehension 13	0.63	0.09	6.99	<.001	1.09	0.18	6.05	<.001

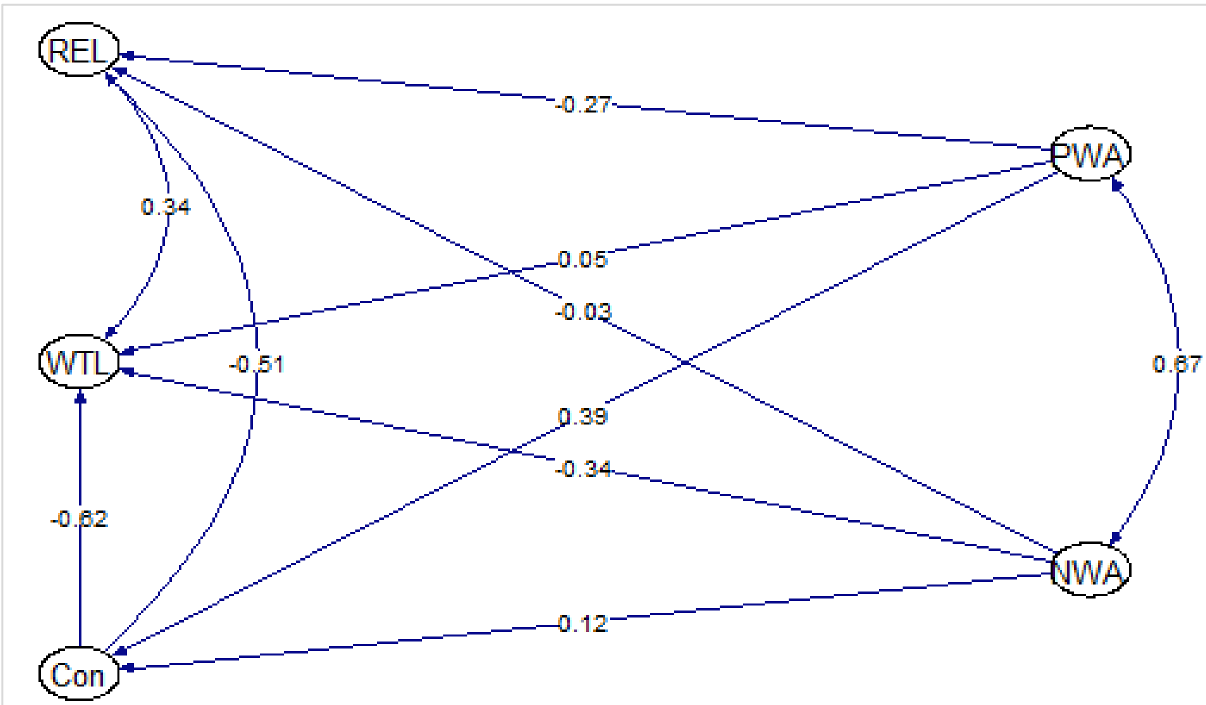
Table 13

Standardized and Unstandardized Regression Coefficients (β, B), Standard Errors (SE), z Statistics, and p Values for the SEM Model Examining the Indirect Effects of Content on Efficacy of WTL, Perceived Relevance of Writing on Negative Writing Apprehension (NWA), and Positive Writing Apprehension (PWA)

		Standardized					Unstandardized			
		β	**SE**	***z***	***p***		***B***	**SE**	***z***	***p***
Content										
	NWA	0.12	0.13	0.92	0.34		0.31	0.35	0.90	0.37
	PWA	0.39	0.13	3.03	**<0.00**		0.60	0.21	2.91	<.001
Efficacy of WTL										
	Content	-0.62	0.07	-9.13	**<0.001**		-0.99	0.15	-6.87	<.001
	NWA	-0.34	0.13	-2.66	**<0.01**		-1.37	0.55	-2.49	0.01
	PWA	0.05	0.14	0.35	0.73		0.13	0.36	0.35	0.73
Relevance of writing										
	Content	-0.51	0.07	-6.95	**<0.001**		-0.44	0.07	-6.34	0.00
	PWA	-0.03	0.14	-0.18	0.86		-0.06	0.32	-0.18	0.86
	NWA	-0.27	0.16	-1.75	0.08		-0.37	0.23	-1.63	<0.10
Indirect effects										
	NWA*WTLE	-0.08	0.08	-0.95	0.34		-0.31	0.34	-0.92	0.36
	PWA*WTLE	-0.24	0.09	-2.64	**0.01**		-0.60	0.24	-2.50	0.01
	NWA*REL	-0.06	0.07	-0.91	0.36		-0.14	0.16	-0.90	0.37
	PWA*REL	-0.20	0.07	-2.81	**<0.01**		-0.27	0.10	-2.62	<0.01

Figure 2

Standardized Regression Coefficients (β) of the SEM Model of Direct Effects of the Factors of Positive Writing Apprehension (PWA), Negative Writing Apprehension (NWA), and the Observed Variable of Content (Con) with Percieved Relevance of Writing (REL) and Efficacy of WTL (WTL)



6.0 Discussion

This study examined the effects of the latent factors of writing apprehension and teaching efficacy along with the observed variables of years teaching, grade level, and content area on the latent factors of the TWTLS. First, this study examined the evidence of validity and reliability of the latent factors of all the scales and then the fit of the entire model. Next, it examined the direct effects of the independent latent factors and observed variables on the dependent latent factors. Finally, it examined the indirect effects of the observed variables on the effects of the latent independent factors on the dependent factors.

6.1 Measurement Validity and Reliability

The teaching efficacy scale (Woolfolk & Hoy, 1990), writing apprehension scale (Daly & Miller, 1975), and the teaching writing to learn scale were analyzed separately with exploratory factor analyses and confirmatory factor analyses and then fit into a final model. The resulting model consisted of 19 items on six factors: (a) relevance of writing (three items), (b) efficacy of WTL (three items), (c) external teaching efficacy (four items), (d) personal teaching efficacy (three items), (e) positive writing apprehension (three items), and (f) negative writing apprehension (three items). Fit indices for each separate scale were acceptable. Reliability coefficients (α and ω) also indicated evidence of strong validity. Both SEM models, which included the observed variable of content area along with the latent variables, also showed acceptable fit indices. Thus, there is strong evidence for construct validity of the data from these models.

As shown in Table 6, Pearson's moment product *r* showed convergent validity evidence between perceived relevance and efficacy of WTL (r=.49), positive writing efficacy (r=-.36), negative writing efficacy (r=-.38), and between efficacy of writing to learn and positive writing efficacy (r=-.43) and negative writing efficacy (r=-.38). Weak or non-significant correlations were found between the dependent variables of perceived relevance and efficacy of WTL and with the factors of teaching efficacy, and the observed variable of years teaching.

ANOVA was used to examine the relationship between the factors of the teaching writing to learn scale and content areas. The results of the post-hoc analyses indicate strong relationships between the scale's factors and the teaching content area of secondary teachers. English/language arts teachers are more likely to feel confident using writing in their classrooms and find writing more relevant than social studies teachers. Social studies teachers are more efficacious in using writing and find it more relevant than science teachers, who are more efficacious and find writing more relevant than math teachers. Since English/language arts teachers are trained to use writing, and since social studies and science teachers are more likely to use writing in their teaching than math teachers, the results of these analyses provide evidence of concurrent validity of the data produced by the teaching writing to learn scale.

6.2 Direct Effects of the Independent Latent Factors and Observed Variables

The results from the bivariate regression analysis, as previously discussed, indicated typical correlations between the factors of the teaching writing to learn scale and the factors of the writing apprehension scale. Low correlations were found between the factors of the teaching writing to learn scale and teaching efficacy scale. As shown in Table 12, the results of the first SEM confirmed the results from the bivariate regression analyses. The model indicated stronger effects of the factors of the writing apprehension scale on the factors of the teaching writing to learn scale. Specifically, positive writing efficacy showed a negative effect (β=-.29) on perceived relevance of writing, and negative writing efficacy showed a negative effect (β=-.31) on efficacy of WTL. The factors of the teaching efficacy scale did not show noticeable effects on the factors of the teaching writing to learn scale. The results from the regression analyses and difference tests showed no effects of grade level or years teaching on the factors of the teaching writing to learn scale. However, as stated, content area showed effects on the ANOVA results and showed negative effects on both factors of the teaching writing to learn scale with β=-.28 for its effects on perceived relevance (and β=-.59) for its effects on self-efficacy of WTL.

The negative relationship between the factors of the WAS and of the teaching writing to learn scale indicates that higher apprehension to write correlates with lower efficacy of using WTL and less perceived relevance of writing. The negative relationship between content area and the factors of the WTLS indicates that the further away a teacher's content was from English/language arts, the less likely they felt confident in teaching writing in their classrooms, and the less relevant they found writing to be in their content areas. The results further indicate that self-efficacy of teaching, years teaching, and teachers' grade level have little correlation with the factors of the teaching writing to learn scale.

6.3 Indirect Effects of the Observed Variables

The results from the bivariate regression analyses and ANOVAs indicated little to no correlation between the factors of the WAS and years teaching or grade level. However, the results of the ANOVA indicated differences in the factors of the WAS and content area. In fact, these differences, like the difference found between the factors of the teaching writing to learn scale and content area, showed a progressive difference in means and effect sizes on the writing apprehension scale's factors given content area, with English/language arts teachers scoring the highest on the factors, followed by social studies teachers, science teachers, and math teachers. These results support the theory that content area may mediate indirect effects of writing apprehension on teacher WTL efficacy and perceived relevance of WTL. The results of the SEM mediation model show an indirect effect of content between positive writing apprehension and efficacy of WTL (β=-.24) and positive writing apprehension and perceived relevance (β=-.20). Content did not show strong mediation effects with the negative writing apprehension factor. These results suggest that writing apprehension may affect teachers' content area decisions, which then further influence their decisions to use writing in their classrooms.

7.0 Conclusion

The results of this study indicate that the effectiveness of implementing WTL across the content in English/language arts, social studies, science, and math in grades six through twelve may be influenced by the content area of the teacher being asked to implement it. This confirms the recent work of Gillespie et al. (2014) and Ray et al. (2016), both of which found preparedness to vary by content area. This also confirms the meta-analysis by Bangert-Drowns (2004), which found that effects varied by content area, with language arts showing the strongest effects. However, the more recent work of Graham et al. (2020) found nearly equal effects of WTL by content area learning. Further, the content area of the teacher may also be, in part, a function of that teacher's apprehension to write as measured by Daly and Miller (1975). Since different undergraduate programs require different levels and types of writing, majors that require less writing may attract preservice teachers who feel less confident about writing and who will thus be less likely to implement writing as a tool for learning in their classrooms.

Further, self-efficacy of teaching, as measured by Woolfolk and Hoy (1990), grade level, and years teaching show little to no effect on perceived relevance or efficacy of WTL. This suggests that administrators, educators, and others interested in WTL across the content should consider teachers' backgrounds and experiences with writing as a part of professional development, but not necessarily teacher efficacy or longevity. Further, professional development should focus on communicating the ways in which writing can benefit content areas like math and science. The literature shows a gap in empirical evidence of WTL on student learning of content. Further research should test WTL strategies using experimental and quasi-experimental designs. The results of successful WTL strategies should be presented to content teachers with empirical evidence of their effectiveness. Math and science teachers may be interested in concrete statistical evidence of effectiveness of WTL that goes beyond single case examples or demonstrations of journaling or other pedagogical strategies.

8.0 Directions for Future Research

This study measured theoretical dimensions relating to WTL and tested the effects of other latent factors and variables on those effects. In addition, though this study solicited over 3,000 potential participants, only 377 completed the study, and of those, only 157 completed all the items of the scales for the first SEM and 172 for the second. In addition, this study used one of many potential scales of teaching efficacy. As Woolfolk Hoy (2020) illustrates, there are many teaching efficacy scales. A different dimension of teaching efficacy may yield different results. This study should be replicated on a variety of teachers from more geographic areas and should include other content areas and primary educators. Finally, the dimensions of the teaching writing to learn scale only measure perceived relevance and efficacy of using WTL; they do not measure actual use of WTL across the content or other potential theoretical elements of any latent concept relating to teaching or using WTL. Therefore, the next step in this work is to try different models with different scales to try to test other latent factors that may relate to the implementation of WTL. In addition, there is a need to develop and test professional development, preservice teacher training, and other interventions on using WTL across the content; test the effects of those interventions; and then measure the effects of using the developed strategies on students in different content areas. Thus, the ultimate objective for future research is to develop intervention studies on WTL effectiveness.

Author Biography

Mark Perkins is an assistant professor of educational research at the University of Wyoming in Laramie. He previously served as the director of Institutional Research at Laramie County Community College in Cheyenne, WY. Prior to his graduate studies and professional work in educational research, he was a middle school English teacher in Colorado, which sparked his interest in writing. Outside of research methods and psychometrics, his other research interests include machine learning, data science, the connection between education and economics,

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Appendix A: The Items on the Final Model

Item number	Item content
Relevance of Writing 3	Writing is not really related to my content area.
Relevance of Writing 4	I don't think that writing is important in my area of focus.
Relevance of Writing 5	If I used writing, it would take away from the things I really need to teach.
Efficacy of WTL 1	On a scale from 1 to 10, this is how confident I am at using writing to help students learn the content of my class.
Efficacy of WTL 2	On a scale from 1 to 10, this is how confident I am at integrating writing activities in my class to help students learn my content area.
Efficacy of WTL 3	On a scale from 1 to 10, this is how confident I am in my knowledge about writing to use it to teach my content area.
Ext. Teaching Efficacy 13	If students are not disciplined at home, they are not likely to accept any discipline.
Ext. Teaching Efficacy 17	The amount a student can learn is primarily related to family background.
Ext. Teaching Efficacy 18	When it comes right down to it, a teacher really can't do much because most of a Student's motivation and performance depend on his/her home environment.
Ext. Teaching Efficacy 19	The hours in my class have little influence on students compared to the influence of their home environment.
Pers. Teaching Efficacy 1	When the grades of my students improve it is usually because I found more effective approaches.
Pers. Teaching Efficacy 2	When a student gets a better grade than he/she usually gets, it is usually because I found better ways of teaching that student.
Pers. Teaching Efficacy 6	When a student does better than usual, many times it is because I exert a little extra effort.
Pos. Writing App. 9	I would enjoy submitting my writing to magazines for evaluation and publication.
Pos. Writing App. 17	Writing is a lot of fun.
Pos. Writing App. 19	I like seeing my thoughts on paper.
Neg. Writing App. 4	When I take a class, I am afraid of writing essays when I know they will be evaluated.
Neg. Writing App. 7	My mind seems to go blank when I start to work on a composition.
Neg. Writing App. 13	Generally speaking, I'm nervous when I have to write.